

**UNITE NUCLEAR**  
CORPORATION  
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**SUBJECT:**

Description of Equipment and Facilities  
Green Room

ISSUED July 15, 1963

SUPERSEDES

302. Green Room (Reference Drawing 3712-202, Area 240-3)

The Green Room is utilized for the conversion of  $UF_6$  to  $UO_2$  for U-235 enrichments up to and including 6%. A detailed plan view is shown on Figure 21.

The process consists of:

1. Hydrolysis of  $UF_6$  with ammonium hydroxide to precipitate ADU.
2. Adjustment of the ammonia concentration of the ADU slurry.
3. Filtration of the ADU.
4. Air drying the ADU.
5. Pyrohydrolysis of ADU to  $UO_2$ .
6. Milling and drumming the  $UO_2$ .

The process is run as a batch operation, the batch size equalling the limited safe mass of uranium determined from Table XIV of K-1019, 5th Revision.

The  $UF_6$  is received in standard AEC "MD" cylinders or 8" cylinders. These are described in detail on pages 33 and 32 respectively of TID-7019.

If the enrichment is high enough the capacity of the cylinders may exceed the limited safe mass. In this event, each cylinder received is first subdivided into limited safe mass batches.

302.1  $UF_6$  Subdivision

The cylinder subdivision station is shown on Figure 22. Here, the cylinder to be divided is placed in the steam heating chamber. This chamber has drain holes in the bottom to prevent the accumulation of condensate. Three empty cylinders are hung on a separate scale and are connected to the full cylinder through a manifold system. The  $UF_6$  is vaporized from the full cylinder and collected and condensed in the empty cylinders. When the specified amount of  $UF_6$  has been transferred (as indicated by the scale readings) the cylinders are removed and check weighed on a second scale. The cylinders are then tagged with the enrichment job symbol and gross, tare and net weights in accordance with standard procedures.

The solid angle subtended at cylinder "A" in Figure 22 by the two adjacent cylinders is 1.25 steradians. This is the maximum solid angle subtended at any one of the 5 cylinders in the station. Since this cylinder contains only a limited safe mass a K factor of .65 is applicable and the corresponding safe solid angle is 2.5 steradians.

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**302.3 ADU to UO<sub>2</sub>**

The trays of dried ADU are removed from the oven and placed in the pyrohydrolysis boxes for the conversion to UO<sub>2</sub>. These boxes are 22" wide x 16" high x 50" long. They have seven shelves (counting the bottom) and as such can hold a maximum of 21 trays.

For enrichments up to 3% only one limited safe mass per box is processed. From 3% to 6% two limited safe masses are permitted per box. This is controlled by loading one safe batch in the back of the box followed by an empty set of seven trays and then the second safe batch. This results in a spacing of at least 16" between batches.

The pyrohydrolysis box is placed in the ovens 240-3-11 or 240-3-12 where the material is heated in excess of 1000°F converting the ADU to UO<sub>2</sub>.

Following this the box is transferred to the spray cooling hood (240-3-13) where water is sprayed on the outside of the box to facilitate cooling.

After cooling, the pyrohydrolysis box is transferred to the milling hood. Here each tray is removed from the box individually and the UO<sub>2</sub> milled and collected in a 15 gallon drum.

The movement of the pyrohydrolysis boxes from step to step is done by means of a hand pushed dolly.

**302.4 In Process UO<sub>2</sub> Storage**

A maximum of 15 15-gallon drums each containing a limited safe mass will be stored in the area designated in Figure 21.

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400 DESCRIPTION OF EQUIPMENT AND FACILITIES, BUILDING 255

THE FLOOR PLAN OF BUILDING 255 IS SHOWN ON DRAWING 3712-203. THE BUILDING IS DIVIDED INTO THREE AREAS:

AREA 255-1 HOUSES THE TECHNICAL DEPARTMENT OFFICES, EQUIPMENT USED BY THE TECHNICAL DEPARTMENT AND AN ENRICHED URANIUM STORAGE VAULT.

AREA 255-2 HOUSES THE PELLET PLANT.

AREA 255-3 HOUSES A MAINTENANCE SHOP, STORAGE OF MISCELLANEOUS MATERIALS AND A LAUNDRY. IN ADDITION, THE "ITEM" PLANT IS LOCATED IN THIS AREA.

401 PELLET PLANT (REFERENCE DRAWING 3712-203, AREA 255-2)

THE PELLET PLANT IS USED FOR THE COLD PRESSING OF  $UO_2$  POWDER INTO PELLETS. THE PROCESS CONSISTS OF PREPARATION OF THE POWDER AS PRESS FEED, COLD PRESSING, HIGH FIRING, CENTERLESS GRINDING, INSPECTION, AND PACKAGING.

THE PELLET PLANT IS DESIGNED FOR LARGE QUANTITY PRODUCTION OF PELLETS IN ENRICHMENTS UP TO AND INCLUDING 5%. OCCASIONALLY, CUSTOMERS MAY ASK FOR SMALL QUANTITY (USUALLY NOT EXCEEDING THE LIMITED SAFE MASS) OF PELLETS ENRICHED UP TO 93%. IN THIS EVENT SPECIAL HANDLING IS IMPOSED ON THE MATERIAL.

401.1 ENRICHMENTS OF 5% AND LOWER

THE  $UO_2$  POWDER IS RECEIVED IN LIMITED SAFE BATCHES IN FIFTEEN GALLON DRUMS.

401.1.1 PRESS FEED PREPARATION (Hood 255-2-12)

IF REQUIRED, THE POWDER IS SPECIALLY PREPARED FOR PRESSING USING EQUIPMENT IN THE AGGLOMERATION HOOD 255-2-12. THIS HOOD CONTAINS A HOBART MIXER (SIMILAR TO A KITCHEN CAKE MIXER), A GRANULATOR, AND A DRYING OVEN. BINDERS AND LUBRICANTS ARE ADDED TO THE  $UO_2$  IN THE BLENDER. THE BOWL OF THE BLENDER IS THEN MOVED TO THE GRANULATOR WHERE THE POWDER IS SCOOPED BY HAND SCOOP FROM THE BOWL TO THE GRANULATOR. THE GRANULATOR SCREENS THE POWDER TO PRODUCE THE DESIRED PARTICLE SIZE--THE POWDER COLLECTS ON A ONE INCH DEEP TRAY. THE TRAY IS TRANSFERRED TO THE OVEN FOR DRYING. THE DRIED POWDER IS EMPTIED FROM THE TRAY THROUGH A SLOT IN THE FLOOR OF THE HOOD INTO A FIFTEEN GALLON DRUM.

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AT ANY ONE TIME THE MAXIMUM QUANTITY IN THE HOOD IS THREE LIMITED SAFE MASSES--ONE IN THE BLENDER, ONE BEING GRANULATED, AND ONE IN THE OVEN. THE EQUIPMENT IS FIXED SUCH THAT THE SEPARATION BETWEEN EACH MASS IS A MINIMUM OF TWO FEET. AS PREVIOUSLY NOTED, TWO FOOT SURFACE TO SURFACE SEPARATION OF THIRTY AND FIFTY-FIVE GALLON DRUMS CONTAINING LIMITED SAFE MASSES PROVIDES FOR NUCLEAR SAFETY (TABLE XIX OF K-1019, FIFTH REVISION).

**401.1.2 PELLET PRESS (255-2-8 AND 255-2-9)**

THE PRESS FEED IS TRANSFERRED ONE DRUM (LIMITED SAFE BATCH) AT A TIME TO EITHER OF THE TWO PELLETING PRESSES. A SPECIAL FEED HOPPER FITTED WITH A VALVE IS ATTACHED TO THE DRUM AND THE UNIT HOISTED UP OVER THE PRESS. THE DRUM AND HOPPER ASSEMBLY IS INVERTED AND ATTACHED TO THE PRESS. THE VALVE IS OPENED AND THE  $UO_2$  POWDER FLOWS BY GRAVITY TO THE PELLET DIE. THE DRUM STAYS IN THIS POSITION UNTIL THE ENTIRE BATCH HAS BEEN PRESSED. AS A RESULT A MAXIMUM OF ONLY ONE LIMITED SAFE MASS IS IN PROCESS AT THE PRESS AT ONE TIME.

THE PRESSED PELLETS ARE REMOVED INDIVIDUALLY BY HAND AND STACKED EITHER IN SINTERING BOATS OR STORAGE PANS PRIOR TO FURTHER PROCESSING. THE SINTERING BOATS AND STORAGE PANS ARE LESS THAN THREE INCHES DEEP WHICH IS A SAFE SLAB THICKNESS FOR ENRICHMENTS UP TO 5% (FIGURE 16, TID-7016, REVISION 1).

**401.1.3 PRE SINTERING FURNACE (255-2-6)**

AFTER PRESSING THE PELLETS MAY BE PRE-SINTERED IN THE FURNACE 255-2-6. THIS IS AN ELECTRIC FURNACE AND OPERATES AT TEMPERATURES UP TO 1600°F. THE PELLETS ARE CARRIED THROUGH THE FURNACE ON A CONTINUOUS BELT IN A LAYER THREE INCHES DEEP BY FOURTEEN INCHES WIDE. THESE DIMENSIONS ARE FIXED BY THE FURNACE DESIGN. THE BELT IS MECHANICALLY DRIVEN AT A MAXIMUM RATE OF APPROXIMATELY ONE AND ONE-HALF FEET PER HOUR RESULTING IN A TOTAL RESIDENCE TIME OF ABOUT TEN HOURS MINIMUM. AS THE PELLETS LEAVE THE FURNACE THEY ARE STACKED BY HAND INTO THE SINTERING BOATS. THESE BOATS ARE TWO INCHES DEEP BY FIVE INCHES WIDE BY SEVEN INCHES LONG.

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**401.1.6 DRY BOX AND OVEN (255-2-14)**

SOME CUSTOMERS REQUIRE PELLETS THAT HAVE BEEN SPECIALLY DRIED. THIS IS DONE IN THE DRY BOX 255-2-14.

A PLAN VIEW OF THE EQUIPMENT IS SHOWN IN THE ENCLOSED FIGURE 24. THE OVEN AND DRY BOX ARE BUILT AS A SINGLE UNIT. THE OVEN IS MOUNTED ON ONE END OF THE DRY BOX AND IS FITTED WITH TWO DOORS, ONE OPENING TO THE ROOM, THE OTHER OPENING INTO THE DRY BOX. THE OTHER END OF THE DRY BOX IS FITTED WITH A DOUBLE DOOR AIR LOCK FOR INTRODUCING EQUIPMENT AND THE TUBES IN WHICH THE PELLETS ARE TO BE LOADED.

THE OVEN IS DESIGNED TO OPERATE AT A PRESSURE OF 1 MM OF MERCURY AND A TEMPERATURE OF 250°C. A DRY ARGON ATMOSPHERE IS MAINTAINED IN THE DRY BOX. EXTERNAL CONNECTIONS TO THE OVEN AND DRY BOX ARE LIMITED TO THOSE REQUIRED FOR THE VACUUM AND ARGON SYSTEMS WITH THE EXCEPTION THAT THE OVEN IS FITTED WITH AN EXTERIOR WATER COIL OF 3/8 INCH DIAMETER PIPE TO FACILITATE COOLING AT THE END OF THE DRYING CYCLE.

THE PELLETS WILL BE MADE UP INTO STACKS ON ALUMINUM TRAYS AT THE TUBE LOADING STATION 255-2-21. EACH TRAY WILL HOLD FIFTEEN STACKS. A MAXIMUM OF SEVEN TRAYS (105 STACKS) WILL BE LOADED IN THE OVEN. AFTER COMPLETION OF THE DEGASSING CYCLE, THE SEVEN TRAYS WILL BE TRANSFERRED ONTO A CART IN THE DRY BOX AND THE OVEN LOADED WITH A NEW BATCH.

METAL TUBES SUCH AS STAINLESS, ALUMINUM, OR ZIRCALOY WILL BE INTRODUCED (ON TRAYS) INTO THE DRY BOX THROUGH THE AIR LOCK. ONE TRAY OF PELLET STACKS WILL BE REMOVED FROM THE CART AND THE PELLETS LOADED INTO THE TUBES. THE LOADED TUBES WILL BE RETURNED TO THE AIR LOCK AND A SECOND GROUP OF EMPTY TUBES INTRODUCED AND THE CYCLE REPEATED. AFTER REMOVAL FROM THE DRY BOX THE LOADED TUBES WILL BE HANDLED IN SAFE BATCH QUANTITIES AS DEFINED BY FIGURE 13, TID-7016, REVISION 1.

**401.1.7 IN PROCESS STORAGE**

**UO<sub>2</sub> FEED DRUMS**

A MAXIMUM OF 60 FIFTEEN GALLON DRUMS EACH CONTAINING A LIMITED SAFE MASS MAY BE IN STORAGE ON THE PLANT FLOOR. THESE WILL BE SPACED TWO FEET SURFACE TO SURFACE AND AT LEAST TWO FEET FROM THE INSTALLED PROCESS EQUIPMENT.

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AFTER PRESSING, THE PELLETS ARE HANDLED IN TRAYS, SINTERING BOATS, OR "SAUSAGES" WHICH ARE LESS THAN THREE INCHES DEEP. THE PELLETS ARE MOVED ABOUT THE PLANT IN A SINGLE LAYER ON THE TOP SHELF OF MOVE CARTS. THE CARTS AND TABLE TOPS ARE THREE FEET ABOVE THE FLOOR.

FROM FIGURE 16, TID-7016, REVISION 1 THE SAFE INFINITE SLAB THICKNESS FOR 5% ENRICHED URANIUM METAL RODS WITH OPTIMUM WATER REFLECTION AND MODERATION IS 3-3/4 INCHES AND INCREASES FOR LOWER ENRICHMENTS. THUS, SAFETY IS ASSURED EVEN IF ALL THE PELLET TRAYS, BOATS, "SAUSAGES" WERE ASSEMBLED TOGETHER.

IN THE EVENT PELLETS ARE IN STORAGE ON THE FLOOR, THE THREE FOOT HEIGHT OF THE MOVE CARTS AND TABLES INSURES AMPLE SPACING OF THE TWO SLABS SINCE FROM TABLE XVIII ONLY A ONE FOOT SPACING IS REQUIRED BETWEEN TWO INFINITE SLABS OF THE LIMITED SAFE THICKNESS. THIS IS CONSERVATIVE IN THAT THE PELLET DENSITY IS ONLY 10.5 GM/CC COMPARED TO THE METAL DENSITY OF 18.8 GRAMS/CC.

IN THE CASE OF DRUM STORAGE, THE TWO FOOT SURFACE TO SURFACE SPACING IS MORE THAN ADEQUATE SINCE AS PREVIOUSLY NOTED, THIS IS A SAFE SPACING FOR THIRTY AND FIFTY-FIVE GALLON DRUMS CONTAINING A LIMITED SAFE MASS.

#### PELLET SAW

THE SAW USED IN THE TUBE LOADING STATION TO CUT PELLETS FOR STACK LENGTH PURPOSES INCLUDES A WATER SUMP. THIS SUMP HAS DIMENSIONS OF 9 INCHES BY 4 INCHES BY 21 INCHES OR A VOLUME OF TWELVE AND ONE-HALF LITERS. SINCE THE  $UO_2$  IS NOW FINELY DIVIDED, THIS IS A SAFE VOLUME FOR UP TO 12% ENRICHMENT, TABLE XIII, K-1019, FIFTH REVISION.

#### CENTERLESS GRINDER COOLING WATER

THE COOLING WATER CIRCULATING THROUGH THE GRINDER CARRIES OFF THE  $UO_2$  GROUND OFF THE PELLETS. THIS WATER IS PUMPED TO A SAFE TEN INCH DIAMETER SETTLING TANK BEFORE RECYCLING TO THE GRINDER. THIS TANK IS DESIGNED FOR SETTLING SO THAT THE WATER RETURNED TO THE GRINDER IS PARTIALLY CLARIFIED.

AS THE  $UO_2$  PARTICLES SETTLE, THEY COLLECT IN A ONE GALLON BOTTLE AT THE BOTTOM OF THE TANK. THIS BOTTLE IS REPLACED AT LEAST ONCE A DAY DURING CONTINUOUS PRODUCTION.

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WHEN IT BECOMES NECESSARY TO DRAIN THE TANK, CIRCULATION IS STOPPED AND THE MATERIAL ALLOWED TO SETTLE. A SAMPLE OF THE SLURRY IS DRAINED OFF FROM THE BOTTOM OF THE TANK (GREATEST CONCENTRATION) AND ANALYZED FOR URANIUM. USING THIS ANALYSIS, THE TOTAL URANIUM CONTENT OF THE TANK IS CALCULATED ON THE BASIS THAT THE URANIUM CONCENTRATION OF THE SAMPLE IS CONSTANT THROUGHOUT THE TANK. IF THE TOTAL URANIUM CONTENT IS DETERMINED TO BE LESS THAN THE LIMITED SAFE MASS FOR THE ENRICHMENT INVOLVED, THE TANK IS DRAINED. IF GREATER, THE  $UO_2$  IS PERMITTED ADDITIONAL SETTLING AND THE MATERIAL DRAWN OFF IN THE ONE GALLON BOTTLE. A SECOND SAMPLE IS THEN TAKEN AND ANALYZED. IF THIS SAMPLE SHOWS THE CONTENT OF THE TANK IS LESS THAN THE LIMITED SAFE MASS THE TANK IS DRAINED, IF STILL GREATER THE PROCEDURE DESCRIBED ABOVE IS REPEATED UNTIL THE CONTENT IS REDUCED TO THE LIMITED SAFE MASS.

INTERACTION EFFECTS ON AND BY THIS TANK CAN BE NEGLECTED SINCE IT IS SUFFICIENTLY SEPARATED 10 FEET FROM THOSE AREAS WHERE THE PELLETS ARE STORED IN THREE INCH DEEP LAYERS. ALSO, THERE ARE NO DRUMS STORED IN THIS AREA.

DRY Box (255-2-14)

THE SAFETY OF THIS OPERATION IS BASED ON LACK OF MODERATION SINCE AS STATED ON PAGE 23 OF TID-7016, REVISION 1, UNMODERATED URANIUM COMPOUNDS ENRICHED TO A MAXIMUM OF 5% REQUIRE NO FURTHER RESTRICTION. LACK OF MODERATION IS ASSURED SINCE:

- 1) THE PELLETS ARE DRY BEFORE LOADING IN THE OVEN. THIS IS BASED ON THE FACT THAT THEY HAVE BEEN SINTERED AT TEMPERATURES IN EXCESS OF 1000°C.
- 2) THE TRAYS ARE LOADED IN THE OVEN ONE AT A TIME.
- 3) THE COOLING COIL DOES NOT HAVE A VALVE ON THE DISCHARGE SIDE, THUS IF A LEAK DEVELOPED IN THE COIL, IT WOULD NOT BE UNDER PRESSURE. IF A LEAK DID DEVELOP IN THE COIL, A LEAK WOULD ALSO HAVE TO DEVELOP IN THE STAINLESS STEEL LINING OF THE OVEN IN ORDER FOR THE WATER TO ENTER THE OVEN. IF A LEAK EXISTS IN THE LINING, A VACUUM IN THE OVEN CANNOT BE ACHIEVED AND SINCE THE WATER COIL IS NOT FUNCTIONING UNTIL THE END OF THE DEGASSING CYCLE, SUCH A LEAK WOULD BE DETECTED AT ANY TIME DURING THE HEATING PORTION OF THE CYCLE.

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**401.2: ENRICHMENTS GREATER THAN 5%**

OCCASIONALLY THERE ARE REQUIREMENTS FOR PRODUCING SMALL QUANTITIES OF PELLETS GREATER THAN 5% ENRICHED. EXAMPLES OF THE TYPE OF ORDERS INVOLVED ARE CONTAINED IN THE FOLLOWING TABLE:

| <u>ENRICHMENT</u> | <u>QUANTITY OF URANIUM DIOXIDE</u> |
|-------------------|------------------------------------|
| 5.8%              | 40 POUNDS                          |
| 21%               | 40 POUNDS                          |
| 8.3%              | 35 POUNDS                          |
| 12.5%             | 450 PELLETS                        |
| 17.5%             | 325 PELLETS                        |
| 93%               | 1 TO 2 POUNDS                      |

SINCE OUR CUSTOMERS' REQUIREMENTS FOR PELLETS OF AN ENRICHMENT GREATER THAN 5% ARE FULFILLED BY INFREQUENT ORDERS FOR SMALL QUANTITIES, THE FOLLOWING CONTROLS FOR NUCLEAR SAFETY HAVE BEEN ESTABLISHED.

- A. THE URANIUM DIOXIDE WILL BE HANDLED AND PROCESSED IN BATCHES NOT EXCEEDING THE LIMITED SAFE MASS FOR THE ENRICHMENT INVOLVED AS DEFINED BY TABLE XIV OF K-1019, FIFTH REVISION.
- B. THE PROCESSING OF EACH BATCH THROUGH ANY ONE OF THE FOLLOWING LISTED STEPS WILL BE COMPLETED BEFORE THE NEXT BATCH IS STARTED IN THAT STEP.
  1. PRESS FEED PREPARATION.
  2. DRYING THE AGGLOMERATED POWDER.
  3. PRESSING THE POWDER INTO PELLETS.
  4. CENTERLESS GRINDING.
  5. INSPECTION AND PACKAGING.

THE PREPARATION OF THE PRESS FEED WILL BE DONE IN A SMALL KITCHEN SIZE CAKE MIXER IN THE UTILITY HOOD 255-2-10.

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| ENRICHMENT | H/U-235 | EFFECTIVE<br>U-235 DENSITY<br>GMS/CC | SAFE MASS*<br>Kg U-235 | SAFE VOLUME*<br>LITERS |
|------------|---------|--------------------------------------|------------------------|------------------------|
| 93         | 3.1     | 3.48                                 | 9                      | 2-3/4                  |
| 80         | 3.6     | 3.0                                  | 8.5                    | 3                      |
| 50         | 5.7     | 1.87                                 | 7                      | 3-1/2                  |
| 25         | 11.4    | 0.93                                 | 4 1/2                  | 4.8                    |
| 10         | 28.5    | 0.35                                 | 2 1/2 2.3              | 4.8                    |
| 5          | 57.0    | 0.18                                 | 1 1/2 1.3              | 4.8                    |

\* FROM FIGURES 1 AND 2, TID-7016, REVISION 1 WITHOUT CORRECTION FOR ENRICHMENT PERMITTED BY FIGURE 21 OF TID-7016, REVISION 1.

IN THAT THE SPACING AFFORDED BY THESE SHELVES IS GREATER THAN THAT SHOWN TO BE SAFE FOR 93% ENRICHED STORAGE IN THE RED ROOM, FURTHER COMMENT IS NOT REQUIRED.

#### 401.3 SPECIAL REQUIREMENTS

OCCASIONALLY IT IS NECESSARY TO PROCESS SMALL QUANTITIES OF MATERIALS SUCH AS  $UO_2SO_4 \cdot 3D_2O$  ENRICHED UP TO 93%. THE FOLLOWING IS AN EXAMPLE OF THIS AND THE TYPE OF CONTROLS APPLIED:

TOTAL QUANTITY OF ENRICHED URANIUM: 3 KG U-235, 15 KG U, 23.1 KG  $UO_2SO_4$  ANHYDROUS *20% enrich. U*

TOTAL QUANTITY OF  $D_2O$ : APPROXIMATELY 6,000 GRAMS

THE  $UO_2SO_4$  *65% U* HAS BEEN PRODUCED IN THE HIGH ENRICHMENT AREA (RED ROOM) OF OUR PLANT.

THE ADDITION OF THE  $D_2O$  TO THE  $UO_2SO_4$  WILL BE DONE IN THE DRY BOX 255-2-14. IN THIS CASE, HOWEVER, ONLY A TOTAL OF ONE LIMITED SAFE BATCH (3700 GRAMS  $UO_2SO_4$ ) WILL BE IN THE DRY BOX AND OVEN AT ONE TIME.

THE  $D_2O$  WILL BE STORED IN ITS SHIPPING CONTAINER IN THIS DRY BOX. PRIOR TO INTRODUCING THE  $UO_2SO_4$  BATCH, THE STOICHIOMETRIC QUANTITY OF  $D_2O$  REQUIRED FOR THE BATCH (606 GRAMS) WILL BE WEIGHED OUT INTO A SEPARATE ONE LITER BOTTLE.

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SHIPPING CONTAINERS

BASED ON A K VALUE OF 0.58, WHICH IS APPLICABLE FOR A FIVE INCH DIAMETER CYLINDER (NOTE 6, TABLE X, TID-7019), A TOTAL INTERACTION ANGLE OF 3.2 STERADIANS IS ALLOWED. FOR A K VALUE OF 0.65, WHICH IS PERMITTED FOR NUCLEARLY SAFE MASS QUANTITIES (NOTE 6, TABLE X, TID-7019) A SOLID ANGLE OF 2.5 STERADIANS IS ALLOWED. IN THE CASE OF URANIUM COMPOUNDS AND SOLUTIONS HAVING A URANIUM DENSITY GREATER THAN 3.2 G/CC, THE NUCLEAR SAFETY CONTROL REVERTS TO VOLUME, THE K VALUE OF 0.8 IS APPLICABLE (NOTE 6, TABLE X, TID-7019) AND A TOTAL SOLID ANGLE OF 1.0 STERADIANS IS PERMITTED. BY COMPARISON OF THE ALLOWABLE SOLID ANGLES TO THE ACTUAL SOLID ANGLES LISTED IN THE ABOVE TABLE IT CAN BE SEEN THAT INTERACTION REQUIREMENTS ARE MET FOR THE SHIPPING CONDITIONS DESCRIBED.

**702.5 BE PERMIT 740**

PELLETS ARE FIRST PACKAGED IN "SAUSAGES" AS DESCRIBED IN PARAGRAPH 401.1.6. A MAXIMUM OF SIX SAUSAGES ARE TIED TOGETHER MAKING A BUNDLE EIGHT INCHES DIAMETER BY SIXTEEN AND ONE-HALF INCHES HIGH. THIS BUNDLE IS THEN PACKAGED IN THE SEVEN GALLON DRUM SHOWN ON THE REFERENCED DRAWING. THIS DRUM IS LINED WITH STYROFOAM ON THE WALLS AND A SPONGE RUBBER PAD ON THE TOP AND BOTTOM. THE LID IS SEALED BY MEANS OF A BOLTED CLAMPING RING.

SINCE THE PELLET DENSITY IS 10.5 GRAMS  $UO_2$ /CC, THE QUANTITY PER DRUM IS LIMITED TO THE SAFE MASS DETERMINED FROM FIGURE 13 OF TID-7016, REVISION 1. IN THE EVENT THIS QUANTITY IS CONTAINED IN LESS THAN SIX SAUSAGES ADDITIONAL DUNNAGE IS ADDED TO SECURELY BRACE THE BUNDLE.

THE SOLID ANGLE FOR THE 23 DRUMS IS 2.5 STERADIANS WHICH EQUALS THE SAFE SOLID ANGLE FOR MASS CONTROLLED CONTAINERS.

**702.6 BE PERMIT 1001**

THE URANIUM COMPOUND IS PACKAGED IN THE INNER FIVE GALLON TYPE 37A PAIL. THIS PAIL IS CENTERED INSIDE A STANDARD FIFTY-FIVE GALLON "SHORTY" DRUM BY MEANS OF ANGLE IRON STOOLS AS SHOWN ON THE DRAWINGS. A STEEL HOOP OR SKIRT HAS BEEN ADDED TO THE FIFTY-FIVE GALLON DRUM INCREASING ITS DIAMETER TO TWENTY-SEVEN INCHES. THE LID OF EACH DRUM IS GASKETED TO PREVENT WATER INLEAKAGE AND HAS A CLAMPING RING HOLDING THE LID FIRMLY IN PLACE. IN ADDITION, THE WORDS "DO NOT STACK" WILL BE STENCILED ON THE OUTSIDE OF THE FIFTY-FIVE GALLON DRUM AND A PYRAMID FRAME HAS BEEN ADDED TO THE DRUM LID AS SHOWN ON THE ENCLOSED SKETCH TITLED "FIFTY-FIVE GALLON DRUM LID ADDITION."

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BE PERMIT 740

USE:  $UO_2$  PELLETS ENRICHED TO AND INCLUDING 5%; LIMITED SAFE MASS PER UNIT.

TRANSPORTATION: TWENTY-THREE UNITS LTL, LCL, AIR OR RAILWAY EXPRESS.

REFERENCE DRAWING: FIGURE 31 7 gal inside - 65 gal outside

BE PERMIT 1001

USE: URANIUM COMPOUNDS UP TO 10% ENRICHMENT IN LIMITED SAFE MASS PER UNIT.

TRANSPORTATION: TWENTY-FOUR UNITS LTL, LCL, AIR OR RAILWAY EXPRESS.

REFERENCE DRAWINGS: FIGURE 32 5 gal - 55 gal outside

BE PERMIT 911

USE:  $UO_2$  PELLETS IN STACKS. ENRICHMENT UP TO 5%; LIMITED SAFE MASS PER UNIT.  
42" x 43" x 72" - inside - 55 gal outside 14 gal

TRANSPORTATION: TWENTY-TWO UNITS LCL, LTL, AIR OR RAILWAY EXPRESS.

REFERENCE DRAWINGS: SKETCHES 7499, 7500, 7501, SK-22, AND SK-22-1.

BE PERMIT 1351

USE: URANIUM METAL OR DRY COMPOUNDS UP TO FULLY ENRICHED. MAXIMUM DENSITY FULL METAL OR 6 GM/CC FOR COMPOUNDS. (all)

TRANSPORTATION: NINETEEN UNITS LCL, LTL, AIR OR RAILWAY EXPRESS.

REFERENCE DRAWINGS: SK-5, SK-23, SK-23-1. 16" dia x 17 1/4" h drum  
inter-container 6" sch 40 pipe  
6" I.D. x 5" h

BE PERMIT 1483

USE: URANIUM COMPOUNDS OR SOLUTIONS UP TO FULLY ENRICHED. URANIUM DENSITY LESS THAN 3.2 GRAMS U/CC.

TRANSPORTATION: NINETEEN UNITS LCL, LTL, AIR OR RAILWAY EXPRESS.

REFERENCE DRAWINGS: SK-255-1-5 AND SK-8. 65 gal drums, 16 gal  
5.25" I.D. x 36.5" h

THE  $UF_6$  CYLINDERS REFERENCED ABOVE ARE STANDARD AEC CYLINDERS. SOME DETAILS OF THEM ARE PRESENTED ON PAGES 31 THROUGH 33 OF TID-7019.

SINGLE LAYER SHIPMENTS ARE SPECIFIED FOR ALL OF THE ABOVE EXCEPT BE PERMIT 911. "DO NOT DOUBLE STACK" WILL BE STENCILED ON EACH OUTSIDE CONTAINER.

prior  
approval  
may 6, 1963

LIST OF REFERENCES

LAMS-2415, CRITICAL DATA FOR NUCLEAR SAFETY GUIDANCE

TID-7016, REVISION 1, NUCLEAR SAFETY GUIDE

K-1019, FIFTH REVISION

LA-2026, CRITICAL MASSES OF ORALLY LATTICES IMMERSSED IN WATER

K-1317, SELF CONSISTENT CRITERIA FOR EVALUATION OF NEUTRON INTERACTION

TID-7019, GUIDE TO SHIPMENT OF U-235, ENRICHED URANIUM

ORNL-2367, CRITICAL MASS STUDIES, PART IX

TID-5451, AN EMPIRICAL METHOD FOR CALCULATING SUB-CRITICAL PIPE INTERSECTIONS

ANL-5800 REACTOR PHYSICS CONSTANTS