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21 October 1957

Class review notes 4.661 10/24

Mr. Lyall Johnson
Licensing Division
U. S. Atomic Energy Commission
1901 Constitution Avenue, N.W.
Washington, D. C.

SUBJECT: Special Nuclear Materials License No. SNM-33

Dear Mr. Johnson:

Reference is made to our Special Nuclear Materials License No. SNM-33 as amended and more particularly to that part of the license dealing with the operation of our uranium dioxide unit specifically limited to a maximum of 3% enrichment.

Since the issuance of this license as amended we have had inquiries from time to time regarding the conversion of uranium hexafluoride to uranium dioxide at assays between 3 and 5%. We have carefully examined this facility and find that a mode of operation is available in the equipment as currently installed which, we believe, makes it possible to operate safely with assays up to 5%.

A description of the proposed method of operation is attached along with pertinent criticality calculations.

We are specifically requesting an amendment to SNM-33 which will include this method of operation and permit us to operate this particular facility at enrichments up to 5%.

We would appreciate your prompt consideration of the enclosed application. If any additional data are required we will be glad to furnish same on short notice in order to expedite the issuance of this amendment.

E-51

Very truly yours,

Frederick M. Belmore

Frederick M. Belmore
Special Asst. to the President

DOCKETED USAEC Division of Civilian Application OCT 23 1957 RF Docket Officer

FMB:dj
Enclosures

cy Jan 10/25/57

(Not under oath or affirmation)

DOCKET NO. 70-36

APPLICATION FOR LICENSE AMENDMENT IN THE LOW ENRICHMENT FACILITY

A. Present licensed procedures for 3% maximum assay.

Briefly, our current license as amended permits us to operate installed equipment using uranium hexafluoride as the feed material up to 3% assay. The uranium hexafluoride is received from the Commission in MD type cylinders measuring approximately 10" in diameter by 40" in length, each cylinder containing a limited safe batch of the particular assay involved. The cylinder is heated to completely liquify the UF_6. The UF_6 is then withdrawn as a gas and hydrolyzed as an individual batch, precipitated and filtered. The identity of the batch is maintained throughout the processing to insure criticality control. After filtration the entire batch is loaded into a drying oven to accomplish complete moisture removal. The product is then loaded into a furnace box where the final reduction to uranium dioxide occurs. After cooling, the product in the box is unloaded, ground, and packaged in an individual container. The containers are stored in suitably designed and approved birdcages for storage and shipment. These birdcages maintain a spacing of two feet between edges of individual containers to prevent a critical accident.

B. Proposed mode of operation for 3% to 5% assay.

The experience gained in operating this plant over the past year has indicated to us that modification of our method of operation should permit completely safe operation using uranium with up to 5% U_{235} content. The proposed method of operation would be as follows:

1. The receipt of UF_6.

For assays from 3 to about 3.9% the UF_6 would be requested in the standard MD cylinder currently used, with each cylinder containing a limited safe batch for the assay involved. This would cover the range of from 88 down to approximately 52 pounds of U contained per cylinder. For assays from 3.9 to 5% the small (approximately 6" diameter "always safe") cylinder would be the requested shipping container for the UF_6, each cylinder to contain not more than the limited safe batch. Since this cylinder will only hold 60 lbs. of UF_6, less than a limited safe batch would be contained in the cylinder until an assay of approximately 4.6% was obtained, above which assay the cylinder would contain less than a full charge.

2. Hydrolysis operation.

The hydrolysis operation would be carried out in a manner identical to that used in our normal operation. The individual cylinders would be hydrolyzed as a complete batch and the batch moved forward to the next operation before the next cylinder would be placed in the hood prior to hydrolysis.

3. Filtration.

Following the hydrolysis and precipitation the batch would be filtered on the currently installed filter press to receive the entire charge of solids. The filtrate would be handled in a manner identical to that now employed under the present terms of our license.

4. Drying.

We currently have two drying ovens installed in this production area. The adjacent sides of these ovens are separated by slightly more than 24 inches to insure adequate spacing to prevent nuclear interaction between batches. The ovens contain 16 shelves on 3 inch centers. For operation between 3 and 5% enrichment we are proposing making essentially two ovens out of each installed oven by blocking off the center eight trays with steel bars. This would allow us to use the upper and lower portion of each oven for individual batches, the two batches being separated by 24 inches of blank space which is adequate to prevent nuclear interaction.

5. Reduction Furnace Operation.

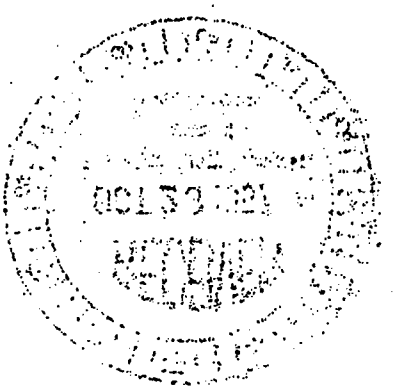
The furnace box as currently licensed is loaded with one limited safe batch per cycle. We are proposing for operation between 3 and 5% assay to essentially duplicate the technique described for the drying oven. These furnace boxes receive a maximum load of 21 trays in three tiers of seven each. For operation in the 3 to 5% range we are proposing essentially to load the box in such a manner as to make it two furnace areas. Seven trays of product or a limited safe batch, if this is contained in less than seven trays, will be loaded at the back of the reactor. An empty set of seven inverted trays will be placed in the center section of the box and another seven trays or a limited safe batch, if contained in less than seven trays, will be placed at the front of the reaction box. This will maintain a spacing between the two batches of a minimum of 16". The material enters the reaction box following a drying operation which essentially removes all moisture. (Analytical information collected over the past few months has indicated that the product at this point has a maximum H:U ratio of 4:1.). The reduction furnace operates at a temperature well in excess of 250°F at all times and during the course of the reaction the H:U ratio is continually reduced to essentially zero at the end of the reaction. Under these circumstances we feel that a spacing of 16" between batches and the low H:U ratio insures complete nuclear safety. This conclusion, we believe, is further substantiated by calculations made on the basis of criticality data obtained from Dr. A. D. Callihan on 4.9% enriched U_3O_8 moderated by Sterotex. These calculations are attached as Appendix I.

6. Final Packaging.

The furnace box following the reduction cycle and cooling will be unloaded as two separate batches. The first group of seven trays at the front of the box will be unloaded, ground, and packaged as one lot, which lot will then be removed from the packaging station prior to the unloading of the second batch. The individual lots will be stored in birdcages of approved design to prevent interaction between batches prior to shipment and during shipment.

C. Conclusion.

Based on the above proposed method of operation and data collected during the past few months of production on material below 3% we believe the plant facilities to be entirely adequate for handling UF_6 at enrichments between 3 and 5%. We believe the comparison with Dr. Callihan's data substantiates these conclusions.



APPENDIX I

CRITICALITY CALCULATIONS ON THE REDUCTION FURNACE OPERATION

Basic Facts:

1. Ammonium diuranate cake from the dryer has been shown repeatedly by analysis to contain 4 hydrogen for each uranium atom as a maximum H:U ratio.

2. Tray capacity in the reduction furnace by actual plant experience has been shown to be between 8 and 12 pounds of UO_2 product depending upon the type of product being made.

3. Data from Dr. A. D. Callihan, Oak Ridge, Tennessee, taken on 4.9% enriched U_3O_8 moderated by Sterotex and taken on a cubic structure are partially listed below:

H/X	Density grams U_{235}/liter	Critical Mass, kg
145	83	8.8
160	73	7.9
200	65	6.2
245	55.5	5.1
320	49	3.9

Assumptions:

For the purpose of our safety calculations on our furnace box operations, we are assuming the following:

1. Because of the possibility of error in analyses we are using 8:1 H:U ratio in the following calculations. This value should not change with assay although the corresponding H/X ratio will be effected by assay.

2. A maximum tray loading of 15 lbs. UO_2 will be assumed. The maximum number of trays under the operating conditions described will be 14.

Calculations:

Therefore, based on the above facts and assumptions, the H/X ratio in our furnace box will have the following values:

At 3% enrichment $\quad 8 \times \frac{1}{.03} = 267$

At 4% enrichment $\quad 8 \times \frac{1}{.04} = 200$

At 5% enrichment $\quad 8 \times \frac{1}{.05} = 160$

The maximum quantity of UO_2 in the furnace will be 14 x 15 = 210 lbs. UO_2

$$210 \times 88\% = 184.8 \text{ lbs. of U}$$

$$\frac{184.8}{2.205} = 83.81 \text{ kg of U}$$

Therefore, at 3% enrichment the box could contain a maximum of

$$83.81 \times .03 = 2.514 \text{ kg of } U_{235}$$

at 4% enrichment the box could contain a maximum of

$$83.81 \times .04 = 3.352 \text{ kg of } U_{235}$$

at 5% enrichment the box could contain a maximum of

$$83.81 \times .05 = 4.1905 \text{ kg of } U_{235}$$

It should be pointed out that in all cases the furnace box loading anticipated in actual operation will not attain the maximum quantities so calculated and the main purpose of these calculations is to demonstrate the inherent safety of the proposed operation allowing ample safety margins with regard to both moderation and quantity in making the calculations.

Although the uranium is not uniformly distributed in our box, we believe a calculation showing uranium density is warranted. To simplify this calculation, we are assuming (a) the uranium to be uniformly distributed in the box and (b) two sets of trays not separated by a blank tray spacing. The volume occupied by the uranium would be, therefore,

$$14\text{"H} \times 32\text{"L} \times 21\text{"W} = 9{,}408 \text{ in}^3$$

$$9{,}408 \times 16.387 = 154{,}169 \text{ ml or}$$

154.2 liters volume

The U_{235} density at 3% enrichment could be

$$\frac{2514 \text{ grams}}{154.2 \text{ liters}} = 16.3 \text{ g/l maximum}$$

The U_{235} density at 4% enrichment could be

$$\frac{3352 \text{ grams}}{154.2 \text{ liters}} = 21.74 \text{ g/l maximum}$$

The U_{235} density at 5% enrichment could be

$$\frac{4190.5 \text{ grams}}{154.2 \text{ liters}} = 27.18 \text{ g/l maximum}$$

Conclusions:

The above calculations based on actual operating experience with this equipment indicate:

1. That the quantity of U_{235} contemplated in the reaction box at the density and H/X ratio which are to be expected fall well below the critical values obtained by Dr. Callihan's research on a perfect cubic structure by a factor of approximately 2 in every case so calculated.

2. Since our proposed operation contemplates a division of the quantity of U by a minimum of 16" between halves, we feel, therefore, that the proposed operation offers considerable safety factor and that no single mistake could cause a critical accident.

3. Since each batch being processed will be of limited safe quantity, and will maintain its identity throughout the process, we believe the proposed mode of operation is adequately protected from a safety consideration by at least two independently controlled factors.