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ANALYTICAL AND INDUSTRIAL PURPOSES

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SECOND AND MALLINCKRODT STS. ST. LOUIS 7, MO.

May 15, 1956

70-36

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Mr. Lyall Johnson
Chief, Licensing Branch
Division of Civilian Application
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Johnson:

Enclosed are three executed copies of an application for a license to handle special nuclear material.

You will note than an Appendix I, marked "Company Confidential," has been attached to the main body of the application. We request that this Appendix be not disclosed to the public or to AEC employees whose duties do not require them to have access to the information contained therein, for the following reasons:

(1) that the detailed procedures and techniques set forth in the Appendix are the result of Mallinckrodt research and development programs in the course of which its own employees, facilities and financing were exclusively utilized,

(2) that these procedures and techniques are in the nature of "trade secrets" which should be protected against disclosure to competitors and other third persons, and

(3) that these procedures and techniques are included only for the purpose of providing the AEC with a fuller explanation of the process to be used than is necessary under the applicable regulations and might, therefore, be considered as not a required part of the application.

For your further information, the process proposed to be used in the production of enriched UO_2 in the new plant at Hematite, Missouri, is presently being utilized in our pilot plant for the production of normal UO_2. The present operation is identical in process, batch size and equipment to that planned for the new plant. By the time operations are ready to begin at the new plant, we will have produced more than 2,500 lbs. of UO_2 from normal UF_6. In producing this quantity of normal UO_2, we will have trained a nucleus of personnel for the new plant and obtained valuable operating data which should eliminate many of the difficulties otherwise present in starting the new plant.

G-1

We would appreciate your prompt consideration of the enclosed application because of the rather tight schedule involved in the Westinghouse production. If any additional data are required, we will be pleased to furnish the same on short notice in order to expedite issuance of the license.

Very truly yours,

Frederick M. Belmore

Frederick M. Belmore
Special Asst. to the President

FMB/VHK
cap

Enclosure (3)

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SECOND AND MALLINCKRODT STS. ST. LOUIS 7, MO.

APPLICATION FOR SPECIAL NUCLEAR MATERIAL LICENSE

1) Applicant: Mallinckrodt Chemical Works, incorporated in the State of Missouri and having its principal office at 3600 North Second Street, St. Louis 7, Missouri.

The names, addresses and citizenship of applicant's principal officers (all of whom are U. S. Citizens) are as follows:

Edward Mallinckrodt, Chairman of Board, [redacted] Missouri.

Charlton MacVeagh, Vice-Chairman of Board and Treasurer, [redacted] Missouri.

Ex. 6

Joseph Fistere, President, [redacted] Missouri.

Harold E. Thayer, Vice-President, [redacted] Missouri.

John R. Ruhoff, Vice-President, [redacted] Missouri.

The applicant is not owned or controlled, directly or indirectly, by any alien, foreign coporation or foreign Government.

2) The activity for which the special nuclear material license is requested is the production of enriched uranium dioxide. Applicant intends to process special nuclear material of all enrichments pursuant to the requirements of its customers.

The activity is to be performed at a new plant under construction by the applicant located near the Village of Hematite, Missouri, on Missouri Highway Route 21-A approximately 5 miles west of Festus in Jefferson County, Missouri and approximately 40 miles from the City of St. Louis, Missouri. The process involves the conversion of enriched UF_6 to UO_2 of the same enrichment. The plant is being designed so that batch sizes of less than "always safe" amounts for the specified enrichment will be used. Additional safety will be designed into the plant by using, where possible, "always safe" geometry of tanks and other equipment, by use of spacing devices to prevent more than one batch being placed immediately adjacent to another and by use of materials of high "cross section". Movement of batches within the plant will be under the control of an inspector whose main function will be to control the movement of each batch of material from its arrival at the plant until it is shipped to the user.

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The initial processing operation under the license herein applied for is the production of UO_2 for the Westinghouse Electric Corporation to be used in the preparation of fuel elements for the Belgian Thermal Reactor. The references in the following paragraphs of this application to amounts of special nuclear materials, enrichments, deliveries, operating losses, batch sizes, etc., are in connection with the supply of enriched UO_2 to Westinghouse for the BTR. In the event the applicant supplies UO_2 of higher enrichment than required by the present Westinghouse order or makes material changes in the processing operations described herein, it will apply for any necessary amendment to the license granted pursuant to this application.

3) This license is requested for a period of five years.

4) As stated previously, applicant proposes to convert UF_6 of any enrichment to UO_2 of the same enrichment. In general, applicant will process material allocated to prime users who in turn, will furnish material to applicant in enrichment and quantity they desire to be processed. Thus, quantity and enrichment can not be specified in advance of specific orders from prime users. Normally, it is expected that the material will be received in the form of UF_6.

In the case of the material for the Belgian Thermal Reactor, it is presently planned that sufficient UF_6 of 4 to 5% enrichment will be supplied to applicant by Westinghouse to permit the production of 6,000 to 10,000 pounds of UO_2. The exact quantity and enrichment required has not yet been determined by Westinghouse. The batch sizes and procedures described later in this application are intended to cover the processing of material enriched up to 7½% in U^{235} since this was the maximum enrichment specified by Westinghouse at the time it was necessary to freeze plant design.

5) The first shipment of special material for the BTR is desired on or about July 1, 1956 and all shipments of enriched UF_6 for this order are to be completed on or about October 1, 1956. Requests for the delivery of the material from the Commission will be made by Westinghouse, although it is presently planned that the material will be delivered into Mallinckrodt's custody at the Commission facilities. Operating losses are expected to be in the general area of 1%. The product will be transferred to the Westinghouse Electric Corporation as soon as it is produced and analyzed.

6) Applicant has operated uranium refining and processing plants for more than 12 years. In addition, the applicant makes many chemical products where problems associated with purity, toxicity and value of the material require rigid control from the technical health, safety and accountability standpoints. As a result, the applicant has a large reserve of technical manpower qualified to handle the problems associated with the processing of special nuclear materials.

The principal technical staff members involved in carrying out the work covered by this license application all have experience in the field of uranium processing. A brief description of the experience and training of the principal technical staff members follows:

Frederick M. Belmore

B.S. (in Chemistry); B.S.E. (Chemical Engineering), University of Virginia. Nineteen years experience in chemical industry in research, development, production and management, of which more than 13 years were in the field of atomic energy. Six years with du Pont as chemist and chemical engineer leaving position as Assistant Technical Director. Tetra Ethyl Lead Plant in 1943 to join newly organized Manhattan Project. From 1943 to 1954 was employed in various capacities by the Manhattan District and the Atomic Energy Commission in connection with the production of uranium metal and uranium compounds. Resigned as Deputy Manager, New York Operations Office in 1954 to return to private industry. Now Special Assistant to the President of Mallinckrodt and in charge of the Special Metals Division which includes Mallinckrodt's commercial uranium activities.

W. M. Leaders

B.S., Ohio University, and Ph.D., Mass. Inst. of Tech., (in Chemistry). 8 years experience in research, pilot plant and production of edible and inedible fat and oil products. 3 years at Oak Ridge in research—pilot plant on isotope separation and other types of uranium purification processes, including solvent extraction and distillation. 5 years with Uranium Division of Mallinckrodt in charge of process development relating to all phases of uranium metal production. Now Technical Assistant in the Special Metals Division.

G. W. Tompkin

B.S. - Ph.D. (Chemistry) University of Colorado - 1 year teaching experience in Radio Chemistry, at University of Colorado. 5 years industrial research and development at Mallinckrodt. Currently in charge of pilot plant producing uranium dioxide from uranium hexafluoride as prototype material for commercial reactor evaluation.

D. E. Rhodes

B.S. - M.S. (Chemistry) University of Nebraska. 5 years experience in Uranium Division of Mallinckrodt in research and development on all phases of normal uranium production.

J. A. Rode

B. S. (Chemical Engineering) - University of Texas. 1½ years research on hydrogen and bromine at University of Texas. 3 years in process development with Uranium Division on problems associated with uranium metal manufacturing.

G. C. Hemkens

B. S. (Chemistry) St. Louis University. 3 years with Mallinckordt in laboratory and development work in connection with extraction and purification of uranium from crude concentrates., Currently acting as shift supervisor of pilot plant producing uranium dioxide from uranium hexafluoride.

7) General equipment and facilities to be utilized by applicant to protect health and minimize danger to life and property are as follows:

Separate "clean" and "dirty" locker facilities

Showers

Protective Clothing

Laundry facilities

Film Badges

Survey Meters

Room monitors sensitive to gamma radiation connected to alarm system

Air Filters

Air Samplers

Vacuum Cleaning System

Dry boxes for handling all uranium containing material of dusty nature

Hoods for use in handling UF_6

"Always safe" diameter cylinders for UF_6 received from AEC.

"Always safe" diameter containers for packing UO_2 product.

"Bird cages" for use in transporting and storing UF_6 and UO_2.

Storage facilities for UF_6 and UO_2 separate from each other and from other buildings. Separate storage facilities will also be provided for each enrichment handled at any one time.

Separate processing facilities for each enrichment handled at any one time.

Design of process equipment to conform insofar as possible to "always safe" geometry or to contain no more than "always safe" quantities of the enrichment being processed.

8) The operating procedures for the plant are based on providing maximum safety to operating personnel, other employees and to the public. In general, these procedures are set up to prevent criticality and exposure to radio-active or toxic materials as well as to protect against the more common industrial hazards. Details of the processing methods are given in the attached Appendix I which is classified "Company Confidential".

All enriched UF_6 to be processed in this facility will be packaged in "always safe" diameter cylinders by the A.E.C. Contractor from whom it is obtained, and each cylinder will be placed in a "bird cage" before it is loaded on applicant's truck. The "bird cages" are the applicant's property and their design has been based on discussions with Dr. A. Dixon Callihan at Oak Ridge. The "bird cages" (two are shown with cylinders in Mallinckrodt sketch 5831 attached) are so designed that a spacing of two feet will be maintained between cylinders.

UF_6 cylinders placed in "bird cages" will be transported from the A.E.C. site of origin to the plant at Hematite, Missouri, in applicant's truck or a truck leased for the purpose. A "Q" cleared technically trained employee of the applicant will accompany each shipment. Upon arrival at the plant, the cylinders of UF_6 will be placed in a concrete block storage vault. The cylinders will remain in the "bird cages" in storage and no cylinder will be removed from its "bird cage" until it is introduced into the manufacturing process under strict control of technically trained supervisors.

Uranium hexafluoride of only one enrichment level will be stored in a single storage vault, and no other material will be stored with the UF_6. When more than one enrichment is being processed at one time, a separate storage vault will be provided for UF_6 of each different enrichment. The storage vaults will be under the control of the technical supervisor who will be responsible for all material movement from the time it reaches the plant until it is shipped.

As stated above, UF_6 cylinders will be stored in "bird cages" in the storage vault until required in the process. Operators will be required to obtain approval from the technical supervisor before moving a cylinder (still in its "bird cage") to the operating floor. When a new cylinder is brought to the hood housing the first step in the process, it will then be removed from its "bird cage" for the first time and placed in its proper place in the hood. The empty cylinder removed from the hood will be placed in the now empty "bird cage" where it will remain until the empty cylinder is returned to the A.E.C. and a full cylinder placed in the cage for delivery to the Hematite plant.

Details of the processing operation have been given in Appendix I. All operations involving toxic materials will be carried out in hoods or dry boxes. In general, wet operations will be in hoods and those in which radioactive dust might be generated will be in dry boxes. Operations will be on a batch basis and each batch will be limited to 14 pounds of UO_2 or UO_2 equivalent. Equipment is sized to hold no more than this quantity except where it has been possible to design the equipment to "always safe" dimensions. In the latter event, applicant has used 5" as maximum diameter and 4" as maximum thickness depending on the type of equipment involved.

At the completion of the processing operations the UO_2 will be packaged in 14# batches in polyethylene bottles slightly less than 5" in diameter. Three of these "always safe" bottles will be placed in a specially designed "bird cage" one bottle on top of another, but each separately supported, to form a discontinuous cylinder 5" in diameter. The UO_2 will be stored in the "bird cages" in a product storage vault similar to, but completely separate from the vault in which the incoming UF_6 willbe stored. Upon accumulation of a lot, the UO_2 will be shipped in the "bird cages" to the user on a truck owned or leased by applicant.

In the preceding paragraphs, some of the procedures for transporting, storing and processing the enriched materials have been outlined. Numerous other procedures will be in effect in the plant to protect health and minimize danger to life or property. Some of these procedures are included in the outline of the programs for health control, material control and criticality control which follows:

Health Control

1) All employees will be thoroughly screened prior to employment on this work to determine that they are in top physical shape, have no noticeable lung defects as detected by x-ray, have no detectable urinary albumin, and have normal blood count.

2) A quarterly check for blood count and urine analyses on all employees will be made regardless of their work activities at this plant, and more frequent checks will be made if it is suspected that a man has been exposed to large concentrations of uranium dust or if his radiation film badge indicates high radiation dosages.

3) Radiation film badges for detecting radiation will be supplied to all employees and developed on a biweekly basis to determine their body exposure.

4) For employees operating dry boxes, a wrist type film badge will also be used to determine radiation exposure to hands and forearms. These badges will also be developed on a biweekly basis. It is contemplated at the present time that Nuclear Corporation of America, which has a St. Louis plant, will be the supplier of film badge service.

5) A complete annual physical checkup of all employees will be given which will include chest x-rays.

6) The technical and supervisory personnel will all be trained in simple first-aid and a dispensary containing first-aid equipment will be available at Hematite. It is not contemplated that a fulltime nurse will be available at the Plant at the present time but will be added when employment increases.

7) Personnel Safety - The hazards that will have to be provided against at the Hematite Plant are primarily:

1) Possibility of HF generation through the hydrolysis of UF_6.
2) Airborne uranium dust.

To protect personnel from these hazards, the following steps are planned:

a) All hydrolyses operations will be carried out under hoods. These hoods will be exhausted to the atmosphere through wet scrubbers to stop the accidental dispersal of HF fumes into the surrounding atmosphere.

b) For additional protection of the men operating this hydrolysis equipment, it will be standard procedure for the Chief Operator to wear a polyethylene suit designed for work around HF and the Assistant Operator to wear face mask and apron while assisting in the hydrolysis operation.

c) The remaining operations in the preparation of UO_2 will be essentially dry processes. The operators will be required to wear standard dust respirators while performing operations and handling product throughout the line.

d) All points that may be dust generating will be surrounded by local air pickup to minimize the general atmospheric dust burden.

e) Extreme dust operations, such as grinding or transfer of dry material from one tray to another and packaging will be performed in dust hoods to localize airborne dust and simplify the ventilation problems for the general manufacturing area.

f) Air supply to the room will be filtered and cooled to maintain comfortable working conditions.

g) Periodic dust samples of the general room atmosphere will be taken by a representative of the Health Physics Department to determine the actual airborne dust as well as the localized dust generation. If it is found that any operation is producing more than the desired amount of dust, additional precautions and/or changes in design will be undertaken immediately.

h) The Health Physics Department will also make periodic checks of the airborne dust contamination down-wind from the plant to determine stack losses.

i) Health Physics monitors will also check the ground around the plant site on a periodic basis to determine what, if any, fallout is occurring as a result of stack losses.

Material Control

In order to comply with A.E.C. health recommendations for both air and stream contamination, and because of the high value of the material, special precautions will be taken to minimize stack losses and the soluble uranium carried in our waste water. To accomplish these purposes, the following is planned:

1. All hydrolysis hoods will be vented through wet scrubbers, probably of the Roto-Clone variety. The reason for this is two-fold:

    a) If there is an uranium hexafluoride leak, the gas will hydrolyze instantly on contact with air to form HF and fine airborne UO_2F_2. These materials are both extremely water soluble and will be effectively recovered by using a Roto-Clone. This will prevent pollution and material losses from the plant.

b) All dust operations will be exhausted through high efficiency dust collectors, either of the wool bag type or of the disposable pad type such as designed by the Chemical Warfare Service. Both of these filters are efficient in excess of 99% and permit simple recovery procedures to be used to recover and recycle the dust collected.

All air to the building will be filtered prior to admission to reduce the dust load on the dust collectors.

2. All plant effluents will be treated in one of two ways:

a) If the value of the uranium is less than $200.00/lb., it is planned that the water will be precipitated by lime addition to precipitate uranium and fluoride values, filtered, and the filtrate tested prior to dumping to the streams. The cake will be stored for recovery.

b) In the case of higher value material in excess of $200.00/lb., waste waters containing this material will be evaporated to dryness to simplify the recovery process. Steam from the evaporators will probably be condensed and used as makeup water in the plant.

These provisions are planned to insure that applicant does not contaminate either the surrounding atmosphere or the streams into which effluent is discharged.

Criticality Control

To prevent the assembly of a critical mass, following safety precautions are being adopted:

1) Incoming uranium hexafluoride of assay in excess of 4% U^{235} will be received in "always safe" cylinder size. This is the cylinder that is used to transfer UF6 from the diffusion plants. Its dimensions are essentially 5 in. inside diameter by 30 in. length and will hold 55 lbs. of UF_6. Highly inaccurate!

Dr. A. D. Callihan, of Oak Ridge, has been contacted for advice in proper spacing of these cylinders to insure an "always safe" geometry. On Dr. Callihan's advice, applicant will maintain a minimum of 2-ft. spacing between cylinders during shipment and storage through the use of "bird cages" as previously stated.

MALLINCKRODT CHEMICAL WORKS

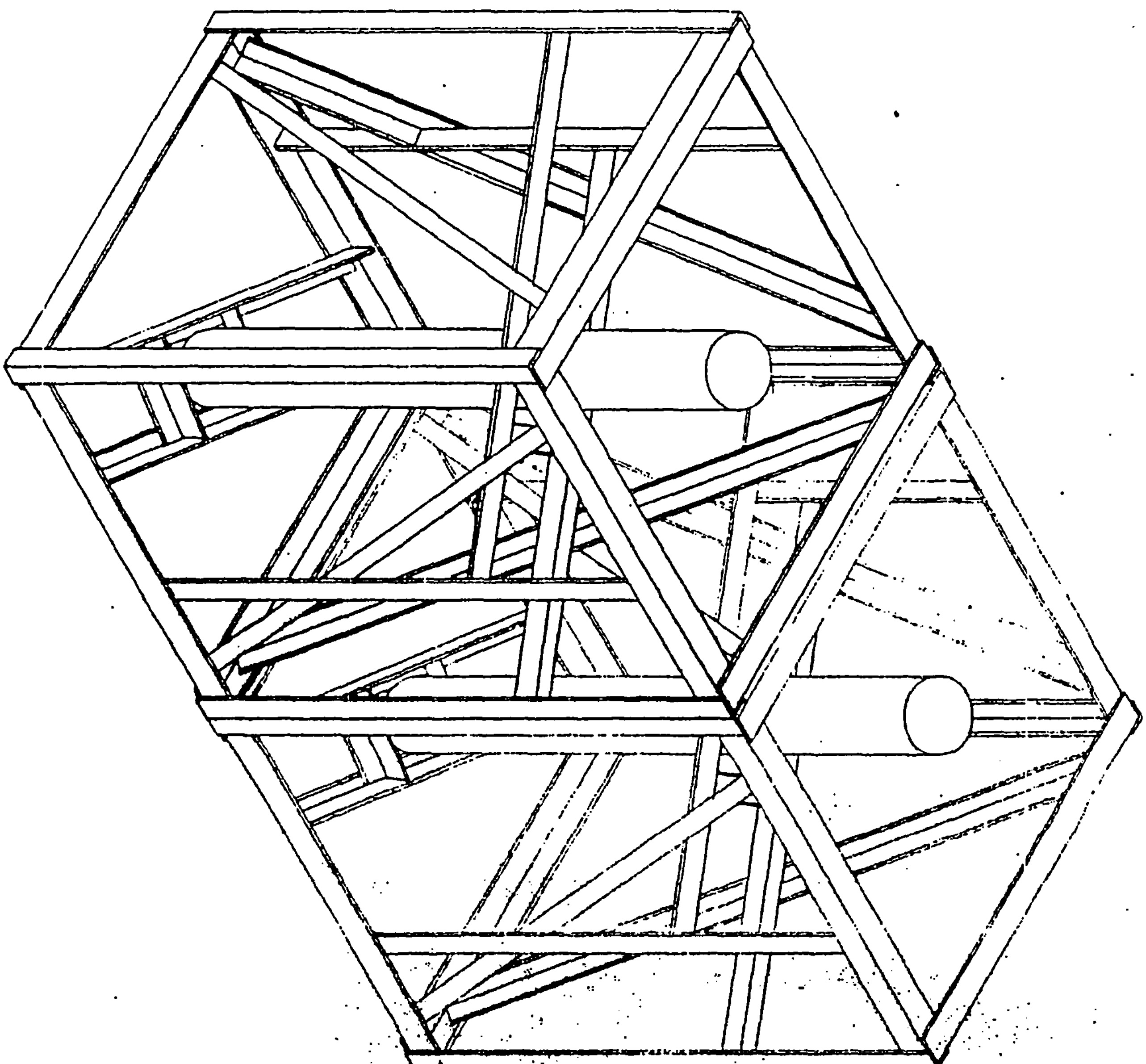
ENGINEERING DEPT.

COMPUTATION SHEET

PLANT [illegible] BLDG.

DATE [illegible] SUBJECT ISOMETRIC OF WITHDRAWING CYLINDER CONTAINER Sketch No. [illegible]

WITHDRAWING CYLINDERS IN CONTAINERS



L7793

Signed [illegible] P No. E No. 503 Scale 1" = 1'-0"