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DOCKET NO: 70-36

LICENSEE: Combustion Engineering, Inc. (CE)
Hematite, Missouri

SUBJECT: SAFETY EVALUATION REPORT, AMENDMENT APPLICATION DATED MAY 1, 1989, AND SUPPLEMENTS DATED AUGUST 18, OCTOBER 26, AND NOVEMBER 8, 1989, RE USE OF NEW PELLET PRODUCTION LINES WITH ENRICHED URANIUM

I. Background

On September 30, 1988, CE informed the NRC staff of the intent to construct additional manufacturing space at the Hematite facility. This new manufacturing facility is a large extension that joins together two existing facilities, the pellet plant (Building 255) and the recycle area (Building 240). A major portion of the new manufacturing space will be dedicated to the use of two new pellet production lines. The remainder of the building is to be used for additional utilities, offices, and material storage. In addition to the construction of this manufacturing space, the September 30, 1988, letter included a discussion of the expansion of the shipping, receiving, and storage areas. By letter dated October 31, 1988, NRC expressed no objection to CE initiating construction of the additional space provided that soil survey results were submitted for NRC review prior to constructing any flooring. CE submitted those results on December 20, 1988, and on January 24, 1989, Oak Ridge Associated Universities conducted an independent confirmatory survey. Accordingly, on February 24, 1989, CE was informed that there was no objection to the construction of the flooring for the pelletizing and warehouse areas. CE has since completed this construction and has installed the pellet production lines. On March 22, 1989, CE requested authorization to startup and test the new pellet production lines with depleted uranium and to use the additional warehouse space for storage of licensed material. The NRC amended the license granting this authorization on July 28, 1989. On May 1, 1989, CE requested authorization for full scale production of the new pelletizing lines with enriched uranium. CE supplemented certain portions of the May 1, 1989, application on August 18, and October 26, 1989. In response to staff questions, CE further revised the application on November 8, 1989.

This Safety Evaluation Report is based on the review of the May 1, 1989, application; the August 18, October 26, and November 8, 1989, supplements; discussions with the Region III Project Inspector; and a site visit on August 24-25, 1989. Region III inspections were conducted on March 20-23, August 25, and November 13-17, 1989. No violations or safety issues were identified during the inspections.

The maximum uranium enrichment of 5 w/o U-235 and the maximum quantity of this material will not be changed with the proposed operations.

II. Description of Operations

A. Current Operations

CE is authorized to convert UF_6 to UO_2 powder in a series of three fluidized bed conversion reactors. UO_2 powder from the third reactor passes through a water jacketed screw cooler prior to further processing. The powder is then transferred to one of two storage silos. From the storage silos, the power is milled and blended. The blending operation is performed in four cylindrical vessels. The blended powder is then transferred either into cans for packaging and shipment or into 5-gallon pails for further processing and pellet fabrication. Current pellet fabrication activities are conducted in Building 255 and consist of agglomeration, granulation, pressing, dewaxing, sintering, grinding, inspection, and packaging operations.

B. Proposed Operations

Oxide Building

The process of converting UF_6 to UO_2 will not change. Changes associated with the new pellet production lines will occur after the cooler in the oxide building. When the new pellet lines are operating, the UO_2 powder will bypass the milling operation and the storage silos and will be transferred directly into only one of the blenders (Blender 4). From this blender, the powder will be transferred in 100 kg batches to a 1,000 kg bulk storage hopper. The bulk storage hopper will be transported to the new pellet production facility (Building 254) for further processing.

Recycle/Recovery (Building 240)

As an alternative to processing recycle material as feed to the existing pellet line, CE has proposed processing this material in the new pellet production lines. CE will transfer pails of recycled oxide powder into 100 kg recycle storage hoppers which then are transported into the new pellet production facility as feed material for the new pellet lines.

New Pellet Production Facility (Building 254)

Building 254 has two parallel pellet lines. Each line has the same equipment including one new oxide unloading hood, one recycle oxide unload hood, one mill, three blenders, and one pellet fabrication line.

Uranium oxide powder in the bulk storage hoppers and the recycle hoppers will be transferred to the oxide blenders. A hopper will be lifted above either the new oxide unload hood or the recycle unload hood, and the powder oxide will be fed from the hopper to the mill (micronizer) by means of a vibratory feeder. The milled powder will be transferred pneumatically to the oxide blender. Powder from several hoppers will be blended into a homogeneous batch by the action of air jets located at the lower end of the blender. Dry plant air will be used for the blending operation.

After blending, the uranium oxide powder will pass through a rotary valve in the bottom of the blender and will be pneumatically transferred to the receiver at the top of the pelletizing station. The powder will be passed through several process steps ending at the pellet press. The steps may include additions of poreformer, lubricant, and press fines; mixing; and will include agglomeration by dry powder slugging; and granulation. The granulated powder will flow by gravity to the multiple die rotary press. Green pellets from the press will be randomly loaded into boats. These boats will be processed through dewaxing and sintering furnaces. The sintered pellets will be processed through the grinding system, inspected, and packaged for shipment.

III. Nuclear Criticality Safety

A. General

CE has proposed moderation control as the main criterion for nuclear criticality safety of the new process. The moisture content of all material transferred to the recycle hoppers and the bulk storage hoppers will be maintained at $\leq$1 w/o water. In Part I of the application, CE has provided commitments to control the moisture content from the time of material transfer to the hoppers through final pellet pressing.

Prior to transfer of new UO_2 powder to the bulk storage hopper, two independent sets or moisture measurements will be made. The first will be an automatic dewpoint measurement in the hopper at the exit of the screw cooler in the oxide building. A high dewpoint reading will cause an alarm and an automatic termination of material transfer. The second measurement will be conducted in Blender 4 in the oxide building by sampling a representative mixture of the 100 kg batch and measuring the sample for moisture content. Once this second measurement is satisfactorily completed, the 100 kg batch may be transferred to the hopper. During the transfer of the product to the hopper, equipment design will be used to ensure moderation control. The hood arrangement at the connection between the blender and the hopper will prevent the ingress of extraneous moderating materials while the top flange cover is off. The hopper will be mechanically sealed with a flange to prevent moisture entrance during storage and transport.

Prior to the transfer of recycle material to the recycle hopper, each pail of powder will be sampled and measured for moisture content. Once the recycle hopper is full, it will be blended and a second sample will be taken and measured for moisture content. During transfer of the powder to the hopper, moisture will be controlled by equipment design in the same way as described above for the bulk storage hoppers. To prevent ingress of moderator material during storage and transport, the hopper will be mechanically sealed with a flange cover. In Part I of the application, CE has provided a commitment to close all moderation controlled units such that moderator cannot enter the units when out of protective hoods.

Once the hoppers are transported to the new pellet production facility, they will be placed in an unload hood to introduce material into the process. During unloading of the hoppers, moderating material will be prevented from entering the oxide stream by design of the unload hood. The only other entrance path for moderator (moisture) at the unload step is via the plant air supply employed for milling and blending. Utilizing the dewpoint measurement technique, two independent moisture detectors will measure the moisture in the plant air supply. The first is located at the exit of the air dryer, and the second is located ahead of the blenders at the exit of the air accumulator. A high dewpoint reading will cause an alarm and subsequent cessation of the process. Failure of any dewpoint measuring device will result in a false high indication which in turn will activate an alarm and initiate process termination. CE has committed to check and calibrate, every 6 months, all instruments used in determining moisture content.

Moderation control continues through the blending and pellet pressing process. Addition of binder and lubricant in batch quantities to the oxide powder will introduce negligible amounts of hydrogeneous material to the operation.

Nuclear criticality safety for the final processing of the green pellets (i.e., dewaxing, sintering, and grinding) is controlled in accordance with geometrical and concentration criteria currently established in Part I of the license.

B. Analysis

In Part II of the application, CE provided a safety analysis for the processes. The first computer analysis of the neutron multiplication factor (k-effective) for the process array deals with filling of the bulk storage hoppers in the oxide conversion building. The equipment includes the three conversion reactors (R-1, R-2, and R-3), the screw cooler, the two storage silos, the four blenders, the R-1 hopper, and a bulk storage hopper. The lower 10-inch diameter sections of Reactors R-1 and R-2 and blenders 1 and 2 were filled completely with 2.5 g/cc UO_2 powder and 1 w/o water. Reactor R-3 was assumed to be completely filled with 2.5 g/cc powder at optimum water moderation. The screw cooler was assumed to be filled with 3.5 g/cc UO_2 powder and 5 w/o water. The 0.5-inch thick water jacket which surrounds the screw cooler was also included in the model. CE assumed that the silos, R-1 hopper, and Blender 4 were completely filled and the bulk storage hopper was filled to the 1,000 kg level with 3.5 g/cc UO_2 powder and 1 w/o water. An external water mist of 0.001 g/cc was assumed, and the entire array was reflected by 12 inches of concrete with the exception of the roof which was modelled as 12 inches of water. CE reported that this array corresponded to an effective multiplication factor of 0.971 $\pm$ 0.003. CE conducted another analysis of the oxide conversion system using the same model as above, except for replacing the 2.5 g/cc UO_2 in the R-3 reactor with UO_2 at a density of 3.5 g/cc. The k-effective for this array was reported as 0.952 $\pm$ 0.003.

The second analysis concerned the transportation of the bulk storage hoppers through Building 255. The bulk storage hoppers will be transported through or stored in the east-west corridor of Building 255 between the north wall and the virgin powder and storage conveyors. Above this area on the mezzanine is the agglomerated feed storage area. CE assumed that the agglomerated feed buckets on the mezzanine were in a 6 x 8 array situated on a 24-inch edge-to-edge spacing. Each bucket was assumed to contain 41 kg of UO_2 powder at 5 w/o U-235 and 5 w/o water. The new powder cans located on the three double-high conveyors were modelled as six slabs with the height and width of the slab equal to the height and diameter of the can. The bulk storage hoppers were modelled as a 96-inch wide slab with a height equal to the top of the oxide level in a loaded hopper (53 inches). All slabs had a UO_2 density of a 3.5 g/cc, an enrichment of 5 percent U-235, and a water content of 1 w/o. A 12-inch slab of concrete represented the floor, the north, east, and south walls; and a 12-inch slab of water represented the west wall and roof. CE reported that this array corresponded to an effective multiplication factor of 0.847 ± 0.004.

The final analysis was performed on the front-end pelletizing process in Building 254. Fifty-four bulk storage hoppers, each filled with 1,000 kg of UO_2, were arranged in a manner to maximize neutron interaction between equipment. The six blenders were filled with 4,200 kg of UO_2. The two pneumatic transport lines were represented as 15-inch diameter right cylinders extending from floor to ceiling at the micronizer location. The two vertical arrays of equipment from the vacuum receiver on the third floor to the rotary press on the first floor were represented as 15-inch diameter right cylinders. The floor, north, west, and east walls were modelled as 12 inches of concrete, and the ceiling and heat wall was 12 inches of water. The density of UO_2 in all regions was 3.5 g/cc and the enrichment was 5.0 w/o U-235. The water content was assumed to be 1.0 w/o water with the exception of the two vertical cylinders representing the pelletizing array contained in addition to the 1 w/o water, 2.5 times the normal amount of poreformer and lubricant. Storage arrays of material on the second and third floors of Building 254 were represented as 13-inch slabs containing 3.5 g/cc UO_2 at 5 w/o U-235, and 1 w/o water, 1 w/o starch, and 1 w/o zinc sterate. CE reported that this array corresponded to an effective multiplication factor of 0.860 ± 0.004. Even though CE has assumed 2.5 times the normal amount of poreformer and lubricant in this analysis, controls were not established in Part I of the application to limit the poreformer and lubricant additions. Therefore, until these controls are added or a reassessment is conducted assuming no limits on the addition of poreformer and lubricant, the following license condition is recommended:

> The addition of poreformer and/or lubricant in the pelletizing process in Building 254 is not authorized.

To fully characterize the storage arrays on the second and third floors of Building 254, CE conducted an analysis evaluating the effect of water on this storage configuration. CE used the same model as above except that, in one analysis, CE reflected the third floor array with water. In another analysis, CE placed a water reflector between the third and second floor arrays. The corresponding k-effective values were 0.883 ± 0.004 and 0.816 ± 0.005. Based on this anaylsis, CE concluded that there is no need to limit hydrogeneous materials on the second and third floors. In Chapter 4, Part I, of the application, however, CE committed to a limited number of mop and poreformer/lubricant buckets on the second and third floors of Building 254. CE however, has failed to assess the effect of interspersed moderator between the units in the arrays which could result in a higher k-effective value. Therefore, until this assessment is conducted or a control is established in Part I limiting storage of interspersed moderator between these units, the staff recommends the following license condition:

> Storage of special nuclear material in storage arrays on the second and third floors of Building 254, as specified on page 8-11(1), Part II, of the application, is not authorized.

CE also conducted an analysis for infinite and finite arrays of bulk storage hoppers to examine the possible limitations on storage configurations. The most reactive condition was an infinite array of hoppers filled with 1,000 kg of UO_2 at a density of 3.5 g/cc, an enrichment of 5.0 w/o U-235, and water content of 1 w/o. The effective multiplication factor was reported as 0.867 ± 0.004.

CE calculations were performed using the 16-group cross section set along with KENO IV, a Monte Carlo code.

The staff confirmed these k-effective results with independent calculations using the 27-group cross section set which is found in SCALE, along with KENO Va, a Monte Carlo code. The staff gave special consideration to the calculated k-effective value of 0.971 ± 0.003 reported by CE for the oxide conversion array. The k-effective value for the array corresponds to an assumed loss of one of at least two required sets of limits and controls. Moderation control was assumed lost, and the reactor R-3 was filled beyond the control limit. The effects of moderator material (e.g., water) were evaluated in reactor R-3 in the overfilled condition. There are at least two independent controls which make the introduction of moderation unlikely. These include low temperature controls and alarms (to ensure that steam does not condense) and high pressure controls and alarms (to ensure that the fluid bed chemical reactor does not fill with uranium oxide). If the normal condition of dry (unmoderated) operations had been evaluated, the k-effective would have been shown to be below 0.35.

C. Double Contingency Principle Implementation

In Chapter 4, Part I, of the license, CE committed to the following design philosophy, "Process designs shall, in general, incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible." The implementation of this policy was reviewed and the staff concludes that the policy is adequately satisfied. Examples of specific implementation include: (1) double barriers for moderation controlled units; (2) dual, independent verifications of moisture content; and (3) use of low temperature and high pressure controls and alarms in the oxide conversion process.

IV. <u>Radiation Safety</u>

Staff has determined that CE's current radiation safety program, combined with 10 CFR Part 20 requirements, is adequate to protect the health and safety of the public.

V. Environmental Protection

NRC staff prepared an Environmental Assessment for the proposed activities at CE. Based on that assessment, a Finding of No Significant Impact was made pursuant to 10 CFR Part 51. The Finding was published in the Federal Register on May 24, 1989.

VI. Utilities/Support Building (Building 253)

In Section 1.7, Part I, the application includes Building 253 as an authorized place of use. However, the NRC review and confirmation of CE's soil survey results has proved to warrant additional decontamination. Therefore, until the staff determines that the soil has been adequately decontaminated, the following license condition is recommended:

> Building 250 (boiler room and warehouse) shall remain as an authorized place of use. Building 253 is not an authorized place of use.

VII. Conclusion/Recommendation

The staff concludes that the proposed activities will have no adverse effect on the public health and safety or the environment. Subject to the license conditions discussed above, approval of the amendment application is recommended.

The Region III Principal Inspector has no objection to this proposed action.

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