70-1113

GE Nuclear Energy

General Electric Company
P.O. Box 780, Wilmington, NC 28402
910 675-5000

May 14, 1996

Mr. R. C. Pierson
Licensing Branch, NMSS
U.S. Nuclear Regulatory Commission
Mail Stop T 8-D-14
Washington, D.C. 20555-0001

Subject: Supplemental Information Supporting License Renewal

Reference: License Renewal & Letter, R. J. Reda to E. Q. Ten Eyck, 4/5/96

Dear Mr. Pierson:

GE's Nuclear Energy Production facility in Wilmington, N. C. hereby transmits the enclosed supplemental information in support of our license renewal currently under consideration by the NRC. This information summarizes the processes and associated equipment for the facility and provides a snapshot overview of the implementation of the key aspects of the safety programs described in our license renewal application as referenced.

This transmittal completes the documentation committed on our application of 4/5/96. Eleven copies of this submittal are being provided for your review. An additional copy is being sent to Region II.

GE would like to reiterate our willingness to work with you and your Staff in this renewal effort. We are very willing to support you and your Staff in site visits to go into whatever detail is necessary to complete your evaluation of the adequacy of the programmatic elements of our license. We will also need to work with you to determine appropriate schedules for completing a renewed integrated safety analyses of the continuing portions of our operations which have not been reviewed in accord with current concepts.

NF04 1/1

Please contact me on (910) 675 5889 or Charlie Vaughan on (910) 675 5656, if you need to discuss this matter further.

Sincerely,

GE NUCLEAR ENERGY

R. J. Reda
Manager
Fuels and Facility Licensing

/sb
attachments

cc: RJR-96-055

GE-WILMINGTON

SUPPLEMENTAL INFORMATION TO THE APPLICATION FOR RENEWAL OF SPECIAL NUCLEAR MATERIALS LICENSE SNM-1097

DOCUMENT CONTENTS

Overview:

The GE-Wilmington product manufacturing operations authorized by this license consist of receiving low-enriched, less than or equal to 6.0 weight percent U-235, uranium hexafluoride; converting the uranium hexafluoride to uranium dioxide powder; and processing the uranium dioxide through pelletizing steps, fuel rod loading and sealing, and fuel assembly fabrication, and shipping of the products (bundles, UO_2 powder and pellets, and Hydrofluoric Acid).

Two types of processes are used to convert uranium hexafluoride (UF_6) to uranium dioxide powder: the Ammonium Diuranate (ADU) process, and the Dry Conversion Process (DCP). As DCP is implemented, the existing ADU process will be phased out. The manufacturing operations are served by ancillary support systems such as scrap recovery and waste disposal, which are also described in the license. Details concerning the facility and process systems are presented in this supplemental information document. The salient Environmental Protection, Criticality Safety, Radiation Safety, Industrial Safety, Chemical Safety, and Fire Safety controls are included where applicable for each system. Emergency situations and planning are addressed in the Emergency and Radiological Contingency Plan, the Safeguards controls are described in the Fundamental Nuclear Material Control Plan and Physical Security Plan for the GE-Wilmington product manufacturing operations.

Introduction:

This document describes the existing Fuel Manufacturing and support/ancillary processes, the future Dry Conversion Process, and the integration and transition steps to be taken to fully implement the Dry Conversion Process.

The integration/transition from the existing-to-future fuel manufacturing capability basically includes a new transfer corridor to connect the new DCP Facility and the FMO/FMOX areas where powder will be required. New rooms will be constructed off this corridor in both the FMO and FMOX areas to support powder transfer and the recycle operations. The corridor area will be approximately 10 feet wide and will extend from the DCP to the GAD Area in FMO. Affected existing equipment within the new transfer corridor path and the new room areas will be relocated or removed.

The work will be done in two phases. During Phase I, all existing equipment, conduit, wiring, and walls will be relocated to prepare for the installation of the corridor. During Phase II, construction of the corridor, rooms, and installation of the new equipment or modification of existing equipment will occur. Rooms will be required for the Recycle Integration Area (on the first floor and mezzanine), the powder dump station areas, and the GAD Integration Area. Certain rooms will include water-tight siding and roofing. The existing building structural systems will be analyzed to ensure that they will carry the loads of the new structures and equipment plus the weight of the materials being transported through the corridor area.

THE STRUCTURE OF THIS DOCUMENT IS AS FOLLOWS:

EXISTING OPERATIONS TO BE DISCONTINUED

- ADU CONVERSION (EXCEPT LINES 5 & 6) SECTION A.1
- UF6→ UO2 CONVERSION ADU PROCESS A.1.2

EXISTING OPERATIONS TO CONTINUE

- UF6 RECEIPT HANDLING & STORAGE A.1.1
- URANIUM RECOVERY & WASTE TREATMENT B.1
- SCRAP RECOVERY (URU) B.2

OPERATION ADDITIONS

- DRY CONVERSION PROCESS C.1
- DRY RECYCLE PROCESS C.2

INTEGRATION / TRANSITION EXISTING-TO-FUTURE SECTION E

- PELLET PRESSING D.1-2
- PELLET SINTERING D.3
- PELLET GRINDING D.4
- Rod Load, Outgas, Weld D.5
- Gadolinium Processing D.6
- Fuel Assembly, Pack &Ship D.7-10

A.1 ADU CONVERSION OPERATIONS

Process /Equipment Description:

Chemical conversion currently utilizes six conversion lines. Conversion lines 1 through 4 utilize the ADU process, which is a wet conversion application involving continuous processing of slurries of nuclear material for converting UF_6 to uranium dioxide. Lines 1-4 will be phased out as the Dry Conversion Process is brought on line (typically by 12/31/97). Conversion line 5 utilizes the Uranyl Nitrate Conversion (UCON) process for converting uranyl nitrate to uranium dioxide. Conversion line 6 is used to convert uranium-bearing powder to uranium oxides (UO_2 and U_3O_8). Both lines 5 and 6 will continue as required to complete the recovery of on-site materials and possibly some near term uranium supply options.

Lines 1-4 will be phased out as the Dry Conversion Process is brought on line and will be discontinued by the end of 1997. Should the operation need to be extended beyond this time, GE-Wilmington will notify the NRC and determine an appropriate plan. The operation is consistent with currently licensed information, and GE-Wilmington plans no changes to the operation or basis for safety. GE-Wilmington does not plan to perform an Integrated Safety Analysis for this operation.

Lines 5 and 6 will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for these lines in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

The Uranyl Nitrate Conversion operation is described later in this document.

Criticality Safety:

Conversion lines 1, 2, 4, and 5 have been demonstrated to be critically safe to process uranium up to a maximum of 4.013 weight-percent (w/o) U-235 and conversion lines 3 and 6 have been demonstrated to be critically safe to process uranium up to a maximum of 5.00 weight-percent (w/o) U-235. Initial spacing of the equipment components was determined using the surface density method, and has been subsequently verified using both solid angle and KENO methods.

For UF_6 operations, U-235 enrichment is verified by analysis of samples (withdrawn at the enrichment facility) prior to introduction of the material to the conversion process. The maximum U-235 enrichment shipped in Model 30-B cylinders is 5.00 w/o.

The mechanical design of the ADU and Uranyl Nitrate conversion equipment systems has been analyzed, and demonstrated to be safe, under both normal and abnormal operating conditions, including consideration of drainage from favorable to unfavorable geometries.

The safety features are incorporated in approved, documented operating procedures, included in operator training, and are reviewed during periodic audits.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Emissions from these areas are captured and treated prior to release into the environment. There are no untreated release pathways. Treatment of the air effluents flows include as appropriate permitted scrubbers with a stage of HEPA filtration or double HEPA filtration. Liquid effluents are treated and discharged in the site's NPDES permitted wastewater treatment operations. Nitrate liquids, after treatment, are transferred to a paper company for beneficial use as a nutrient for their waste treatment operations.

Chemical Safety:

The notable chemicals in the area are UF_6, cracked Ammonia, ammonium hydroxide and natural gas. Chemical job hazard analyses have been performed for each of these operations and appropriate chemical control actions and procedures are documented for routine operations. Additionally these chemicals are factored into the emergency planning, as appropriate.

Fire Safety:

The natural gas and cracked ammonia represent potential fire and explosion hazards. Each of these systems have been reviewed for safety internally and by Factory Mutual. Appropriate controls are in place to minimize the potential for fire and explosion.

Industrial Safety:

Eye and foot protection are required in the area. Material and equipment lifting are also appropriately controlled.

A.1.1 UF_6 RECEIPT, HANDLING, AND STORAGE

Process /Equipment Description:

UF_6 enriched in U-235 up to 5.0 w/o is received from an enrichment facility supplier, in Model 30 cylinders within NRC and DOT authorized packagings. The cylinders are then removed from the outer packages, individually weighed, and placed in a cylinder storage position on the receiving and storage platform or on an outside storage pad. Based on production need, the cylinders are transferred into the UF_6 Vaporization area (either ADU or Dry Conversion). After addition of the UF_6 into the process, the cylinders are returned to the UF_6 pad to await return to a supplier. GE is not changing these operations nor the basis of safety from the current license.

Criticality Safety:

UF_6 receipt enrichment control actions include the following:

- Independent witnessing of 30-B cylinders being filled from the parent cylinder.
- Three aliquot samples taken from the parent cylinder; one for gaseous diffusion plant analysis; one for independent laboratory analysis; and one referee sample (in case the two analyses do not agree).
- On[illegible]r-one independent verification upon receipt by Rad Protection an[illegible]terials Controls and Accountability.
- HiE valve adapters installed on each HiE 30-B cylinder, each with a unique serial number identification tracked by computer. Adapters remain installed until cylinders packaged for shipment offsite.
- Computerized material accountability system controls.

Storage of 30-B cylinders based on moderation control of UF_6 assuming 99.5% UF_6 and less than or equal to 0.5%. Integrity of the 30-B cylinder wall prevents water intrusion. Only single planar arrays allowed for loaded cylinders.

Radiological Safety:

Upon arrival at the GE-Wilmington site, the UF_6 protective overpacks are inspected for integrity and are surveyed for radioactive contamination and direct radiation prior to being unloaded from the carrier. After unloading, all cylinders are weighed and the net weight checked against the maximum fill limits. These cylinders are stored on an outside storage pad or internal dock which is monitored by the plant criticality alarm system.

Low-enriched uranium in sealed containers requires only routine radiological safety precautions. Furthermore, UF_6 reacts with atmospheric humidity to form UO_2F_2, a non-volatile solid; thus a small leak would tend to be self-sealing. The cylinder valve cover is in place when the cylinder is being moved.

After processing the contained UF_6, the cylinders are re-surveyed for radioactive contamination and/or direct radiation, prior to return to outside storage.

Environmental Protection:

The UF_6 containers are very robust containers and a release during handling and storage is not felt to be credible. Therefore, there are no special controls in place.

Chemical Safety:

The UF_6 containers are very robust containers and a release during handling and storage is not felt to be credible. Therefore, there are no special controls in place.

Fire Safety:

Combustibles are strictly minimized and controlled in the UF_6 pad storage area.

Cylinders in good condition, with properly maintained valves and caps, are required to prohibit entry of foreign contaminants, especially hydrocarbons. Cylinders are inspected for damage upon receipt to assure integrity. Prior to release for transport from the site, cylinders are again inspected for damage. The cylinders are shipped in accordance with DOT regulations.

Industrial Safety:

Standard industrial safety practices associated with material handling are used in UF_6 cylinder handling and storage.

A.1.2 UF_6-TO-UO_2 CONVERSION: ADU PROCESS **(Phase out by 12/31/97)**

Process /Equipment Description:

The conversion of UF_6 to UO_2 powder via water hydrolysis and ammonia precipitation is referred to as the ammonium diuranate (ADU) process. The ADU process steps include UF_6 vaporization through ADU calcination to UO_2 powder and are described in the following sections.

This existing operation will be discontinued by the end of 1997. Should the operation need to be extended beyond this time, GE-Wilmington will notify the NRC and determine an appropriate plan. The operation is consistent with currently licensed information, and GE-Wilmington plans no changes to the operation or basis for safety. GE-Wilmington does not plan to perform an Integrated Safety Analysis for this operation.

A.1.2.1 UF_6 Vaporization

Cylinders are moved one at a time on the transfer cart from the storage platform into the adjacent vaporization room where a crane is used to lift the cylinder on the scale for weighing prior to moving it into one of the vaporization chambers. With the cylinder at ambient temperature, the valve cover is removed and flexible tubing (pigtail) is connected. The pigtail connection is pressure checked before the cylinder valve is opened and heat applied.

The UF_6 is continuously vaporized by slowly heating the air in the chamber. As UF_6 is vaporized, the gas flows through an automatic, open/close block valve and then to hydrolysis. The UF_6 lines are heated to prevent pluggage due to possible UF_6 solidification during vaporization. The lines are also purged with nitrogen when the UF_6 flow is off to prevent pluggage due to backflow moisture infiltration. The system is monitored and controlled by a computerized process control system.

All cylinders are evacuated via the cold trap process before shipping. The cold trap cylinder is an externally cooled 12-inch cylinder into which a 30-inch cylinder is evacuated.

Criticality Safety:

- ADU lines 1, 2, and 4 are restricted to processing low enrichment (LoE) uranium bearing materials containing less than 4.013 w/o U-235. ADU line 3 is used to process up to 5.0 w/o U-235. Lines 1, 2, and 4 are restricted to using 30" diameter UF_6 cylinders containing LoE UF_6. Line 3 can be used with either 30" diameter cylinders containing HiE or LoE UF_6 or 12" diameter UF_6 cold trap cylinders. All processing on HiE Line 3 requires special HiE pigtail adapters (referred above). Enrichment is controlled by means of a special nuclear material accountability transaction that uses a read-only cylinder bar code before a cylinder is loaded into the vaporization chamber. The automatic UF_6 block valves will not open if a cylinder with the wrong enrichment is installed in the chamber.

- Backflow of water from the safe geometry hydrolysis receiver tanks back into the 30-B cylinders is prevented by controls for detection of UF_6 piping low pressure or UF_6 cylinder low temperature which prevent opening the UF_6 block valve if either condition exists. If these controls were to fail, it has been calculated that the reaction between UF_6 and water would generate enough pressure to stop water backflow, well before the point of a potential criticality.

- Criticality safety of the primary exhaust system scrubber reservoir is based on controls in the manufacturing operation which preclude major releases of uranium to the scrubber and on limiting the surface concentration in the scrubber basin itself. The reservoir is a safe geometry slab. Based on the postulated worst case accident of loss of an entire UF_6 cylinder into the scrubber system, safety is demonstrated for the most reactive condition in the collection basin. Adequate mixing is assured by the constant agitation of the scrubber system.

- The UF_6 vaporization control system and safety-related valves are designed to actuate to safe shutdown conditions in the event of loss of instrument air, nitrogen, or electrical power. That is, all active engineered controls (AECs) are failsafe.

Radiological Safety:

UF_6 Containment:

Full-face respirators are worn by personnel when performing cylinder connection activities to protect against a potential UF_6 exposure. Additionally, each vaporization chamber is independently connected to a ventilation duct which may be activated from a local control panel to exhaust the chamber atmosphere to the roof scrubber in the event of unusual leakage. The vaporization room is equipped with an emergency HVAC system to contain a UF_6 release within the vaporization room. The vaporization room has multipleemergency exits and is equipped with an automatic overhead sprinkler system.

UF_6 Gas Release:

- Hydraulic rupture of a UF_6 cylinder is prevented by checking the weight of each cylinder before heating (to assure the weight is below maximum fill limits) and by continuously monitoring the cylinder temperature and pressure.

- The vaporization temperature is automatically controlled, UF_6 line pressure is monitored and the vaporization heaters are de-energized on detection of high temperature and/or high line pressure. Upon detection of low UF_6 line pressure or low cylinder temperature, the UF_6 flow to hydrolysis is automatically shut off to prevent water backflow to the cylinders.

- Each vaporization chamber is equipped with photoeye smoke detectors to detect UF_6 leaks which alarm in the control room when the optical path is broken.

- Each vaporization chamber is equipped with a pigtail emergency remote shutoff connected to the cylinder pigtail valve that is activated from outside the vaporization room. Each ADU line is also equipped with hydrolysis UF_6 flow shutoff switches located in the control room and outside the vaporization room.

- Each vaporization chamber is equipped with CO_2 valves to freeze a UF_6 leak.

Environmental Protection

The environmental considerations are included and treated under the radiological safety conditions at this point in the process.

Chemical Safety:

The primary chemical safety concern is hydrofluoric acid release as a result of a UF_6 leak. Prevention and detection of a UF_6 leak, and thereby a hydrofluoric acid leak, has been addressed in the Radiological Safety section.

Fire Safety:

Hydrocarbon contamination of UF_6 is prevented by using only clean, compatible materials in the piping system.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and requirements are followed.

A.1.2.2 HYDROLYSIS **(Phase out by 12/31/97)**

Process/Equipment Description:

Vaporized UF_6 is introduced beneath the liquid water level in the hydrolysis receiver system to produce uranyl fluoride which is continuously fed to precipitation. Each existing hydrolysis receiver has two associated storage tanks, a scrubber, one or two recirculation pumps, and a transfer pump. Vaporized UF_6 is introduced beneath the liquid water level in the hydrolysis receiver tank. The hydrolysis scrubber tank, with a recirculating pump and eductor, vents the receiver tank and the hood enclosing the top of the receiver tank. As indicated earlier, ADU lines 1, 2, and 4 are restricted to processing low enrichment (less than 4.013 w/o U-235). ADU line 3 can be used to process up to 5.0 w/o U-235.

Criticality Safety:

- The hydrolysis receiver, scrubber, and storage tanks are safe geometry vessels. Interaction in the chemical process area has been analyzed by the solid angle technique and demonstrated to meet acceptance criteria.

- A differential pressure control is provided on the receiver tank that automatically stops the UF_6 feed to the receiver at a density of about

1.21 g/cc. This corresponds to a concentration of about 180 gU/l. A calibration is performed on this control at least once per year. If the safe geometry vessel leak or rupture, the uranyl fluoride solution would flow into a safe slab within the 4 inch high curbing.

Radiological Safety:

UF_6 Gas Release:

- Release of UF_6 from the receiver tank is prevented by automatically maintaining the receiver level above a minimum value. If the level control fails, a scrubber conductivity sensor detects UF_6 in the receiver tank vent and stops the UF_6 flow.

- Safety interlocks monitored by a computerized process control system stop hydrolysis and UF_6 flow by closing the UF_6 valves if any of the following occurs:

  - Low UF_6 line pressure or temperature
  - Low hydrolysis scrubber level
  - High hydrolysis scrubber water conductivity
  - Hydrolysis receiver or storage tank level outside the upper or lower allowable limits
  - High hydrolysis storage tank density

- The emergency shutoff valves and emergency push buttons to shut off UF_6 flow on the floor are located in the hydrolysis area near each of the hydrolysis receiver tanks. Emergency push buttons to stop UF_6 flow are also located in the control room.

Environmental Protection:

Environmental considerations and controls are also included as Radiological condition at this point in the process.

In addition, gaseous effluents are treated through a permitted scrubber and HEPA filter system.

Chemical Safety:

Operator exposure to chemicals has been minimized by containing chemicals in closed process vessels and piping with control instrumentation to prevent vessel overflows. In the event of an overflow, the liquid is directed into a curbed containment area. The vessels are vented to the chemical scrubber exhaust system to minimize chemical vapors in the work environment.

Fire Safety:

There are no special considerations in this area as all the systems are liquids in nature and are non-flammable/non-combustible.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

A.1.2.3 PRECIPITATION AND DEWATERING **(Phase out by 12/31/97)**

Process /Equipment Description:

The hydrolyzed uranyl fluoride (HUF) product from hydrolysis is pumped to a safe geometry precipitation tank where the ADU is precipitated using ammonium hydroxide. The solids are concentrated in a dewatering centrifuge, then pumped to a calciner (defluorinator). The liquid overflow from the centrifuge may be further treated by a clarifier centrifuge to remove the remaining solids, if needed. The waste ammonium fluoride solution is then pumped to the ADU fluoride waste slab tank system for further solids removal.

Criticality Safety:

- All components of the ADU precipitation and dewatering process are geometrically safe.
- The aqueous solution is confined in a geometrically safe precipitation tank.
- Dewatering centrifuges are contained within an outer casing. The centrifuges have been designed to preclude build-up of solids. The uranium-bearing portionof the centrifuge is enclosed by concentric shells which preclude close reflection by any materials.

- The solid material discharged from the dewatering centrifuge falls into a geometrically safe slab feed hopper from which it is pneumatically pumped using directly into the defluorinating calciner (via a squirt tube).

- ADU Line 3 which processes up to 5.0 w/o U-235, uses a computerized process control system which detects and activates responses for such interlock conditions as:

  - Stopping feed streams to precipitation and dewatering centrifuge if the centrifuge stops

  - Stopping the uranium stream to precipitation if the uranium-to-ammonium hydroxide ratio exceeds the maximum allowable limit or for dewatering centrifuge hopper high level

Radiological Safety:

This is a wet process area and therefore radiological contamination is not a high risk. People working and visiting in the area wear standard protective clothing. Radiation work is done by procedure or by radiation work permit either of which call out any special requirements in effect for the area.

Environmental Protection:

Air effluents are released through permitted HEPA filter system. Liquid waste effluents are discharged through NPDES permitted waste treatment operations.

Chemical Safety:

- Precipitation and centrifugation processing steps are conducted in vented systems. Precipitation vessel level controls, with alarms, are provided to prevent system overflows. Leakage from the dewatering centrifuge equipment is readily detectable as dilute aqueous feed solution.

- Chemically resistant face shields and full-face respirators are provided for use by operators, as needed when working with nitric acid and ammonia.

Fire Safety:

There are no special considerations in this area, as the systems are liquid in nature and are non-flammable/non-combustible.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

A.1.2.4 CALCINATION **(Phase out lines 1-4 by 12/31/97)**

Process/Equipment Description:

ADU lines 1, 2 , 3, and 4 calciners are rotating, gas-fired kilns that are used to convert wet and dry feed to UO_2 powder. Wet ADU feed is pumped from the dewatering centrifuge hopper into the calciner via a squirt tube. Dry feed (recycle) is fed through the recycle feed system into the calciner. Each calciner is designed to calcine and transport the UO_2 powder within a geometrically safe tube, ultimately discharging the powder into geometrically safe 3 or 5 gallon containers.

Steam, hydrogen from dissociated ammonia, and nitrogen are injected into the discharge end of the calciner in a controlled manner to accomplish the calcination process. The offgas from the calciner is water scrubbed and discharged into the plant process venting system.

Criticality Safety:

- The calciner tube with front and rear bellows has been demonstrated to be safe geometrically for processing up to 5.0% U-235.

- Lines 1, 2 and 4 calciners are equipped with interlocks such that if calciner tube rotation stops, or if temperature in any zone drops below 400°F, or discharge end is plugged over 90 minutes; uranium feed and steam must be stopped to calciner and cans filled at calciner discharge must be either sampled for moisture or sent to scrap recovery.

- Lines 1, 2, and 4 calciner hood entrances and exits physically prevent receiptand discharge of 3 gallon (HiE) containers and Line 3 calciner hood entrance and exit physically prevents receipt and discharge of 5 gallon (LoE) containers.

- Each container of UO_2 powder discharged from the calciner is visually inspected for moisture. Containers of visibly moist powder are physicallyidentified and reprocessed.

Radiological Safety:

Nitrogen purges, water seal pot, rotating grease seals, and operating the calciner at a slight negative pressure are used to minimize the loss of calciner contents due to pressurizations. The seals are also pressure-checked after the calciner is initially heated up before the feed material is started, or as needed. Operators are provided with full face respirators while trouble-shooting or performing maintenance.

Environmental Protection:

The offgas is treated and released through a permitted scrubber and HEPA filter. Liquid waste effluents are discharged through the NPDES permitted waste treatment operations.

Chemical Safety:

Natural gas and cracked ammonia are the significant chemicals at this stage of processing. The natural gas is used and controlled in accordance with OSHA and NFPA standards.

Fire Safety:

- A primary risk of fire or explosion is the use of hydrogen in the calciner to convert the feed material to UO_2 powder. The calciner is a sealed system and operates at a slight negative pressure to prevent release of hydrogen to the work environment Because the calciner tube is maintained above the hydrogen combustion temperature, any in-leakage of air results in the consumption of the oxygen.
- Hydrogen safety in the calciner is assured by two safety interlocks:
- Calciner temperature must be above the hydrogen explosion limits before starting and during hydrogen flow.
- If calciner pressurization above the calciner relief pressure occurs, the hydrogen flow is shut off to avoid hydrogen release outside of the calciner and potential fire at the point of release.
- The calciner and off-gas scrubber system is designed to operate with a hydrogen concentration above the maximum flammability limit or below the minimum air concentration required for combustion.

- Flame safety of the gas fired calciner heating burners is assured by a combustion safety system which meets the requirements of Factory Mutual Engineering Corporation.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

A.1.2.5 UO_2 POWDER PRE-TREATMENT (MSG) (**Phase out for lines 1-4 by 12/31/97**)

Process/Equipment Description:

Pre-treatment consists of milling the UO_2 powder, pressing it into slugs, and then granulating the slugs into powder to a standard particle size. The containers of powder are subsequently queued for use.

Criticality Safety:

- All components of the MSG processes are geometrically safe.

- Line 3 mill hood entrances and granulator exit physically prevents receipt and discharge of 5 gallon (LoE) containers. All other mill hood entrances and granulator exits physically prevent receipt and discharge of 3 gallon (HiE) containers.

- Each mill/baghouse/slugger/granulator is limited to a maximum total quantity of $U0_2$ powder by an accountability system station limit.

- The normal condition of the UO_2 powder in the pre-treatment stage is dry since it has just been processed through the calciner and has been protected by the container. No sources of moderation are involved in the pre-treatment process; however, powder which has been prepared for pressing may also contain hydrogen-bearing materials which have been added as part of the process.

- Each container of UO_2 powder is visually inspected for moisture prior to milling. Containers of visibly moist powder are physically identified and reprocessed.

- A statistical sampling of the containers discharged from the granulator is analyzed for moisture and uranium content. The containers are then transferred to storage.

- All powder storage facilities have been evaluated for the storage of powder of 4.013 w/o U-235 (except for the high enrichment UO_2 powder pre-treatment and blending area, which was evaluated for 5.0 w/o U-235). Normal condition powder moderator content is less than or equivalent to 50,000 ppm water. Two storage areas, one in the pellet press feed facility and one for LoE material, are used which have been demonstrated to be critically safe.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Air effluents are treated through a permitted HEPA Filter System.

Chemical Safety:

This is not a chemical process. No special requirements apply at this point in the process.

Fire Safety:

Since the product of milling is UO_2, and there is mechanical energy being added by the milling operation, burn-back oxidation to U_3O_8 is a possibility which has been addressed through sealing the system to control air in-leakage, cooling the mill hammer heads with a flow of nitrogen, minimizing combustible materials in the system, and use of metal product containers.

Industrial Safety:

Applicable OSHA practices and regulations are followed. Employee safety is maintained by complying with milling and pressing operations, equipment, and procedures and job hazard analysis.

A.1.2.6 UO_2 POWDER BLENDING **(Replaced by DCP by 12/31/97)**

Process/Equipment Description:

UO_2 powder is blended by use of a rotary slab blender. The LoE rotary slab blender is used for UO_2 processing up to 4.013 w/o U-235. The HiE rotary slab blender is used for UO_2 processing up to 5.0 w/o U-235. Both LoE and HiE blenders adjust the uranium enrichment and/or for assure homogeneity of UO_2 powder physical properties.

Powder to be blended is accumulated in 5 gallon containers for up to 4.0 w/o U-235 (LoE), or in 3 gallon containers for up to 5.0 w/o U-235 (HiE). The containers are then transferred to an enclosed and ventilated hood, where the powder is conveyed pneumatically into the appropriate slab blender.

After the blender has been charged, it is closed and rotated. Upon completion of the blend, the blended material is discharged pneumatically into 5 gallon containers for LoE powder and 3 gallon containers for HiE powder. The containers of blended powder are subsequently staged to await enrichment verification.

Criticality Safety:

- Both the LoE and HiE rotary slab blenders are considered a safe slab geometry for UO_2 powder enrichments up to 4.013 w/o and 5.0 w/o U-235, respectively.

- UO_2 powder released to the LoE and HiE rotary slab blenders must be dry (e.g., moderation control requires powder contain less than 5000 ppm equivalent H_2O moisture).

- Blends of UO_2 and binder/poreformer must be limited to not more than 2% by weight of binder/poreformer.

- Respective blender entrance/exit hoods must physically prevent LoE hood from receiving 3-gallon cans, and HiE hood from receiving 5-gallon cans.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

The exhaust air is discharged though a permitted HEPA Filter System.

Chemical Safety:

This is not a chemical process. No special requirements apply at this point in the process.

Fire Safety:

No specific fire hazards are inherent for the UO_2 blending areas.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

B.1 URANIUM RECOVERY & WASTE TREATMENT OPERATIONS

B.1.1 FLUORIDE WASTE TREATMENT: URANIUM RECOVERY

Process/Equipment Description:

The chemical conversion of uranium hexafluoride to uranium dioxide produces an ammonium fluoride waste liquid containing low concentrations of uranium which is subsequently treated by an ion exchange process to recover the uranium. The waste liquid is released from quarantine tanks to a 65,000 gallon surge tank (V-106) which feeds the ion exchange process.

The fluoride waste treatment ion exchange and ion barrens system basic equipment consists of three annular vessel columns (with neutron absorber panels). Two are operated in series and the third, a regenerated column, in standby. Fluoride liquid flows through the two columns with the uranium being removed by the ion exchange resin. The barrens liquid, nearly uranium-free, flows through redundant pipe detectors prior to being sent to the 100,000 gallon surge tank (V-108) at the waste treatment plant for additional processing and ammonia recovery before final discharge to the final process basins. Operational sequencing, monitoring of process variables, and process control are managed by a computerized process control system.

Criticality Safety:

- All process equipment annular vessels are analyzed as geometrically safe for material process enrichments up to 5.0 w/o U235. Safe geometry units also include associated pumps, sumps, and piping but excludes the 65,000 gal and 100,000 gal surge tanks.

- In addition, the concentration of the liquids processed is maintained at less than the maximum acceptable limit by uranium monitor and/or pipe detector limits on the inputs to the systems.

- The large surge tanks are operated with mass and concentration controls which are maintained by independent active engineered control systems measure uranium concentrations.

- Backflow of uranium into the chemical supply systems is prevented at each connection point by at least two engineered controls, each of which are independently capable of preventing the backflow.

Radiological Safety:

This is a wet process and as such exhibits little radiological exposure potential. Workers use procedurally required protective clothing. Their exposure is determined and maintained ALARA.

Environmental Protection:

Additional processing and discharge occurs through NPDES permitted waste treatment operations.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Level control instrumentation is designed to avoid tank overflow, but in the event of an overflow, the liquid would be directed through a seal pot into a curbed containment area.

Fire Safety:

Fire was included in the geometry considerations for the vessels. There are no special explosion considerations.

Industrial Safety:

Process vessels are designed and fabricated in accordance with applicable ASME codes. The ion exchange columns are pressure vessels equipped with safety pressure valves and designed for a pressure rating well in excess of the pressure which could be delivered by any system pump into a closed vessel.

B.1.2 FLUORIDE WASTE TREATMENT: AMMONIA RECOVERY**(Phase out by 12/31/97)**/WASTE DISCHARGE **(Continues, however quantities decrease)**

Process/Equipment Description:

Fluoride waste (essentially uranium free at this point) barrens discharged from the URU ion exchange process is treated at the fluoride waste treatment plant to recover ammonia for return to the fuel manufacturing operation and to precipitate calcium fluoride for off-site disposal.

Fluoride waste is accumulated in a 100,000 gallon surge tank (V-108) and is subsequently preheated and then pumped to a reactor tank where it is reacted with lime to precipitate calcium fluoride and ammonium hydroxide. The reaction products are pumped to a steam stripping column where ammonium hydroxide is removed and condensed. The aqueous calcium fluoride solution is mixed with a flocculent and settled in an overflow clarifier. Clear effluent from the clarifier is gravity fed to a fluoride basins system for additional settling before it is pumped to the final process basins system for discharge. The solids from the clarifier are filtered and prepared for off-site disposal. The filtrate is returned to the clarifier.

Criticality Safety:

- Criticality safety of the ammonia recovery plant is based on the low uranium content of the feed (typically less than 2 ppm U) and the absence of any credible mechanism in ammonia recovery by which uranium could be appreciably concentrated.

- The uranium content of the feed to ammonia recovery is far below the uranium value established as a criticality safety limit of 25 ppm U in the 100,000 gallon surge tank (V-108).

- Redundant, yet independent on-line analytical (pipe-detector) systems in the uranium recovery operation ensures that only low-level uranium liquid from the ion exchange process is pumped to V-108.

- V-108 is also equipped with redundant density monitors to detect any potential increased concentration of uranium. Alarms from the monitors signal operators to centrifuge the cone of the surge tank or activate valves to prevent further accumulation of material in the tank.

Radiological Safety:

This is a wet system and very low concentrations, therefore there is no special radiological considerations required. Workers wear prescribed protective clothing for normal and maintenance work. Their exposure is determined and maintained ALARA.

Environmental Protection:

These operations are permitted under the site NPDES permit.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Level and pressure control instrumentation are designed to prevent overflows and over-pressures. In the event of overflows or over-pressures, overflow lines are directed to seal pots in sump areas.

Fire Safety:

There are no special fire and explosion considerations at this stage of the process.

Industrial Safety:

- The reactor tank and stripping column are over-pressure protected.
- The solids removal filter has a maximum operating pressure greater than the pressure the feed pump can supply under any conditions.

B.1.3 RADWASTE TREATMENT-URANIUM RECOVERY **(Continues)**

Process/Equipment Description:

The radwaste treatment system is an accumulation of various low-level radioactive waste streams which are generated in the fuel manufacturing operation. The sources of these liquids include the analytical laboratory, decon facility, incinerator, the URU furnace scrubber, and general equipment cleaning for maintenance, and general housecleaning liquids.

The accumulated liquids are treated with lime in the reactor to precipitate the uranium. The uranium is then aged and concentrated into a sludge by recirculating the treated liquid through a filter system. The filtered slurry is centrifuged to remove the solids, which are sent to the scrap recovery operation to recover the uranium. The filtrate, which is nearly uranium-free, is discharged through a receiver and quarantine tanks U-monitor and pipe detector to the final process basins system. The radwaste treatment system components include accumulator annular vessels (V600, V601), a reactor pipe tank (R-605), annular aging tanks (V610, V611), cross flow filters (F-620 to F-625), receiver vessel (V-630), and permeate quarantine annular vessels (V-635, V-636).

Criticality Safety:

- All process equipment in the radwaste system (tanks, pumps, sumps, centrifuges, filters, and piping) are safe geometry for 5.0 w/o U-235 upstream of the aeration basin.

- Concentration in the accumulator tanks, reactor, and aging tank are maintained at less than 50 gU/l on-line density measurements and valve interlocks with feed inputs.

- Backflow of uranium from the process line into the lime slurry system is prevented by the pressure in the supply line being maintained higher than pressures in the process system and the lime supply valve is automatically closed by high level in the reactor.

- Release from radwaste permeate quarantine annular vessels is automatically controlled by passive uranium monitor and pipe detector monitors in series to ensure that the batch release radwaste permeate meet uranium discharge requirements.

Radiological Safety:

This is a wet system and radiological controls require no special attention. Workers are protected in prescribed protective clothing. Exposures are determined and maintained ALARA

Environmental Protection:

Liquid effluent discharge occurs through NPDES permitted waste treatment operations.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Level control instrumentation is designed to avoid tank overflow. In the event of an overflow, the liquid would be directed through a seal pot into a curbed containment area.

Fire Safety:

There are no special fire safety controls at this stage of the process.

Industrial Safety:

Operating safety of the process centrifuge is maintained by a detector which will shut down the centrifuge if a high amperage condition is detected.

B.1.4 RAD WASTE TREATMENT-FINAL PROCESS BASIN SYSTEM **(Continues)**

Process Description:

Rad Waste is combined with other liquid effluents in the final process basins system. The pH of the liquid effluents is monitored and adjusted, if necessary before final discharge.

Nearly uranium-free effluents from the radwaste and fluoride waste streams are discharged through the final basins system. Waste streams from these production areas combine at a mixing tank, which is continuously agitated, for pH adjustment. The effluent from the mixing tank gravity flows to an aeration basin, which provides equalization and settling of suspended solids in the waste water. A final pH adjustment system is located at the outfall of each basin. The monitored outfall to the effluent channel flows to the Northeast Cape Fear River.

Criticality Safety:

The characteristics of the material effluent into the basins (see above) are measured and controlled to ensure that the concentration of uranium in the basins are maintained to a safe level. Periodic sampling confirms the concentration.

Radiological Safety:

This is a wet system and the concentrations are very low. There are no special radiological controls in this stage of the process. The operation of the basins is monitored.

Environmental Protection:

The operation of the basins is monitored to assure regulatory compliance and to verify that there are no adverse impacts to the surrounding environment. The liquid effluents are treated and discharged through the NPDES permitted system.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Flow control instrumentation is dedicated and fails to safe condition. Process piping and addition/adjustment systems are located inside the vessels or weir systems to minimize operator exposure to chemicals.

Fire Safety:

There are no special fire and explosion considerations in this area as all the systems are liquid in nature and are non-flammable/non-combustible.

Industrial Safety:

Discharge overflow weirs of the final process basins are protected by safety railings. Shutoff valves/personal protective equipment and safety showers are located near acid addition systems.

B.1.5 NITRATE WASTE TREATMENT-URANIUM RECOVERY **(Continues to support URU)**

Process/Equipment Description:

The nitrate waste treatment system is an accumulation of radioactive waste streams that are generated primarily from uranyl nitrate conversion and acid flushing of process equipment. The accumulated liquids are treated with lime to precipitate the uranium. The uranium is concentrated into a sludge by recirculating the treated liquid through a filter system. The filtered slurry is centrifuged to remove the solids, which are sent to the scrap recovery operation to recover the uranium. The filtrate, which is nearly uranium-free, is discharged through quarantine tanks U-monitor and pipe detector to a 20,000 gallon accumulator tank.

The solvent extraction process of uranium recovery generates a nitrate aqueous waste liquid which is low in uranium and contains various impurities rejected by the solvent extraction process. The solvent extraction aqueous waste is accumulated in either of two quarantine tanks and is discharged to the same 20,000 gallon accumulator tank (V-103), after analytical confirmation of low uranium content. The contents of the 20,000 gallon surge tank is pumped to the secondary nitrate waste treatment plant.

The primary nitrate waste treatment system components include quarantine slab tanks A and B, annular accumulator tank (V-400), a reactor pipe tank (R-400), annular aging tank (V-402), centrifuge (CEN-405), cross flow filters (F-410, 412, 414), permeate tanks (T-415, 416), annular quarantine tanks (V-421, 422), and a NW accumulator tank (V-103).

Criticality Safety:

- All process equipment in the primary nitrate waste system (tanks, pumps, sumps, centrifuges, filters, pails and piping) is safe geometry for 5.0 w/o U-235, except for the 20,000 gallon accumulator tank (V-103).

- V-103 gallon surge tank is operated with mass and concentration controls. The inputs to the tank (which are limited to a concentration such that if the tank were filled it would not exceed safe mass) are monitored to limit the tank to a safe mass. The tank also has a redundant recirculation system which prevents the settling of material into an unsafe concentration.

- The concentration of uranium in the accumulator tank, reactor, and aging tank is limited by a system of density monitors at the accumulator and aging tanks which stop inputs if the limit is approached.

- Backflow of uranium from the reactor into the lime slurry tank is prevented by redundant pumps which keep the pressure in the lime system above that in the reactor and by a high level switch in the reactor which closes the lime supply valve.

Radiological Safety:

This is a wet process and there are no special radiological controls required. Operators wear prescribed protective clothing. Their exposure is monitored and maintained ALARA.

Environmental Protection:

There are no special environmental considerations at this part of the process.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Level control instrumentation is designed to avoid tank overflow. In the event of an overflow, the liquid would be directed through a seal pot into a curbed containment area.

Fire Safety:

There are no special fire and explosion considerations at this step of the process.

Industrial Safety:

Applicable OSHA practices and regulations are followed. Operating safety of the process centrifuge is maintained by a detector which will shut down the centrifuge if a high amperage condition is detected.

B.1.6 SECONDARY NITRATE WASTE TREATMENT **(Continues)**

Process/Equipment Description:

The liquid effluents from the primary nitrate waste treatment and aqueous wastes from the solvent extraction process are accumulated V-103 (above) and transferred to a 20,000 gallon conical-bottom settling tank at the waste treatment facility. Lime is added to the settling tank to adjust pH and a polymer flocculent is added to enhance settling. The concentrated solids are removed from the bottom of the settling cone and filtered. The filtered solids are collected in cans and retained for recovery or shipped off-site for disposal. The decant liquid is verified to ensure limited uranium content and then pumped to a dedicated basins for storage, aging, and further settling. After analytical confirmation of limited uranium content, the stored nitrate effluent is shipped off-site for disposal.

Criticality Safety:

- The settling tank (V-104) is operated on a batch basis with a combination of density and mass controls. The density is limited by continuous redundant density measurements which alarms the operator to start the operation of the filter to remove solids at a high density limit and activates an air sparge at a higher density limit.

Mass is limited by engineered and procedural controls that limit V-104 to less than a safe mass.

- A series of engineered and procedural controls limits the uranium content to less than a safe mass for the secondary nitrate waste filter. In addition, the system is inspected and cleaned of any accumulations each batch.

Radiological Safety:

This is a wet process that handles liquids. There are no special radiological considerations for this part of the process. Workers wear prescribed protective clothing. Their exposure is monitored and maintained ALARA.

Environmental Protection:

The liquids are accumulated in basins where the area is monitored for leakage. Before trucking to Federal Paper for use as a nutrient in their waste treatment system the liquid undergoes a rigid sequence of measurements to ensure compliance with internal limits.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Level control instrumentation is designed to avoid tank overflows and overflow lines are located at a lower elevation than inlet nozzles.

Fire Safety:

There are no special fire and explosion considerations for this part of the process.

Industrial Safety:

Over-pressure protection of the solids removal filter is accomplished by feed and blow-down regulators and a fail-safe pressure switch that prevents the platen from rising if the filter is pressurized. The filter is fully hooded in a protective enclosure.

B.2 SCRAP RECOVERY (Continues)

B.2.1 OXIDATION PROCESS

Process/Equipment Description:

All uranium-bearing scrap (wet sludges and dry powder/pellets known to be contaminated with gadolinia) is oxidized in a muffle furnace prior to nitric acid dissolution and solvent extraction for uranium recovery. All scrap, prior to transfer to the scrap recovery oxidation furnace, is packaged in 3 or 5 gallon metal containers which are conveyed one container at a time to one of two boat dump hoods where the contents are dumped into open furnace boats. Each furnace boat, which holds one container of scrap, enters the furnace from a hooded enclosure and is cycled through the process via enclosed conveyors and hydraulic rams.

The furnace operating temperature is controlled by a computerized process control system. The boats pass through the furnace in a single line pushed by a timed pusher mechanism. Only one boat is loaded and stoked into the furnace at a time.

The furnace ends are enclosed and the entry end is vented to an exhaust scrubber which maintains the furnace muffle under a negative pressure to ensure vapors and fumes are removed.

A single boat of oxidized scrap exiting from the furnace is routed within an enclosure to an inspection station for inspection for tramp metal and to an automatic boat dump station where the oxidized scrap falls by gravity into a delumper which discharges into a roll crusher. At the can fill station, a single can is filled at a time and then moved to an enclosed blend station. After blending, each container is weighed and scanned for isotopic enrichment. The containers are then moved on conveyors to an off-load station for transport to storage pads to await disposition. The low grade sludges generated in URU are not blended or scanned.

This existing Scrap Recovery processes will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- Material is delivered to the oxidation process in approved 3 or 5 gallon containers (geometry) which are limited to less than a specified weight (mass) by scales at the entrance to the conveyor. Both input conveyors require that each container have a weight verification and be placed on a spacer skid prior to entry.

- Geometry and mass at the can dump stations are limited to one container and one boat at a time.

- A 4-inch safe slab height geometry is redundantly maintained within the oxidation furnace by the patty ram and wipe bar, respectively, at the stoke end of the furnace. The boats are only 3.6-inches in height, and the muffle design precludes double stacking.

- The boat dump, roll crusher, and can which receives the processed material are safe geometry currently for 5.0 w/o U-235. This system is moderation limited to the processing of material which has passed through the oxidation furnace and therefore with less than 25,000 ppm water.

- The out-container conveyor is limited to 3 gallon containers containing less than 25,000 ppm water and weighing no more than the specified weight.

- All components of the oxidation off-gas system are safe geometries currently for 5 w/o U-235. In addition, the uranium content is so limited by a combination of procedural controls that ensure the system will contain less than a safe batch and a continuous water purge.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

The off-gas system is designed to keep the furnace discharges below all required nuclear and non-nuclear discharge limits. This discharge and related control equipment are permitted.

Chemical Safety:

There are no special chemical safety requirements for this part of the process.

Fire Safety:

- Overheating of the furnace and meltdown of the furnace muffle are prevented by zone temperature transmitters. High temperature will shut off the power to the furnace automatically. The furnace muffle is maintained under a negative atmosphere.

- The furnace is heated by electrical elements and power will be automatically secured for a high temperature excursion.

Industrial Safety:

There are no specific industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

B.2.2 DISSOLUTION PROCESS

Process/Equipment Description:

Uranium scrap materials from the fuel manufacturing and uranium recovery operations are dissolved in nitric acid solution to produce a crude uranyl nitrate solution (UNH) which is pressure filtered and processed by solvent extraction for uranium recovery. Undissolved solids obtained by filtration are collected for future disposition (burial or reprocessing). Three or five gallon metal containers containing high-grade uranium materials as well as dried low-grade uranium sludges are moved to the dissolver area lift elevator which is controlled by a programmable logic controller used to verify material type and weight and to provide automation of container movement. After parameters are checked and verified for a single container at a time to ensure moderation control, the container is then automatically raised to the upper level of the dissolver area.

The dissolution operation is a batch controlled process that is managed with a process computer control system. The process computer system, after receiving operator input for containers of material to be dissolved, automatically controls the dumping sequence, chemical additives, ventilation, temperature, pumping operation and other parameters to assure a safe and proper dissolution.

Nitric acid vapors generated during dissolution are withdrawn from the dissolver via the dissolver off-gas system and are also collected in the condenser and drained back to the dissolver. Each of the dissolvers contains an independent system that joins into a common header to the NOx absorber.

The crude UNH solution generated during dissolution contains insoluble solids which are filtered, collected, and washed, and partially dried. The solids are then discharged to containers, dried, and collected for future disposition. The solid-free uranyl nitrate solution is used as feed bypassing the solvent extraction process.

Criticality Safety:

- All process equipment (can dump systems, dissolvers, pumps, sump, filter, and piping) is safe geometry currently for 5.0 w/o U-235.

- The can dump station is limited to one container at a time (mass control) and limited to dry feed material containing less than 50,000 ppm equivalent H_2O (moderation control).

- The uranium recovery dissolution process is managed by a process control computer which monitors process variables and can initiate active engineered or other safety controls as appropriate to ensure that the dissolver and all equipment downstream are limited to a specified concentration control limit.

- Insoluble solids from the safe geometry filter is placed in 3 gallon containers and transferred to the oxidation furnace. Each safe geometry 3-gallon container is limited to 25 kgs gross weight, which corresponds to less than a safe UO_2 mass at 5.0 w/o U-235.

- Backflow of uranium to the steam, air, water, and chemical services is prevented via break tanks and other passive means. Deionized water, nitric acid, and aluminum nitrate break tanks are equipped with high-level switches and overflows.

- Since the NOx scrubber is geometrically unsafe diameter, engineered controls maintain criticality safety conditions by automatic concentration control. A densitometer measures the density of recirculating fluids to control both uranium and nitric acid concentrations.

Radiological Safety:

Powders are handled only in enclosed hoods which completely contain upper sections of the dissolver loading system, and which protect personnel from radiological exposure and potential fumes from the dissolvers.

Environmental Protection:

Nitric Acid vapors generated during this process are contained by the off-gas treatment system.

Chemical Safety:

The dissolver is operated at a negative pressure which protects personnel from fumes. A check is performed on the dissolver vacuum directly and operations are interlocked to shut down when the vacuum is lost.

The potential for operator exposure to chemicals, particularly hot nitric acid solutions, has been minimized by several design features. The chemicals are completely contained in process vessels and piping. The piping is designed to minimize slurry pluggage and subsequent operator exposure.

Fire Safety:

Fire hazards are not significant in the dissolver area due to the nature of the chemicals and equipment materials involved; however, an automatic fire water header does traverse the area and is equipped with fused sprinkler nozzles.

Industrial Safety:

The dissolving temperature is controlled by heat exchangers in the recirculation piping. An additional interlock stops loading operations if the temperature measured in the dissolver exceeds the high limit.

B.2.3 COUNTER-CURRENT LEACHING PROCESS

Process Description:

Uranium scrap materials from the incinerator ash and other uranium recovery operations that contain high amounts of insoluble solids are leached, rather than dissolved, in nitric acid solution to produce a crude uranyl nitrate solution (UNH). This solution is filtered and processed by solvent extraction for uranium recovery. Solids obtained by filtration or counter-current discharge are collected for future disposition.

The leaching equipment include three leaching troughs, bag filters, and associated pumps, piping, and instrumentation. Control of the process is accomplished by a programmable logic controller (PLC). The new leaching process is based on counter-current flows between liquid and solid phases. The conveying means consists of a solid shaft at the center of the channel to which are fastened adjustable paddles. The paddles form an interrupted helix to propel the solids forward and yet offer little resistance to the counterflow of the nitric acid extractant liquid. The paddles are set to overlap so that the solids are gently tumbled from one paddle to the next for maximum contact with the extracting nitric acid solution.

Continuous feed of solids and liquids are adjusted to control the density of the uranyl nitrate solution in a counter-current feed train. The solid residue is collected and dried for future disposition.

Criticality Safety:

- All processing equipment containing uranium in either liquid or solid form associated with the counter-current uranium leaching system has been demonstrated as safe (favorable) geometry for maximum material enrichment of 5.0 w/o U235. This equipment includes the leaching feeder hopper, the leach troughs/discharge chutes, pipe tanks, filters, and material feed/discharge cans.

- Uranium solution concentration in safe geometry units may not exceed 350 gU/l. In cc-leach trough and product pipe tanks this is accomplished by direct measurement of product solution density.

- Geometry/mass/moderation of feed cans are controlled parameters. The cans are limited to 3 and 5-gallon containers, and must be on approve conveyors, the gross weight of feed 3 and 5-gallon containers are limited to 25 and 35 kgs, respectively. The moderation of feed material is controlled by oxidation to be less than or equal to not more than 50,000 ppm equivalent water.

- Geometry/mass of discharge cans are controlled parameters. Only 3-gallon containers are used, and the gross weight is limited to 25 kgs.

- Backflow of uranium to the steam and chemical services is prevented. Deionized water, nitric acid, and aluminum nitrate break tanks are equipped with high-level switches and overflows. Steam backflow prevention is primarily achieved by the use of a jacket heat exchanger on the leachers, rather than steam injection directly to the process and the steam header is automatically blocked closed if header pressure falls below low pressure value to prevent backflow into the main service header. Active monitoring of the steam conductivity in this jacket is used to detect for uranium.

Radiological Safety:

This is treated the same as the dissolution process since they are similar.

Environmental Protection:

This is treated the same as the dissolution process since they are similar.

Chemical Safety:

The computerized process control system constantly monitors the NOx absorber and automatically ceases loading operation if a fault is detected.

The potential for operator exposure to chemicals, particularly hot nitric acid solutions, has been minimized by several design features. Flanges are sparingly used, and where they exist, flange covers are installed. The chemicals are completely contained in process vessels and piping.

Level controls are designed to avoid the overflow of vessels, but if an overflow should occur, it would be directed to a safe location.

Fire Safety:

Fire hazards are not significant in the leacher area due to the chemicals andequipment materials involved; however, an automatic fire water header does traverse the area and is equipped with fused sprinkler nozzles.

Industrial Safety:

The leacher area shares a centrally-located safety shower with the dissolver area.

Piping and vessels with external surfaces in excess of a specified temperature are insulated to protect operating personnel.

B.2.4 HEAD-END CONCENTRATOR PROCESS

Process/Equipment Description:

Various liquid waste streams containing low-level concentrations of uranium, produced in scrap recovery processes, are collected and processed through the head end concentrator (HEC) system to increase the uranium concentration and reduce the overall volume of liquid that is fed to the URU solvent extraction system. This concentration step is accomplished by passing the solution through a reboiler where steam is added to evaporate excess water contained in the various waste streams. During recycle, the water vapors are further removed, until the uranium concentration in the solution increases to the desired density (or concentration). The density of the product from the concentrator is computed and monitored continuously by a computerized process control system. Once achieved, the solution is transferred to the solvent extraction system for processing. The resulting water vapors produced are removed and recovered through an overhead condenser and process through the aqueous radwaste system.

Criticality Safety:

- All equipment in the head-end concentrator system is safe geometry currently for UO_2 at 5.0 w/o U-235, except for the slab section at the top of the concentrator, which is safe for UN at 5.0 w/o U235.

- The density (or uranium concentration) is actively controlled using density probes. The established criticality safety limit is 350 gU/l; the maximum concentration achieved by the HEC system is 280 gU/l. The active engineered control(s) are set at 1.37 g/cc and corresponds to a UN density of 280 gU/l at zero free nitric acid.

- Backflow of uranium into the cooling water system is prevented by maintaining pressure on the cooling water that is higher than the pressure on the process fluids. Also low pressure in the cooling water will stop process pumps. Backflow into the steam system is prevented by isolating the steam supply if low steam pressure occurs and by isolating the steam supply if high conductivity occurs in the condensate.

Radiological Safety:

This is a wet closed system and there are no special radiological considerations. Workers wear prescribed protective clothing. Work is conducted using procedures or radiation work permits. Worker exposure is monitored and maintained ALARA.

Environmental Protection:

There are no special environmental considerations at this point in the process.

Chemical Safety:

Exposure to hot nitric acid has been minimized by using flanged piping at all connections.

Fire Safety:

Formation of red oil (nitrated organic compounds) is controlled in the following manner. Streams containing organic solvent flow through aqueous/organic decanters prior to entering the concentrator feed tank. The temperature at which nitration of the organic could occur is controlled to below a specified temperature by reducing the effective steam pressure to the reboiler. Extremely low nitric acid concentration in the feed to the concentrator further minimizes the potential for formation of red oil.

The head-end concentrator is constructed of non-combustible material and the system is located within a sprinkled fire main area.

Industrial Safety:

There are no special industrial safety controls other than discussed above. Applicable OSHA practices and regulations are followed.

B.2.5 SOLVENT EXTRACTION PROCESS

Process/Equipment Description:

The solvent extraction process is used to remove soluble metal impurities from the uranyl nitrate solutions. The scrap recovery dissolution, counter-current leaching, and head-end concentrator product uranyl nitrate solutions are blended for feed to the solvent extraction process. he solvent extraction system separates soluble metal contaminants from the uranyl nitrate solution. The purified uranyl nitrate solution is then processed through a product concentrator prior to conversion to uranium dioxide on Line 5.

Proven extraction technology is employed to recover and purify uranium from the blended aqueous feed solution. The separation of uranium from soluble contaminants in the solution is achieved by preferential transfer of the uranyl nitrate into an organic phase, scrubbing of the organic stream to remove trace contaminants, and stripping of the purified uranyl nitrate from the organic phase by slightly acidified water.

The solvent extraction process is controlled automatically by the process computer control system. Product density is automatically controlled. The aqueous waste stream stripped of uranium is discharged to the waste treatment facility for additional processing.

Criticality Safety:

- All equipment in the solvent extraction system is safe geometry currently for UO_2 at 5.0 w/o U-235.

- The maximum concentration of uranium within the solvent extraction process is maintained by a combination of active measurements on the feed and by limiting chemical characteristics of the process materials

- Since the NOx scrubber is geometrically unsafe diameter, a combination of active density measurements and procedural sampling keeps the mass and concentration independently to controlled values.

- Deionized water is supplied to the system by way of a break tank which prevents backflow by providing an overflow before the uranium reaches the level at which backflow could occur and by providing closure of the deionized water supply valve on an indication of high level. A double-block and bleed valve closes on low pressure in the air line and a check valve prevents liquid flow through the pneumatic gages on the solvent surge tanks into the air system.

- The annular feed adjustment and S/X feed tanks are equipped with neutron absorber panels. In addition, concentration is limited to a specified amount by upstream controls in the dissolver and head-end concentrator areas.

Radiological Safety:

This system is closed and this isolates the worker from the nuclear material. The worker wears prescribed protective clothing. Their exposure is measured and maintained ALARA.

Environmental Protection:

There are no special environmental considerations at this stage of the process.

Chemical Safety:

The solvent extraction area drains to a central curbed sump where the area is designed to contain a total spill from any of the vessels.

Chemicals handled within the system are contained within the process vessels and piping. Tank overflows are directed to seal pots. Level control instrumentation is designed to avoid tank overflow, but in the event of an overflow, the liquid would be directed into the curbed containment area.

Fire Safety:

Formation of red oil (nitrated organic compounds) is controlled in the following manner. Streams containing organic solvent flow through aqueous/organic decanters prior to entering the concentrator feed tank. The temperature at which nitration of the organic could occur is controlled to below a specified temperature by reducing the effective steam pressure to the reboiler. Extremely low nitric acid concentration in the feed to the concentrator further minimizes the potential forformation of red oil.

Fire safety is attained with a fused, automatic sprinkler header.

Industrial Safety:

The solvent extraction area is equipped with a centrally located safety shower.

B.2.6 URANIUM IN EFFLUENT DETECTION SYSTEM

Process/Equipment Description:

As stated in the various waste treatment sections above, all process liquid waste streams leaving the Uranium Recovery Unit (URU) facility are continuously monitored by an actively engineered control system. This in-line uranium measurement system provides a sophisticated independent means of directly measuring the U-235 content of the effluent waste stream(s) prior to discharge of uranium-bearing liquids to unfavorable geometry vessels. This level of protection is ensured by uranium monitor : pipe detector series measurements or redundant pipe detector: pipe detector series measurement. In all cases, operator actions are not required for the final 'policeman monitor' to close double block and bleed valves which prevents high concentration solution from reaching unfavorable geometry vessels. These are considered 'hardwired' interlocks.

B.2.7 SOLID CONTAMINATED WASTES

Process/Equipment Description:

Contaminated articles such as paper, rags, mops, plastic, wood, protective clothing, damaged tools and equipment, and similar contaminated materials which are no longerserviceable are collected in designated containers to prevent loss of contents and spread of contamination. Containers are located at points in the plant where such wastes may occur. These materials are segregated into noncombustible and combustible categories in the decontamination facility for further processing.

B.2.7.1 Noncombustible Solid Waste Material

Process/Equipment Description:

Containers of noncombustible waste are emptied into a cleaning and sorting hood in the Decontamination Facility. Any combustible waste is separated and placed into a combustible waste container. The remaining non-combustible waste is collected in a 4'x4'x4' metal box, the top applied and then moved to a waste storage area.

Criticality Safety:

- The loading of noncombustible materials into burial boxes is controlled by a fill box monitor which measures uranium content and has a preset alarm limit. The boxes are then scanned to verify the uranium content. If the material in a waste container has more uranium than the established (mass) limit, the container is returned to the decontamination facility for further removal of uranium from the contents prior to shipment.

- Storage of combustible boxes is limited to designated areas in a single planar array (geometry).

Radiological Safety:

Work takes place in well ventilated enclosures when practical. Workers are provided with appropriate respiratory protection and protective clothing in accord with license commitments and as documented in internal procedures.

Environmental Protection:

There are no special environmental considerations at this point.

Chemical Safety:

There are no special chemical considerations at this point in the process.

Fire Safety:

Due to the ventilation there is little chance for a fire. In addition, the area has a fire suppression sprinkler system.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

B.2.7.2 Combustible Solid Waste Material

Process/Equipment Description:

Containers of combustible waste are emptied into a cleaning and sorting hood in the Decontamination Facility. Any combustible waste is separated and placed into a plastic lined combustible 4'x4'x4' waste container which are scanned for uranium content. These boxes are then queued on storage pads in single level planar arrays.

The boxes are then transferred to the waste incinerator facility for processing. The uranium-bearing ash and metal residue are separated and stored for recovery of the uranium and/or disposal at an off-site low-level radioactive waste disposal site. Any non-combustible waste is collected in a 4'x4'x4' metal box and processed as described above.

Criticality Safety:

- The loading of combustible materials into combustible boxes is controlled by a fill box monitor which measures uranium content and has a pre-set alarm limit. The boxes are then scanned to verify the uranium content. If the material in a combustible waste container has more uranium than the established mass limit, the container is returned to the decontamination facility for further removal of uranium from the contents prior to incineration or shipment offsite.

- Storage of combustible boxes is limited to designated areas in a single planar array (geometry).

Radiological Safety:

This work utilizes a specialized room, work table and air suits to eliminate the exposure of the worker. This is all accomplished by the airflow designs and the protective suit. Exposures are monitored and maintained ALARA.

Environmental Protection:

There are no special considerations at this part of the process.

Chemical Safety:

Given the nature of the work and the materials being sorted, workers are instructed and trained to recognize chemical hazards in this area. Appropriate precautions are taken once the hazards are identified.

Fire Safety:

There is some increased potential for fire due to the nature of the material. Containers are kept closed and their lids are tight to prevent initiating events. The area has a fire suppression sprinkler system.

Industrial Safety.

Because the operations utilize supplied air, these systems and their use meet the OSHA and NIOSH requirements. Typical requirements are documented in our procedures and utilized for performing the work and maintaining the equipment.

B.2.8 WASTE OXIDATION-REDUCTION (INCINERATION) FACILITY

Process/Equipment Description:

The combustible waste boxes are moved to the waste oxidation-reduction facility where they are conveyed into the building on motorized conveyors. The boxes are first scanned for uranium content and then queued. A single box is lifted into a loading chamber by a hydraulic lift system. The box is automatically loaded into the primary chamber in a sequence controlled by a programmable control system which also controls the overall operation of the process. The material and ash are conveyed through the primary chamber by a series of rams. The scrubber system is used to treat the offgas prior to discharge to the atmosphere through a stack.

The ash generated from the process is cooled and then removed and screened where the ash and metal/clinkers are separated into 5 gallon metal containers. These containers are scanned for uranium content and transferred to storage. The ash is processed through a uranium recovery process or sent directly to an off-site low-level radioactive waste disposal site.

Criticality Safety:

- Upstream loading of significant quantities of uranium into combustible waste boxes is prohibited as a procedural control. In addition, the waste boxes are loaded under the control of a box fill monitor which alarms at a preset amount ofuranium.

- Mass control on the incinerator: the expected plus 1σ value of U_{238} inside the incinerator burn chamber must not exceed the HOLDUP limit as determined by the primary and diverse UPHOLD incinerator criticality accountability measurement system primary computer. Likewise, the 3σ uncertainty in U_{238} in the chamber as determined by the primary and diverse ICAMs must not exceed the permitted holdup.

- Mass control on the incinerator: the uranium mass inside the incinerator burn chamber must not exceed the HOLDUP limit as determined by the INHOLD incinerator criticality accountability measurement system secondary elephant gun computer.

In addition, the In Incinerator Monitor detectors 5, 6, and 7 are capable of detecting a buildup of 15.9 kgs of U_{238} beneath the burn chamber refractory. This provides additional assurance that the initial 'zero holdup' value assigned at the start of a run is correct.

Radiological Safety:

The equipment and associated enclosures provide the containment of the material and keep the worker separated from it. Special tasks are done by procedure and/or radiation work permit. Workers wear prescribed protective clothing. Their exposure is determined and maintained ALARA.

Environmental Protection:

The permitted off-gas system treats the gaseous products of the furnace. Additionally there are process control parameters on the burn operations that keep the combustion products within the boundary capabilities of the system.

Chemical Safety:

There are no special chemical considerations as this is not a chemical process.

Fire Safety:

Waste materials are sorted prior to placement in a box to avoid possible volatile materials from getting into the process. The waste oxidation-reduction facility is structurally designed to handle volatile reactions with little or no damage

An approved flame safety system is installed and governed by a programmable controller to prevent possible explosions caused by improper ignition of the burners or losses of flame.

Industrial Safety:

The loss of scrubber system quench water could result in melting or burning of fiber-glass reinforced plastic (FRP) components. A flow switch senses the lack of recirculation water flow and automatically shuts off the exhaust blower and process. The exhaust blower shutdown stops the draft of hot gases through the scrubber system thus protecting the FRP scrubber components.

B.2.9 URANYL NITRATE CONVERSION (UCON SKID)

Process/Equipment Description:

Internally generated uranium scrap which does not meet quality standards or which has been mixed with foreign material is recycled through scrap recovery operations for uranium recovery, purification, and conversion to uranium dioxide (UO_2) powder. The final step, conversion of the purified uranyl nitrate to UO_2 powder, is described in this section.

Uranyl nitrate conversion is a continuous uranium precipitation process using ammonium hydroxide. Concentrated uranyl nitrate product from solvent extraction is transferred by enrichment batch from scrap recovery product storage to uranyl nitrate conversion feed storage. Following the completion of precipitation, the ammonium diuranate (ADU) slurry is fed to a dewatering centrifuge. The operation of the dewatering centrifuge is identical to that of the dewatering centrifuge described for the UF_6 Conversion Operation. The ADU sludge from the dewatering centrifuge hopper is pumped into a dedicated calciner after which the UO_2 powder passes through a passivator system that stabilizes the powder to prevent oxidation. The powder is then collected in 5 gallon containers, weighed and forwarded to the UO_2 powder treatment process.

Criticality Safety:

- All of the equipment used in the UCON process is safe geometry currently for 4.013 w/o U-235.

- The precipitation, dewatering, and calcination steps are very similar to the corresponding UF_6 conversion steps for which the criticality safety is described in Sections A.1.2.3.a and A.1.2.4.a.

- Redundant independent laboratory analyses controls enrichment prior to transfer from FMOX storage slab tanks to FMO storage LEM tanks.

- Redundant independent laboratory analyses controls enrichment prior to transfer from FMO storage LEM tanks to the UCON precipitation pipe tank.

- In addition to the safe geometry, the uranyl nitrate stored prior to feed to UCON is limited to not more than 350 gU/l as specified by the concentration controls on solvent extraction and product concentration.

- Backflow of uranium into chemical supply systems is prevented by introducing the chemicals into the system through a passive break tank.

Radiological Safety:

This is a wet process and there are no special radiological controls required. Operators wear prescribed protective clothing. Their exposure is monitored and maintained ALARA.

Environmental Protection:

Air effluents are released through permitted HEPA Filter System. Liquid waste effluents are ultimately treated and discharged through the NPDES permitted waste treatment operations.

Chemical Safety:

Chemicals handled within the system are contained within the process vessels and piping. Level control instrumentation is designed to avoid tank overflow, but in the event of an overflow, the liquid is directed into a curbed containment area. Additionally, the vessels are vented to a roof scrubber exhaust system to minimize chemical vapors in the work environment.

Fire Safety:

The same fire and explosion precautions are applied as in the normal ADU Process and Calcination.

Industrial Safety:

There are no special industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

B.2.10 URANIUM RECOVERY FROM LAGOON SLUDGE (URLS)

Process/Equipment Description:

INTRODUCTION

The URLS objective is to recover uranium from wet sludge stored in basins at the GE-Wilmington facility. The sludges are by-products of treating liquid waste discharges from the fuel manufacturing process. The sludge consists mostly of calcium salts contaminated with varying amounts of uranium from the neutralization of acid waste streams with lime.

These sludges are removed from the storage basins, processed to remove the uranium, and discharged as solid waste that can be disposed off-site. The liquids generated are discharged into the existing waste streams. The uranium is sent to the existing uranium purification facility for further purification.

Concentration is the criticality control mechanism utilized throughout the URLS facility Exceptions include the solvent extraction system (geometry and concentration) and the precipitation/product filtration system where geometry and mass form the basis for criticality safety.

Sludge in the basins is dredged and transferred to a settling tank. Supernate is then decanted and returned to the basins. The settled sludge is drawn out the bottom and transferred to one of two storage tanks and becomes feed for the leaching operation.

The leaching operation removes the uranium from the sludge through use of a multi-stage counter-current leaching process, a standard system used for recovery of minerals from ores. A filtration step is required between each leach stage. (A two-stage system is described.) The sludge from the storage tank is pumped into the first leach tank along with the acidic filtrate retained from the second leach. After leaching, this slurry is filtered. The filtrate liquor, containing the uranium, becomes the aqueous feed to the solvent extraction system. The solids are added to the second leach along with fresh reagents. After leaching, the slurry is filtered. The filtrate liquor is fed to the first leach and the solids are contained for disposal. The solvent extraction operation is a standard two-stage counter-current uranium extraction process. The continuous solvent phase flows countercurrent to the dispersed aqueous phase. The aqueous phase (raffinate) is discharged from the column stripped of the uranium. It is then treated with lime and filtered. The raffinate liquids discharged from the solvent extraction process are continuously monitored for uranium concentration. The filtrate is returned to the basins and the solids are contained for disposal. The uranium-bearing solvent is passed through a strip column to recover the uranium. The barren solvent is then fed through a column and returned as regenerated solvent feed to the extraction operation.

The carbonate solution, containing the uranium, is treated with acid to decarbonate and then treated with magnesium hydroxide to precipitate magnesium diuranate. The uranium solids containing slurry is centrifuged and the uranium and transferred to 5-gallon containers for eventual processing through the purification facility. The centrate is collected and sampled for uranium concentration. If within limits it is transferred to waste treatment. If it is above the limit, it is reworked through the floor sump tank and recycled.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

<u>Criticality Safety</u>:

- The URLS facility criticality safety basis is primarily based on controlling a single parameter - uranium concentration. Using ARH-600, Figure III.B.2.7 for a UO_2-H_2O mixture, the minimum critical concentration for 4.025% U-235 enrichment is 360 gU/l. To meet license requirements, one half of this value or 180 gU/l is the maximum criticality safety limit concentration for all of URLS processes. Exceptions to this include the solvent extraction system (geometry & concentration) and uranium precipitate/filtration systems (geometry & mass) described below.

- The maximum possible concentration of the nitrate sludge feed is 33 gU/l. This is based on extensive sampling statistics which show that the highest uranium concentration in the sludge is 8.4% on a dry weight basis. Since the sludge contains a maximum of 30% solids at a maximum density of 1.3 g/cc, the maximum possible uranium concentration in the feed is 33 gU/l.

- Following leach/filtration, the maximum concentration of the aqueous feed to the solvent extraction process is 37 gU/l.

- The solvent extraction equipment has been demonstrated safe geometry up to 4.025% maximum U-235 enrichment. The maximum possible uranium concentrations for this system are based on the maximum concentrations achievable in the aqueous, TBP/dodecane organic phase, and sodium carbonate strip solutions; these are 37 gU/l, 61 gU/l, and 112 gU/l, respectively.

- A batch transfer of uranium carbonate is transferred to the 10" schedule 80 PVC precipitation pipe tank (safe geometry), where the pH is lowered and uranium is precipitated with magnesium hydroxide. Use of the maximum feed concentration and volume of the precipitation tank results in a safe mass for precipitation.

- Product filtration via centrifuge occurs in a safe geometry vessel; the contents are discharged to a safe geometry 5-gallon can with a mass limit of 35 kgs gross weight (4.025% maximum U-235 enrichment).

Radiological Safety:

The low concentration of material processed in this facility reduces the potential for radiation exposure. Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

The URLS liquid discards are treated in the waste treatment system and discharged through the NPDES permitted discharge point. Air effluents are released through permitted scrubber and HEPA Filter System.

Chemical Safety:

Chemicals handled within the system are contained within process vessels and piping. Level control instrumentation is designed to avoid tank overflow. In the event of an overflow, the liquid is directed into a curbed containment area.

Fire Safety:

Automatic fire detection cut off valves are located in the system. In addition, a high density sprinkler system covers the area.

Industrial Safety:

There are no specific industrial safety controls required in this part of the process. Applicable OSHA practices and regulations are followed.

C.1 DRY CONVERSION DESCRIPTION

The Dry Conversion Process (DCP) is a uranium dioxide (UO_2) production plant which is currently under construction at GE Nuclear Wilmington facility. It comprises three identical parallel production lines for the conversion of uranium hexafluoride (UF_6) to uranium dioxide powder and/or granules, and a common hydrofluoric acid treatment unit for the recovery of HF byproduct from the UF_6 conversion process. The nominal capacity is essentially the same as the current production lines. The design is appropriate through 6% U-235 with proper control.

The DCP is housed in a three story concrete structure (with a concrete roof) on the north side of the current fuel manufacturing facility. This is connected by a pipebridge to a separate building for the production, storage and handling of the HF coproduct from the dry conversion kilns. External to the west side of the DCP building is a UF_6 cylinder laydown area, sized to accommodate six off 30-B cylinders, a cooling tower and electrical transformers.

The equipment building is attached to the west side of the DCP building and also has three floor levels. The first floor contains process utilities such as water chillers and steam boilers. The Motor control center is housed on the second floor adjacent to a HVAC equipment room. The third floor contains mostly HVAC equipment.

A powder packing unit is housed in the south east corner of the building. The inner containers are transferred by conveyor through the east wall of the DCP building to the warehouse, for final packing and shipment.

The plant control room, computer systems room, a staff changeroom and office/conference rooms are located alongside the east wall of the DCP building on the second floor level.

HF production and storage is carried out in a dedicated two-story building. The HF building is a process enclosure with metal siding and a standing seam metal roof. Structural steel and interior walls are painted with HF-acid resistant paint, and the floor is sealed and coated with an acid resistant surface. The concrete foundation is lined to prevent seepage of acid spills and leaks into the ground. A standpipe is provided for routine monitoring of any seepage.

There are two segregated containment areas within the HF building: one for condensers, a polluted HF tank and two concentrated HF storage tanks; the other contains two dilute HF storage tanks and the two washing columns. The contained areas slope to a low point containing a sump in which a pump is installed. The wall height of the contained areas is sufficient to retain the contents of one HF tank plus 6" freeboard. Liquid arisings collected in the sump are pumped directly to the "dirty" dilute HF storage tank for sampling, analysis and subsequent disposal.

A single bay drive-through truck loading area is provided. The bay is fully enclosed with motorized roll up doors on each side to allow drive in/drive out access. This area is also designed to contain the contents of one HF tank, and the floor slopes to a low point with a sump in which a pump is located. Again, any liquid arisings are pumped directly from the sump to the "dirty" dilute HF storage tank.

The HF building is ventilated in the summer and heated in the winter. Ventilation air is drawn in through louvers backed by motorized dampers, and discharged via wall mounted exhaust fans on the opposite side of the building. In winter, the dampers are closed and the exhaust fans are shut down. Space heating, as necessary, is provided by steam unit heaters.

The enclosed HF building and loading area is equipped with an emergency scrubber for evacuation of fumes in the event of a spill or loss of containment. The scrubber is designed to remove the volume of the largest space (the storage area) within 20 minutes. In the event of this system being energized, then the general exhaust fans for the HF building are de-energized and the intake dampers are held in the fully open position.

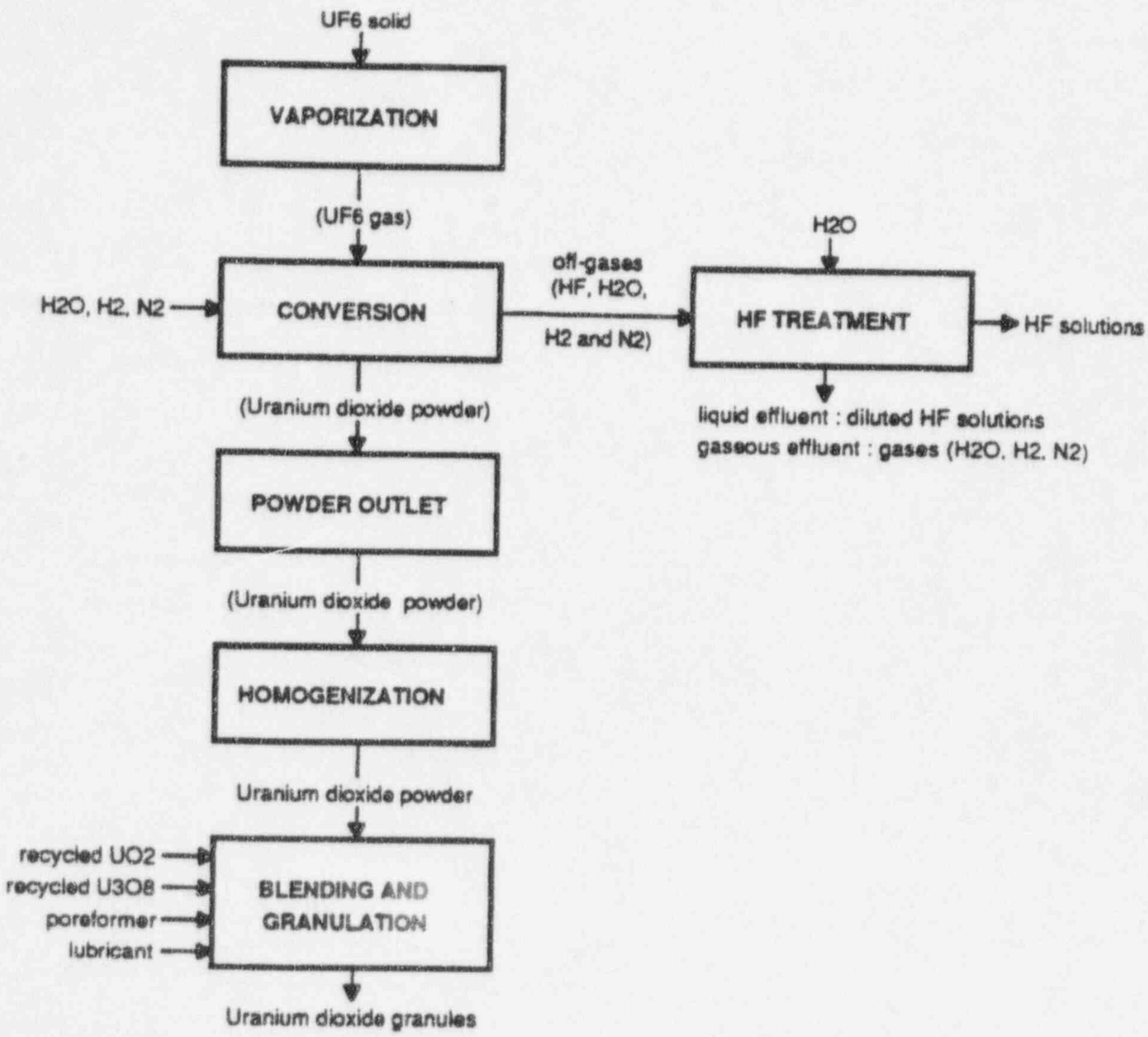
The purpose of the Dry Conversion Process Plant is to transform enriched uranium hexafluoride (UF_6) into uranium dioxide (UO_2) powder or granules. As shown on the following Figure C.1, the Dry Conversion Process Plant is divided into six Process Units:

- Vaporization (of UF_6),
- Conversion (of UF_6 into UO_2 powder),
- Powder Outlet (cooling, sampling and control of the UO_2 powder at the kiln outlet),
- Homogenization,
- Blending and Granulation,
- Hydrofluoric Acid Treatment (HF recovery of the Conversion offgas).

The Dry Conversion Process Plant is designed for enrichments up to 6% U-235 and a nominal annual capacity of 1000 metric tons of uranium per year.

FIGURE C.1
DRY CONVERSION PROCESS PLANT
GENERAL PROCESS BLOCK DIAGRAM

Each of the main process areas are describe in more detail below.



Criticality Safety

A criticality risk applies to all material with a U-235 content in excess of 1%. The criticality hazard in the Dry Conversion Process (DCP) facility is associated with normal and credible abnormal conditions that increase the moderation and its distribution within large unfavorable geometry containers loaded with enriched UO_2 powder.

The criticality risk associated with vaporization is failure to maintain the initial low moderator content of the 30-B cylinder containing UF_6 in solid, liquid, or gas form. The criticality risks associated with the conversion process and powder outlet is associated with preventing the condensation of steam used in the conversion process. The criticality risks associated with the blending and tumbling processes are categorized as either a failure to mix uniformly or exceeding the total allowed quantity when adding moderating material to uranium oxide powders during normal operation. Criticality safety risk associated with homogenization, powder packaging, and powder transfer and storage are failure to exclude to introduction of moderating material or failure to exclude material that exceed the moderation limit.

Criticality safety is based on multi-parameter limits and simultaneous control of process parameters. Criticality parameters that can be modified by normal and credible abnormal conditions are controlled as process parameters. All other parameters are controlled outside the boundary of the process, or a parameter may be assigned a worst case value that is limited by credible normal and abnormal process conditions.

Geometry, mass, moderation, material composition, neutron absorbers, process characteristics and interaction are utilized as criticality safety control parameters in the Dry Conversion Process areas. Concentration, reflection, and enrichment are either not control parameters or limited by process or material characteristics or both. Processes where geometry is not controlled assume a minimum critical dimension or mass for a spherical shape. Concentration control is not used and reflection is limited to enclosing systems by a contiguous layer of water of unlimited thickness. Enrichment of U-235 is limited to 5 wt%. Process characteristics are controlled to assure the maximum credible uranium density does not exceed the uranium density in uranium dioxide powder at a bulk density 3.0 g/cc. Material composition is controlled to assure the particle size is less than the limit at which heterogeneous effects must be considered, otherwise process characteristics assure the material composition is homogeneous.

Multi-parameter control assures criticality safety in the DCP facility operation. Moderation, mass, material composition, neutron absorbers, process characteristics, and interaction may each be controlled to process limits that assures a safety factor for the parameter of interest. One or more of these parameters may be controlled simultaneously to individual parameter limits. Exceeding any one of the moderation, mass, material composition, bulk density, or interaction safety limit may result in exceeding the sub-critical limit.

The likelihood of exceeding a parameter safety limit is minimized by multiple control systems and safety factors for each control parameter. Three independent control systems and a safety factor of three prevent accidentally exceeding the process moderation limit when the normal process intentionally introduces moderation into the defined system. Otherwise, two independent control systems are required to prevent exceeding the process parameter limit (e.g., moderation) when the normal process does not intentionally introduce moderation.

The process control parameters are summarized in Table 1. Geometry is the only control parameter for which the parameter limit is independent of the other control parameters. Mass, moderation, material composition, bulk density, and interaction control parameters are interdependent. Multiple controls on each parameter and safety factors assure that the parameter limit is not accidentally exceeded. Normal process conditions and credible abnormal condition intentionally introduced moderator in the Conversion process at the Conversion Reactor and Kiln Tube, in the Blend/Slug/Granulate process at the Blender, and in Tumbling at the Bicone powder container. Moderator is not intentionally introduced in the remaining process equipment.

Table 1. Dry Conversion Process - Nuclear Criticality Safety Control Summary

Process	Equipment	Fissile material	Control Parameters
UF_6 Handling	30-B Cylinders	UF_6 - HF homogeneous	Moderation Interaction
Vaporization	Autoclave	UF_6 - HF homogeneous	Moderation
	Cold Trap	UF_6 - HF homogeneous	Moderation Geometry
Conversion	Conversion Reactor	UF_6 - HF and UO_2F_2 - H_2O	Moderation
	Kiln Tube	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Moderation
	Powder Outlet Box	$UO_2 \cdot H_2O$	Moderation
Powder Outlet	Cooling Hopper	$UO_2 \cdot H_2O$	Moderation
Homogenization	Homogenizer	$UO_2 \cdot H_2O$	Moderation Mass
Blend/Slug/ Granulate	Blender	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Moderation Mass
	Precompaction press	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Moderation Geometry
	Granulator	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Moderation Geometry
Tumbling	Bicone powder container	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Moderation Mass
Powder transfer and storage	Unicone powder container Bicone powder container	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Moderation Mass Material Composition Process Characteristic
	Storage array	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Interaction
Powder Packaging	Powder container	$UO_2 \cdot H_2O$	Moderation Mass Geometry
HVAC	HEPA Filters	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Mass Moderation
Utilities	Nitrogen, Hydrogen, Steam, Distilled Water Chilled Water, and Refrigerant	UF_6 - HF , UO_2F_2 - H_2O $UO_2 \cdot H_2O$	Mass
HF	Recovery and Storage		Geometry Mass

Radiological Safety

Release of radioactive material contained in the process equipment or facility results in the risk of dispersion of radioactive material. The radiation and contamination risk is due to the presence of uranium compounds in the process areas. Physical and chemical forms of U^{238} enriched to a maximum of 6% U-235 in the uranium powder manufacturing process are UF_6 (Uranium hexafluoride) in solid, liquid or gaseous state, UO_2F_2 (Uranium oxyfluoride), UO_2 and U_3O_8 (Uranium oxides).

Release of gaseous uranium hexafluoride is credible when handling 30-B cylinders containing UF_6 in solid form and utilizing uranium hexafluoride in the vaporization and conversion processes. Release of uranium oxides is credible when handling powder or granule forms of uranium oxides in powder outlet, homogenization, blending/granulation, powder container handling, powder packaging, and equipment and facility cleaning processes. Three containment barriers prevent the release of radioactive material from the process and facility.

The first containment barrier reduces the risk of dispersion from the process equipment in areas accessible to the personnel. The first containment is achieved by the pressure tightness of the process equipment. Metal packaging (UF_6 cylinders, UO_2 powder containers), and process equipment (conversion kilns, mixing vessels, tanks, and piping) provide first containment. Engineered seals around rotating shafts in the process equipment (conversion kilns) provide dynamic containment near the passage of the shaft using nitrogen barriers under excess pressure (conversion kilns). Transfer of uranium oxide powder or granule forms between process equipment and metal packaging requires a temporary break in first containment. An engineered containment barrier consisting of an inflatable seal is provided for the connection of the containers at the powder container loading and unloading stations. Powder packaging and dry vacuum powder collection operations utilize glove box containment. Portable dry vacuum cleaners used for equipment cleaning provide sufficient airflow and HEPA filtration to contain uranium oxides in powder and granule form.

The second containment barrier reduces the risk of dispersion to the facility areas with little or no contamination. The barrier consists of a first containment (wall tightness, sealing of the penetrations, use of air locks allowing materials to be transported in and out of the rooms) and a dynamic containment implemented by the ventilation of the rooms. A ventilation system establishes negative pressure in the rooms in such a way that the air is drawn from areas with little or no contamination to the most contaminated areas. Each process room has one or more ventilation exhaust points through a filter housing consisting of primary and secondary HEPA filters.

The third containment barrier reduces the risk of dispersion from the facility to the external environment. The HVAC system maintains the facility structure at a negative pressure with respect to the outside environment.

The plant receives uranium enriched to a maximum of 5% U-235 coming from natural uranium. The risks of exposure are quite low and are mainly due to the beta and gamma rays emitted by the daughter products of U^{238}, namely Th^{234} and Pa^{234} (half life of 24 days and 1.18 minutes respectively).

The vaporization area presents no sources of external exposure during operation. The low energy gamma rays are either totally absorbed by the UF_6 itself or strongly attenuated by the equipment.

Once the cylinder has been emptied, there remains about 1 kg of uranium hexafluoride. The concentration of Th^{234} and Pa^{234} fluorides is much higher. As a direct consequence of the disappearance of the self-absorption of uranium, the risk of irradiation increases.

Uranium oxide is stocked in large quantities under different forms as powder and granules.

The external irradiation hazard inside the Dry Process Conversion facility is limited. Taking into account the duration of exposure of the operators and the low levels of radiation, no protection measures with respect to risk of external exposure to ionizing radiation are required.

Environmental Protection

The raw materials used for production are UF_6, nitrogen, steam and hydrogen. Of these the fluoride associated with the uranium hexafluoride and the slight amount of radioactivity associated with the low enriched uranium are the principal concerns.

The exhausts from the processing area are filtered through a double step of HEPA filters (99.97 % efficient for 0.3 micron and larger particles) which minimize the release of radioactive emissions to very low values. The vaporization areas where the uranium hexafluoride is handled are well enclosed and protected against external to the facility releases.

The HF facility includes scrubbing of the exhaust to significantly limit the HF discharge. Further the loading area is designed to contain HF effluents during loading. HF discharges should be less than 20 kg per year.

Since the process is a dry process, very few liquids are produced. The excess fluoride is used to produce 40 - 50 % (nominal) hydrofluoric acid for sale as a commercial chemical. There will be very little liquid left to treat in the NPDES permitted facility on-site.

The conversion process is also very simple and direct. This minimizes the solid waste discharges as well.

Current estimates based on the FBFC operating experience and comparisons to our current ADU process which is being replaced indicates a very significant reduction in environmental impact. Some key examples typical cf the facility are as follows:

- 80% Reduction in radioactive/solid waste
- 99% Reduction in radioactive/chemical sludge
- 86% Reduction in the discharges through the NPDES permitted facility for fluoride derived discharges

Chemical Safety

The chemical hazard is linked to the presence of hydrofluoric acid which might be produced either accidentally, should an UF_6 leak occur, on contact with the air moisture as represented by the following reaction:

$UF_6 + 2\ H_2O$ -------> $UO_2F_2 + 4\ HF$

or generated normally by the hydrolysis of UF_6 in the conversion kilns.

Hydrofluoric acid is characterized by very high toxicity.

The aim here is to restrict the HF concentration and the inhalation of UF_6 to the following values in the plant :

- HF < 2.4 Mg/M3 (1.9 ppm or 3 vpm)
- UF_6 inhalation < 2.5 mg/day

Finally, the layout of the vaporization and the conversion areas is designed so as to permit rapid evacuation of the personnel in the eventuality of an UF_6 leak. In case of a major leak, the affected area can be isolated and the ventilation stopped.

A leak of UF_6 resulting in the production of HF with air moisture can be qualitatively detected by the operator present in the plant (the threshold for the olfactive detection of HF being very much lower than the level of concentration considered dangerous).

However, a quantitative measurement is carried out when it concerns the concentration in air of hydrofluoric acid.

Leak detection is provided for in the autoclaves.

Fire Safety

Fire and explosion hazards are inter-related, when a fire involves the simultaneous presence of fuel products, oxidizer and a heat source sufficient to initiate a combustion reaction, or when an explosion involves the simultaneous presence of chemical products capable of reacting violently. Use of hydrogen in the conversion process presents an explosion hazard in the DCP facility.

Measures taken against fire and explosion risks are preventive measures whose aim is to avoid the coexistence of fuel, oxidizer and a heat source, and measures taken in order to limit the direct or the indirect consequences of fire and explosion (detection, prevention of propagation, extinction).

Solid fuels such as wood (packaging or furniture), plastic (containers, electric cable sheathing, furniture), paper and fabric (present in small quantities) used in building materials or in products required for the process are minimized in the DCP facility. Preference is given to non-inflammable materials. The only solid fuel in the process is uranium dioxide. The spontaneous oxidation Of UO_2 and U_3O_8 is related to the specific surface of the product and the temperature. The specific surface of the UO_2 powder used in the plant is less than 3 m^2/g and an over oxidation given such a grain size can occur only for temperatures exceeding 150°C.

Inflammable liquids found in the facility are used in cleaning and decontamination, for example, methanol and acetone, and inflammable liquids such as mineral oils present in mechanical and specific handling equipment. The quantities of inflammable liquids are restricted to certain limits. In certain cases (such as acetone, methanol) these liquids are subjected to specific management in order to limit their storage.

Inflammable gases or explosives found in the facility are hydrogen which is used as a reagent in conversion kilns, and acetylene that is stored and used for maintenance activities

The conversion kilns, in which hydrogen is used as a reagent, function under excess pressure with respect to the room in order to prevent air being introduced from the outside. Nitrogen barriers are provided and they ensure the inerting of the kilns. Finally, the tightness of the kilns and the air renewal rate maintained by the ventilation system guarantee, inside the room, a level of H_2 concentration lower than the explosive limit of this gas.

The temperature of UO_2 powder leaving the conversion kilns and the need to avoid a pyrophoric reaction require a nitrogen sweeping to create an inert atmosphere and cool down the powder.

Due to the temperature rise during homogenization and blending operations, homogenizer and blender are inerted with nitrogen and the temperature is controlled by using a special process sequence.

Facility temperature control, restriction of hot work, qualification of the electrical equipment represent the principal measures taken towards limiting the fire initiating factors.

The ventilation system is designed in such a manner that, in the event of a fire, the air supply is stopped, the air exhaust maintained, the hot gases diluted in the ventilation ducts, and as a last resort, that the ultimate filtration barriers which are part of the static containment of the building are protected, the ventilation stopped and the impaired fire sectors isolated (fire dampers).

Industrial Safety

The electrical equipment is installed in accordance with current regulations in effect. Certain additional restrictions might however be included should the process involve other risks.

All electrical devices are locked inside cabinets or rooms. Only qualified personnel has access to this type of equipment.

Local protection has also been set up in order to avoid any risk of electric shock when working with high or medium voltage equipment.

Handling equipment is as follows: overhead traveling cranes, hoists, stackers, etc. This equipment is used in the plant for handling mainly powder containers or uranium hexafluoride cylinders.

The use of these handling methods might have direct consequences on the operators (load fall), but also indirect consequences on other safety hazards : dispersion (container fall), criticality, electric, etc.

All handling equipment and accessories are in accordance with the regulations in force. The handling systems are checked periodically or after each modification carried out by an approved authority (condition of motors, inspection of the speed limiters, performance of the braking systems, etc.). The safety regulations and the nominal loads are displayed on the machines. The operators using this equipment are trained and qualified. The gripping and the hoisting systems are self-locking. The handling areas are marked out on the floor. Certain machines are also equipped with signaling systems which are activated as soon as the machine moves.

C.1.1 Vaporization

Process/Equipment Description

The purpose of Vaporization is to vaporize the solid uranium hexafluoride (UF_6) contained in the 30-B cylinders, in order to feed the conversion kilns with gaseous UF_6. A cold trap, operating with a cooling circuit (approx -40°C), is used for trapping the "heels" of the cylinders.

The vaporization process can be controlled and monitored from the DCP Control Room. However, as necessary, operations can be carried out locally and manually by the floor operator.

UF_6 cylinders are retrieved from the DCP Storage pad external to the west side of the DCP building one at a time and transferred by fork lift truck to the airlock at the entrance to the vaporization hallway. The UF_6 cylinder is then lifted by a monorail system and transported into the inlet hallway and positioned at the designated autoclave. The cylinder is loaded directly onto the trolley and introduced into the autoclave.

In the autoclaves, the uranium hexafluoride is brought to temperature (nominal 85°C) through electrical heating. The electrical heating is monitored by the pressure of the downstream UF_6 circuit through the internal temperature of the autoclave. The autoclaves are airtight rated pressure vessels and are fitted with a fan for mixing the warm atmosphere.

Each Vaporization Unit is equipped with two identical autoclaves operating alternately in order to ensure the continuous supply of the corresponding conversion kiln with UF_6.

While a cylinder of one of the two autoclaves feeds UF_6 to the kiln, the other autoclave is either in loading / heating up phase, or in unloading phase, or in stand-by. Cylinders are cold trapped on-line after processing and before removal.

The autoclave is maintained under pressure of nitrogen (about 1.50 10^5 Pa). In case of UF_6 leakage, the autoclave is immediately put under a pressure of nitrogen of 6.0 10^5 Pa. UF_6 leaks are usually controlled in this manner and cylinder processing can safely continue to conclusion.

UF_6 in the cold trap is vaporized to the conversion kiln through a heat-insulated and electrically heated pipe at a controlled mass flow and pressure., It takes normally 1 to 2 hours to empty the cold trap.

Criticality Safety

- Autoclave:
    - Safety moderation limit is 0.5 wt % moisture content.
- Cold Trap
    - Favorable geometry limit is for uranium enriched to 5 wt% U-235, and includes stainless steel material of construction as a neutron absorber.
    - Safety moderation limit is 0.5 wt % moisture content.

Radiological safety

Full-face respirators are worn by personnel when performing cylinder connection activities to protect against a potential UF_6 exposure. Additionally, each vaporization chamber is a rated pressure vessel that contains a dry nitrogen atmosphere which can overpressure in the event of a leak to neutralize the flow. The units also include a leak detection system.

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Safety

Emissions from these areas are captured and treated prior to release to the environment.

Chemical Safety

The safety aspects of uranium hexafluoride which contains fluoride and the production of HF from the fluoride are covered in the general safety discussion for the facility.

Fire Safety

There are no special considerations related to fire and explosion in this section of the process.

Industrial Safety

Eye, foot and respiratory protection are provided and required in the area. Material lifting and handling equipment are controlled. Applicable OSHA practice and regulations are followed.

C.1.2 Conversion

Process/Equipment Description

The purpose of the Conversion Units is to transform the gaseous uranium hexafluoride (UF_6) into solid uranium dioxide (UO_2) powder.

The conversion is achieved in a kiln through two main successive reactions:

$UF_6 + 2\,H_2O = UO_2\,F_2 + 4\,HF$ (hydrolysis)

$UO_2\,F_2 + H_2 = UO_2 + 2\,HF$ (pyro-hydrolysis)

The initial hydrolysis reaction takes place in the first part of the kiln (static reactor). The uranium oxyfluoride (UO_2F_2) powder formed is carried to the second part of the kiln (rotating tube) through means of an internal screw conveyor. The uranium dioxide (UO_2) powder produced is then discharged from the kiln into the Powder Outlet.

The HF-containing gases formed are evacuated at the top part of the static reactor where they are filtered before being removed to the Hydrofluoric Acid Production equipment.

Each conversion kiln is equipped with a specific powder recycling device in order to recycle powder out of specification (excessive O/U or F/U ratios).

The main process gases (i.e.: UF_6, steam to reactor, steam to kiln, and hydrogen) are controlled through individual control loops. The steam flows to the reactor and kiln are heated and controlled to 250 °C and 350 °C, respectively by superheaters upstream of the conversion unit.

The UO_2 powder produced flows from the lower part of the rotating tube to an output hopper.

An air-lock device prevents conversion gases from going out from this hopper to the downstream equipment (Powder Outlet). Nitrogen is introduced in order to initiate cooling of the powder and to separate steam from powder.

The gases resulting from conversion reactions contain hydrofluoric acid (HF), steam (excess), hydrogen (excess) and nitrogen (mainly from injector introduction and sweeping). These gases are evacuated at the top of the static reactor where they are filtered by a set of filter tubes made of sintered Monel before being removed to the HF Production equipment. A second level of filtration is installed downstream to mitigate the effect of a breakthrough of the primary kiln filters.

The conversion kiln is an airtight chamber. Its internal pressure is controlled and the unit will shutdown if the pressure exceeds $1.3\ 10^5$ Pa.

The conversion kiln can also be used to reprocess non-conforming UO_2 powder (excess of O_2 for "oxidized powders", excess of F_2 for fluorinated powders). In these cases, the main UF_6 supply is cut off. A container of non-conforming powder is connected above a first screw conveyor and the powder is introduced into the kiln through means of a second screw conveyor. An air-lock device separates these two conveyors.

The Process Control of the conversion operation is normally carried out completely from the main Process Control Room. Although, if necessary it can be carried out locally.

Criticality Safety

- Conversion Reactor, Kiln Tube, and Powder Outlet Box
    - Uniform moderator distribution: safety moderation limit is 1.2 wt% moisture content and process moderation limit is 0.4 wt% moisture content.
    - Non-uniform moderator distribution: safety moderation limit is 15 kg. water equivalent moderator and process moderation limit is 5 kg. water equivalent moderator.
    - Process mass limit is 1000 kgs.

Radiological safety

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Safety

Emissions from these areas are captured and treated prior to any potential release to the environment.

Chemical Safety

Chemicals of interest here are the fluoride associated with the uranium hexafluoride and associated reactions and the hydrogen. Both items are discussed in detail in the overview and/or in the section or fire and explosion safety.

Fire Safety

An inert gas supply is used to purge air from the process equipment prior to start-up and to purge the system clear of hydrogen at shutdown.

The system includes hydrogen leak detection with alarms in the control-room. These controls and alarms are supported by disciplined reaction and recovery procedures.

The equipment is also outfitted with special seals to assure containment between the rotating kiln barrel and the static portions of the assembly.

Industrial Safety

Applicable OSHA practice and regulations are followed.

C.1.3 Powder Outlet

Process/Equipment Description

The purpose of Powder Outlet is to cool the uranium dioxide (UO_2) powder going out of the conversion kilns.

At each conversion kiln outlet, uranium dioxide (UO_2) powder flows alternately into the two associated cooling hoppers. A nitrogen sweeping allows powder cooling.

An installed proportional sampler enables UO_2 samples to be taken in order to check powder characteristics and, to verify conformity of the UO_2 powder to the appropriate customer product specification.

Humidity probes allow permanent checking of sweeping gases moisture rate (which has to be lower than 0.4 % to ensure less than 1 % weight H_2O in powder).

At each cooling hopper outlet, uranium dioxide (UO_2) powder is transferred into powder containers, up to a maximum net weight of 500 kg.
No chemical reaction can occur in these units, even in case of abnormal conditions.

Cooling hoppers are weighed continuously. When one cooling hopper is full, the weighing system switches automatically powder to the other cooling hopper.

Gases going out of the cooling hoppers are filtered at the upper part of the hoppers before being sent to HVAC system.

Humidity probes allow permanent monitoring of humidity content inside each hopper. Humidity content of the powder must be lower than 1 % weight H_2O to meet the assumptions in the safety analysis.

Powder containers are then stored at the Powder Storage Area.

The operation of the Powder Outlet is normally carried out completely from the main Process Control Room but it can also be carried out locally as necessary.

Criticality Safety

- Cooling Hopper:
    - Uniform moderator distribution: safety moderation limit is 12 wt%moisture content and process moderator limit is 4 wt% moisture content.
    - Non-uniform moderator distribution: safety moderation limit is 15 kilogram water equivalent moderator and process moderation limit is 5 kg. water equivalent moderator.
- Release to Powder transfer and storage
    - Safety moderation limit for release is 1.2 wt% moisture content and process moderation limit for release is 0.4 wt%
    - Safety mass limit is 1000 kg. and process mass limit is 500 kg.

Radiological safety

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Safety

Air effluents are released through a permitted HEPA filter system.

Chemical Safety

Normal operation does not require the use of chemicals.

Fire Safety

No specific fire or explosion hazards exist for this area.

Industrial Safety

Applicable OSHA practice and regulations are followed.

C.1.4 Homogenization

Process/Equipment Description

The purpose of Homogenization is to homogenize the uranium dioxide (UO_2) powder produced in the conversion process, and to incorporate any add-back material of tri-uranium octoxide (U_3O_8) which may be available. The homogenization is achieved in homogenizers (conical tanks), under a nitrogen atmosphere, through mechanical mixing by means of an orbital-arm and screw mixing device. Before this operation, uranium dioxide (UO_2) powder is sifted.

Again (see Powder Outlet), no chemical reaction can occur in these units, even in case of abnormal conditions.

Homogenous blends will not exceed 3 metric tons bulk.

Sifting and homogenization operations are carried out under an inert atmosphere of dry nitrogen.

Powder is then stored in same type of powder containers (Unicones) as those used for feeding the Homogenizers.

Homogenization control is manual. Nonetheless, an automatic controller located in a local control panel gives the floor operator some monitoring and diagnostic capability.

Criticality Safety

- Homogenizer:
    - Uniform moderator distribution: safety moderation limit is 1.2 wt% moisture content and process moderator limit is 0.4 wt% moisture content.
    - Non-uniform moderator distribution: safety moderation limit is 15 kilogram water equivalent moderator, process moderation limit is 5 kg. water equivalent moderator.
    - Process mass limit is 3000 kg. UO_2.
- Release to Powder transfer and storage:
    - Safety moderation limit for release is 1.2 wt% moisture content and process moderation limit for release is 0.4 wt%
    - Safety mass limit is 1000 kg. UO_2, process mass limit is 500 kg. UO_2.

Radiological safety

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Safety

Air effluents are released through a permitted HEPA filter system

Chemical Safety

Normal operation does not require the use of chemicals

Fire Safety

No specific fire or explosion hazards exist for this area.

Industrial Safety

Applicable OSHA practice and regulations are followed

C.1.5 Blending and Granulation

Process/Equipment Description

The purpose of Blending and Granulation is to adjust the enrichment level and the ceramic properties of the UO_2 product.

This operation is carried out in a blender (conical tank), under nitrogen atmosphere, and through mechanical mixing. Poreformers and lubricants are added at this stage of the process as necessary.

No chemical reaction can occur in these units, even in the event of abnormal conditions.

The product granules flow into specific containers having a double-cone shape (bicones). Then, bicones, full of spheroidized and lubricated granules, are transferred to the Pellet Fabrication Plant.

The cont... of the Blending operations and the control of the Granulation operations are carried out locally by means of a control panel equipped with manual controls. The control panel does include some automatic features to support the operator.

Criticality Safety

- Blender:
  - Uniform moderator distribution: safety moderation limit is 7.6 wt% moisture content and process moderator limit is 2.3 wt% moisture content.
  - Non-uniform moderator distribution: safety moderation limit is 15 kilogram water equivalent moderator and process moderation limit is 5 kg. water equivalent moderator.
  - Process mass limit is 1000 kg. UO_2.

- Material composition is homogeneous.

- Precompaction Press and Granulator:

    - Uniform moderator distribution: safety moderation limit is 7.6 wt% moisture content and process moderator limit is 2.3 wt% moisture content.

    - Non-uniform moderator distribution: safety moderation limit is 15 kilogram water equivalent moderator and process moderation limit is 5 kg. water equivalent moderator.

    - Process mass limit is 1000 kg. UO_2.

- Release to Powder Transfer and Storage:

    - Safety moderation limit for release is 6.5 wt% moisture content and process moderation limit for release is 3.0 wt%

    - Safety mass limit is 1000 kg. UO_2, process mass limit is 500 kg. UO_2.

Radiological Safety

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection

Air effluents are released through a permitted HEPA filter system

Chemical Safety

Normal operation does not require the use of chemicals other than ammonium oxalate and acrawax, neither of which pose a safety threat. Protective measures to handle these potential hazards are covered under radiological safety.

Fire Safety

No specific fire or explosion hazards exists for this area.

Industrial Safety

Applicable OSHA practice and regulations are followed

C.1.6 HF Production

Process/Equipment Description

The purpose of Hydrofluoric Acid Production is to produce from the conversion kilns gases, aqueous solutions of hydrofluoric acid and to scrub process gases before release to atmosphere.

These feed gases are composed of gaseous hydrofluoric acid, steam, hydrogen and nitrogen.

Production of concentrated hydrofluoric acid solutions (at about 50 % weight HF) is accomplished using a condensation process.

Non condensable gases are washed in two washing columns. Residual HF gas is thus dissolved in water: diluted hydrofluoric acid solutions are recovered from the washing column (less than 10 % weight HF).

A uranium detection system is incorporated on line in order to ensure permanent checking of HF condensed solutions. In case of a process upset, the solution is immediately transferred to a special storage tank of polluted solutions and the conversion process is shut down.

The liquid aqueous solution is temporarily placed in one of the two storage tanks of unitary capacity 20 m^3.

Nitrogen ejectors located before each column allow the regulation of the pressure in the kilns.

A fraction of these diluted hydrofluoric acid solutions may be added to the concentrated HF solutions.

The HF product is transferred into trucks for delivery to the customer. Excess HF or off-specification HF is treated in the current fluoride waste treatment system.

A control panel, where the manual commands and the process measurements are grouped, allows the local control / command of the process. The control can also be carried out using an automatic mode. The automatic controller is located in a cabinet adjoining the control panel.

Criticality Safety

The criticality risk applies to all material with a U-235 content in excess of 1%. The normal condition is an over-moderated condition with respect to optimum moderation for uranium enriched to 5 wt% U-235. The criticality hazard associated with normal and credible abnormal conditions is an accumulation of uranium in the Hydrofluoric Acid (HF) facility that exceeds either the minimum critical concentration or minimum critical mass. Uranium in the form of UF_6 or UO_2F_2 transported from the Dry Conversion Process (DCP) conversion process to HF facility through the off-gas system results in an increase in the quantity of uranium in the HF facility.

Moderation, material composition, process characteristics, interaction, concentration, reflection, and enrichment are either not control parameters or limited by process or material characteristics or both. Processes where geometry is not controlled assume a unlimited dimensions or a minimum critical mass. Moderation is not a controlled parameter and the quantity of moderator is unlimited. Reflection is limited to enclosing systems by a contiguous layer of water of unlimited thickness. The maximum credible enrichment of U-235 is 5 wt%. Process characteristics are not controlled to assure chemical and physical characteristics. Material chemical form is normally UF_6 or UO_2F_2 from the conversion reactor, or UO_2 or U_3O_8 from the kiln tube or powder recycle. Material composition is assumed to be homogeneous since the maximum credible particle size is less than the limit at which heterogeneous effects must be considered.

Geometry, mass, concentration and neutron absorber are utilized as criticality safety control parameters in the HF process areas. The geometry limit depends on use of a fixed neutron absorber system. Geometry, mass, and concentration limits are independent. Loss of at least two independent parameter controls is required before a criticality accident is possible. Exceeding the mass or concentration, and geometry safety limits may result in exceeding the subcritical limit. The likelihood of exceeding a mass or concentration safety limit is minimized by applying a safety factor of at least 2 is applied to the mass and concentration safety limits to protect against a limit being accidentally exceeded. The process control parameters are summarized in Table 1.

Mass of uranium is controlled by measuring uranium concentration in the HF liquid process flow to limited storage tank volume. The concentration safety limit assures that minimum critical mass is also less than the minimum critical concentration. Detection of uranium in the HF flow prevents excessive carryover of soluble and insoluble uranium. Mechanical integrity of physical barriers between the conversion process and HF facility prevent carry over of solid, insoluble uranium oxides. Continuous balance of flow control for the reactants, UF_6 and steam, assures that there is no unreacted UF_6 gas in the HF offgas flow.

Detection of uranium in excess of the process limit for unfavorable geometry equipment and tanks in HF facility diverts process flow to a favorable geometry storage tank. Continued operation for limited time allows recovery to normal operating conditions or normal shutdown of the conversion process. Detection of uranium in excess of the process limit during operation with the HF liquid process flow is diverted automatically shuts down all conversion process gas flows to the affected conversion process.

Table 1. HF Acid Process - Nuclear Criticality Safety Control Summary

Process	Equipment	Fissile material	Control Parameters
HF Recovery	Condenser	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Geometry Mass
	Wash Column	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Mass
HF Storage	Vapor- Liquid Separator	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Geometry Mass
	Concentrated HF Storage Tanks	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Mass
	Dilute HF Storage Tanks	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Mass
	Polluted HF Storage Tank	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Geometry Mass
	Floor sump	UO_2, U_3O_8, UO_2F_2, and UF_6 homogeneous	Geometry Mass

Radiological Safety

DCP facility provides containment of the radioactive material during normal operating conditions. Abnormal operating conditions resulting in release of radioactive material from DCP facility to the HF facility results in the risk of dispersion of radioactive material. The radiation and contamination risk is due to the presence of uranium compounds in the HF facility as result of a process upset in the DCP facility. Physical and chemical forms of Uranium 238 enriched to a maximum of 5% U-235 in the uranium powder manufacturing process are UF_6 (Uranium hexafluoride) in solid, liquid or gaseous state, UO_2F_2 (Uranium oxyfluoride), UO_2 and U_3O_8 (Uranium oxides).

The HF facility does not normally contain radioactive material.

The concentration of uranium does not normally exceed three parts per million by weight of the liquid. The plant receives uranium enriched to a maximum of 5% U-235 coming from natural uranium. The risks of exposure are quite low and are mainly due to the beta and gamma rays emitted by the daughter products of U^{238}, namely Th^{234} and Pa^{234} (half life of 24 days and 1.18 minutes respectively).

The external irradiation hazard inside the HF facility is no greater than naturally exists under normal operating conditions.

Environmental Protection

Noncondensible gases scrubbed in two parallel water washing columns are vented to atmosphere. The noncondensible gases result from the treatment of the conversion kiln off-gases. Theses gases are composed of hydrofluoric acid, steam, hydrogen and nitrogen. The hydrofluoric acid content of the gaseous effluent rejected to atmosphere is typically 1.5 mg/m3 at the nominal production rate. The quantity of HF released to the atmosphere is approximately 1.5 kg per year, for a continuous production of 320 days.

Noncondensible gases are scrubbed in two parallel water washing columns to recover residual hydrofluoric acid gas.

Pure and diluted hydrofluoric acid solutions are recovered from washing the conversion kiln off-gases composed of hydrofluoric acid, steam, hydrogen and nitrogen. Pure concentrated hydrofluoric acid solutions are condensed from the conversion kiln off-gases, stored in two 20 m^3 storage tanks and loaded into tank trucks for removal from the GE Wilmington site. Dilute hydrofluoric acid is scrubbed from the process noncondensible gases and generated from maintenance rinsing operations of equipment or piping . The dilute hydrofluoric acid is stored in two 20 m^3 storage tanks and loaded into tank trucks for transfer to the Waste Treatment facility.

Chemical Safety

The chemical hazard is linked to the presence of concentrated and dilute hydrofluoric acid which is present in large quantities in the HF facility. HF acid is generated normally by the hydrolysis of UF_6 in the conversion kilns on contact with steam as represented by the following reaction :

$UF_6 + 2\ H_2O$ -------> $UO_2F_2 + 4\ HF$

Hydrofluoric acid is characterized by very high toxicity. HF concentration is restricted to less than 2.4 Mg/m^3 (1.9 ppm or 3 vpm).

A ventilated outfit must be worn during operations in the HF Facility recovery and storage areas. The installation of retention capacities and special floor coverings for the storage areas, control the spreading and easy recovery of HF. Workers in the HF area must wear ventilated clothing.

Fire Safety

Use of hydrogen in the conversion process presents a potential explosion hazard in the HF Facility.

Solid fuel in the HF facility consists of the polypropylene used as a material of construction for the tanks, piping, and wash column, and the synthetic graphite used in the condensers. The polypropylene is a grade of flame-retardant polypropylene that is V-O Grade based on UL-94, Test for Flammability of Plastic Materials.

No inflammable liquids are found in the HF facility.

Inflammable gases or explosives found in the HF facility are hydrogen which is used as a reagent in conversion kilns.

Noncondensible gas vented from the washing columns is diluted with air to maintain hydrogen content less than the lower explosive limit.

Facility temperature control, restriction of hot work, qualification of the electrical equipment represent the principal measures taken towards limiting the fire initiating factors.

Industrial Safety

The electrical equipment is installed in accordance with current regulations in effect. Certain additional restrictions might however be included should the process involve other risks.

All electrical devices are secured inside cabinets or rooms. Only qualified personnel has access to this type of equipment. Local protection has also been set up in order to avoid any risk of electric shock when the personnel is working with high or medium voltage equipment.

C.2. DRY RECYCLE FACILITY

Process Description and Equipment

Discrepant powder, clean-out powder, green pellets, sintered pellets, grinder swarf, and UO_2 powder are converted to U_3O_8 powder or blended in the Dry Recycle Process. The process provides recycle U_3O_8 for use in the Dry Conversion Process Facility or blended recycle UO_2 for feed material to the Wet Recovery Process.

The dry recycle area extends from the ground floor level through the mezzanine floor level. An oxidation furnace, DM-10 Vibro-mill, and blender are installed in the dry recycle process area. Platforms with stairs provide access to mezzanines where process operation and control is conducted. A can dump station for the oxidation furnace is located on a mezzanine outside the enclosed area. Mezzanines inside the enclosed provide access to moisture measurement for UO_2 powder containers, weigh scales, vibrating tables, can dump station above the blender and DM-10 Vibro-mill, and blender base.

The collection process provide feed material to the Dry Recycle Facility. No chemical reaction takes place in the collection process. Recycled material, except grinder swarf, is sent to the collection hoods via a conveyor system. Two glove boxes are used for collection. One handles three gallon cans and beakers, the other handles boats, trays and beakers. The waste is consolidated by enrichment bands into three gallon cans, inventoried, and placed in a storage area.

Oxidation converts all material to U_3O_8. Oxidation of UO_2 to U_3O_8 takes place in the recycle furnace. The furnace operating temperature is around 500 °C. From the storage area the cans will be returned through a computerized accountability system station and sent to the oxidation furnace via a dual can dump station and a feeder system capable of handling both pellets and swarf. The oxidation furnace is an electrically heated rotating tube reactor. The furnace is operated at 500 °C and a slight vacuum (-0.1 to -0.5 in WC) which is maintained using plant vacuum. The outlet from the furnace is dropped into a hood which contains a screener. The oversize material is collected into 3 gallon cans. The proper size material goes through the floor to a moisture analyzer where it is released into a unicone, (on roller/scale) which is in a Moderation Restriction Area (MRA).

Milling reduces the particle size of the recycle material. No chemical reaction takes place in the Vibro-mill. A unicone is lifted above the mill onto a vibrating table and the bottom outlet will be attached to the feed system by a nitrogen-inflated seal. The feed system will contain a batch metering device and discharges to the vibro-mill for particle size reduction. The particle size leaving the mill will be controlled to less than 15 microns and will be discharged to a unicone, which is attached to the mill discharge with another nitrogen-inflated seal.

The blender is used for enrichment blending for U_3O_8 and homogenization of UO_2 batches from the wet recovery operations. No chemical changes take place in the blending process. Unicones are hoisted on a monorail system and placed on a vibrating table. The unicone is attached to the feed piping using the nitrogen-inflated seal. A metering device located in the feed piping monitors batch constituents going to the blender. It is capable of accepting feed through both a can dump station in a hood for UO_2 and the unicone feed station for U_3O_8. The cans will be inventoried using a computerized accountability control system and lifted to the dump station in an elevator and the feed will be monitored for moisture using an analyzer like the one monitoring the furnace discharge. The blender is a single screw conical mixer with a maximum blend load of 680 kilograms. A nitrogen blanket is in place to ensure that during operation involving UO_2, it will not be oxidized. The exiting nitrogen will be sent through a cyclone separator and a HEPA filter before it enters the plant exhaust. The product discharge has a nitrogen inflated seal for a unicone or a hood for 3 gallon can loading.

Unicones are used for storage of U_3O_8 powder and transfer of uranium oxide powder to the Dry Conversion Process Facility. Three gallon cans are used for storage feed material and transfer of UO_2 powder to the Wet Recovery process. No chemical reaction takes place in the powder transfer and storage containers. The unicone may be stored in an area near the blender discharge. The unicones are eventually removed from the Dry Recycle Facility and sent to the Dry Conversion Process Facility. Charging station for the motorized carts is used for unicone and bicone transport. The carts will be used to transfer unicones to and from storage and between the different areas using the transfer corridor in the Integration Facility.

Criticality Safety

The criticality hazard in the Dry Recycle Facility is associated with normal and credible abnormal conditions that increase the moderation. Normal uniform moisture content of the uranium oxide powder exceeds the minimum critical moderation for 5 wt% U-235, and the total quantity of moisture exceeds the minimum critical quantity of water. The quantities of uranium oxide contained in process equipment exceed the minimum critical mass. Non-uniform distribution of moisture and other moderating material may result in a critical configuration of mass and moderation.

Concentration, material composition, process characteristics, interaction, concentration, reflection, neutron absorber and enrichment are either not control parameters or limited by process and material characteristics. Processes where geometry is not controlled assume unlimited dimensions or a minimum critical mass. Reflection is limited to enclosing systems by a contiguous layer of water of unlimited thickness. The maximum credible enrichment of U-235 is 5 wt%. Process characteristics are not controlled to assure chemical and physical characteristics. Material chemical form is normally UO_2 or U_3O_8 from the blending, precompaction/granulation, or tumbling processes in DCP Facility. Material composition from precompaction/granulation and tumbling is assumed heterogeneous, and material composition from blending is assumed homogeneous.

Geometry, moderation and mass are utilized as criticality safety control parameters in the process areas. Geometry limits are independent of moderation and mass limits, but dependent on material composition and process characteristic. Moderation, mass, material composition, and process characteristic are dependent, and loss of a single parameter control may result in a criticality accident. Exceeding the moderation, mass, material composition, or process characteristic limit may result in exceeding the subcritical limit. The likelihood of exceeding a moderation or mass safety limit is minimized by applying a safety factor of at least 3 to the process moderation limit and a safety factor of 2 to mass limits to protect against a limit being accidentally exceeded. The process control parameters are summarized in Table 1.

Geometry limits are specified in the equipment design. Moderation, mass, material composition, and process characteristic are controlled during the processes that fill the equipment. Mass of uranium is controlled by weighing the container contents on scales. Detection of mass exceeding the process limits places an administrative hold on the movement of material. Moderation is controlled by measuring the powder moisture content and limiting the addition of moderating materials. Mechanical integrity of the powder container provides a barrier against unintended ingress of moderating material. Material composition and process characteristic are controlled by identifying the source of the material in the powder containers.

Table 1. Dry Recycle Facility - Nuclear Criticality Safety Control Summary

Process	Equipment	Fissile material	Control Parameters
Collection	3-gallon cans, beakers, pellet boats, and pellet trays	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Geometry Mass
Oxidation	Recycle Furnace	$UO_2 \cdot H_2O$ and $U_3O_8 \cdot H_2O$	Geometry Mass
Milling	Vibro-mill DM-10	$U_3O_8 \cdot H_2O$	Geometry Moderation
	Screener	$U_3O_8 \cdot H_2O$	Geometry Moderation
Blending	Recycle Blender	$U_3O_8 \cdot H_2O$	Moderation Mass
Transfer/Storage	Unicone Powder Containers	$U_3O_8 \cdot H_2O$	Moderation Mass
	3-gallon cans	$UO_2 \cdot H_2O$	Geometry Mass

Radiological Safety

Dispersion of Radioactive Material

Release of radioactive material contained in the process equipment or facility results in the risk of dispersion of radioactive material. The radiation and contamination risk is due to the presence of uranium compounds in the process areas. Physical and chemical forms of Uranium 238 enriched to a maximum of 5% U-235 in the Dry Recycle Facility processes are uranium oxide powders and pellets in the chemical form of UO_2 and U_3O_8. Release of uranium oxides is credible when handling powder or pellet forms of uranium oxides in all processes in the Dry Recycle Facility.

Three containment barriers prevent the release of radioactive material from the process and facility. The first containment barrier reduces the risk of dispersion from the process equipment in areas accessible to the personnel. The first containment barrier is achieved by the pressure tightness of the process equipment.

The second containment barrier reduces the risk of dispersion to the facility areas with little or no contamination. The barrier consists of a second containment barrier (wall tightness, sealing of the penetrations, use of air locks allowing materials to be transported in and out of the rooms) and a dynamic containment barrier implemented via the ventilation methodology for the rooms. A ventilation system establishes negative pressure in the rooms in such a way that the air is forced to flow from areas with little or no contamination to the most contaminated areas. Each process room has one or more ventilation exhaust points through a filter housing consisting of a primary and secondary HEPA filters.

The third containment barrier reduces the risk of dispersion from the facility to the external environment. The HVAC system maintains the facility structure at a negative pressure with respect to the outside environment. All discharges are through double HEPA filters and monitored.

The plant receives uranium enriched to a maximum of 5% U^{235} coming from natural uranium. The risks of exposure are quite low and are mainly due to the beta and gamma rays emitted by the daughter products of U^{238}, namely Th^{234} and Pa^{234} (half life of 24 days and 1.18 minutes respectively). Uranium oxide is stocked in large quantities under different forms of powder and granules.

The external irradiation hazard inside the Dry Recycle Facility is limited. Taking into account the duration of exposure of the operators and the low levels of radiation, no protection measures with respect to risk of external exposure to ionizing radiation are required.

Environmental Protection

There are no gaseous or liquid effluents from the Dry Recycle Facility.

Chemical Safety

No hazardous chemicals are used in the Dry Recycle Facility processes.

Fire Safety

Potential fire and explosion hazards in the Dry Recycle Facility concern the simultaneous presence of fuel products, oxidizer and a heat source sufficient to initiate a combustion reaction. There are no explosion hazards in Dry Recycle Facility.

Measures taken against fire and explosion risks are preventive measures whose aim is to avoid the coexistence of fuel, oxidizer and a heat source, and measures taken in order to limit the direct or the indirect consequences of fire and explosion (detection, prevention of propagation, extinction).

Solid fuels such as wood (packaging or furniture), plastic (containers, electric cable sheathing, furniture), paper and fabric (present in small quantities) used in building materials or in products required for the process are minimized in the Dry Recycle Facility. Preference is given to non inflammable materials. The only solid fuel in the process is uranium dioxide. The spontaneous oxidation of UO_2 and U_3O_8 is related to the specific surface of the product and the temperature. The specific surface of the UO_2 powder used in the plant is less than 3 m^2/g and an over oxidation given such a grain size can occur only for temperatures exceeding 150°C.

Liquids found in the facility are inflammable liquids used in cleaning and decontamination, for example, methanol and acetone, and inflammable liquids such as mineral oils present in mechanical and specific handling equipment. The quantities of inflammable liquids are restricted to certain limits. In certain cases (such as acetone, methanol) these liquids are subjected to specific management in order to limit their storage.

The temperature of U_3O_8 powder leaving the recycle furnace and the need to avoid a pyrophoric reaction require a nitrogen sweeping to create an inert atmosphere and cool down the powder.

Due to the temperature rise during milling and blending operations, Vibro-mill and blender are inerted with nitrogen and the temperature is controlled by using a special process sequence.

Facility temperature control, restriction of hot work, qualification of the electrical equipment represent the principal measures taken towards limiting the fire initiating factors.

The ventilation system is designed in such a manner that, in the event of a fire, the air supply is stopped, the air exhaust maintained, the hot gases diluted in the ventilation ducts, and as a last resort, that the ultimate filtration barriers which are part of the static containment of the building are protected, the ventilation stopped and the impaired fire sectors isolated (fire dampers).

Industrial Safety

The electrical equipment is installed in accordance with current regulations in effect. Certain additional restrictions might however be included should the process involve other risks.

Electrical devices are secured inside cabinets or rooms. Only qualified personnel has access to this type of equipment.

Local protection has also been set up in order to avoid any risk of electric shock when the personnel is working with high or medium voltage equipment.

Handling equipment is as follows: overhead traveling cranes, hoists, stackers, etc. This equipment is used in the facility for handling mainly powder containers.

Handling equipment and accessories are in accordance with the regulations in force. The handling systems are checked periodically or after each modification carried out by an approved authority (condition of motors, inspection of the speed limiters, performance of the braking systems, etc.). The safety regulations and the nominal loads are displayed on the machines. The operators using this equipment are trained and qualified. The gripping and the hoisting systems are self-locking. The handling areas are marked out on the floor. Certain machines are also equipped with signaling systems which are activated as soon as the machine moves.

D.1 PRESS WAREHOUSE OPERATIONS (Continues)

Process/Equipment Description:

The Press Warehouse performs two important functions. First, the conveyors in the room provide a storage queue area for material prior to pressing. Second, the powder transfer stations provide a controlled method to transfer the powder to the presses in the Press Room directly below the Warehouse.

The conveyors in the Warehouse can store both low enriched 5-gallon containers and high enriched 3-gallon cans. The cans of powder are moved on the conveyor system for further processing to the powder lubricant additive station, Roll Tumbling, and then to the queuing conveyors at the Press transfer stations

The Press transfer stations are physically located in the powder Press Warehouse. Each transfer station is used to dump containers of powder into a powder feed system that supplies the pellet press on the floor below. The Press transfer station is a vented enclosure which contains a powder feed system, powder hopper, and container dumping mechanism. Containers of powder are moved into the transfer station from the conveyor and onto the dumping mechanism. The container is clamped to the transfer mechanism and the hopper lid is opened. The powder feed system is controlled either automatically or manually with controls located at both the press and the transfer station.

At each Press transfer station in the Powder Warehouse a material control system transaction must take place to transfer the container in the Press transfer hood. When the Press Operator indicates the press below is ready, the Warehouse Operator performs the material control system transaction, and transfers the can of powder into the Press transfer feed hopper.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

Criticality safety in the Press Warehouse is assured by a combination of passive, procedural, and moderation controls which include the following:

- Powder may only be transported on the conveyor in approved 3 and 5-gallon metal containers. 3-gallon containers of powder are limited to 25 kgs gross weight for UO_2 enrichments up to 5.0 % and 5-gallon containers are limited to 35 kgs gross weight for UO_2 enrichments up to 4.013%.

- Containers of powder may only be moved on approved conveyor systems.

- Stacking or storage of full containers of powder on the floor is not allowed.

- All containers of powder in the Press Warehouse are controlled to 50,000 ppm equivalent water moderation (moderation control).

- The Press transfer station and powder feed system are demonstrated as safe geometry for maximum UO_2 enrichments of 5.0 w/o U-235.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accordance with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accordance with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Air effluents are released through a permitted HEPA Filter System.

Chemical Safety:

Normal operation does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No specific fire and explosion hazards exist for the area.

Industrial Safety:

Applicable OSHA practice and regulations are followed. Standard industrial safety practices for items related to pressing operations are applied.

D.2 PELLET PRESSING OPERATIONS (Continues)

Process/Equipment Description:

The presses in the Press Room process the UO_2 material from a powder to a green pellet form. The green pellets which have been stamped with enrichment marks are transferred into permanently numbered furnace boats which are weighed, processed through the material control system, and transferred to a conveyor storage system in the Furnace Room to await sintering.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Equipment Description:

Criticality Safety:

- Powder is transferred to the press by a combination of favorable geometry hoppers and favorable diameter tubes for UO_2 powder enrichments up to 5.0 w/o U-235.

- Moderation is controlled within the UO_2 press feed system to UO_2 powder not exceeding 50,000 ppm equivalent water.

- A banner eye level detector is installed in each of the HiE (5.0 w/o U-235) press feed tubes to operate such that when the powder level in the feed tube reaches the upper level detector, then an interlock will stop the flow of powder by shutting off the powder feeder (geometry and mass controls).

- Loaded pellet boats are limited to a 4 inch safe slab height and shall not exceed a the safe mass limit of 25 kgs net (heterogeneous UO_2 at 5.0 w/o U-235).

- The pellet conveyor storage system is limited to a 4 inch safe slab height (geometry control). Sprinkler water deflection covers are installed over the high enrichment presses and over the green pellet conveyors (moderation control).

- The pellet press lubricant sump reservoir is passively and administratively controlled to a safe slab height of less than 4 inches to prevent sludge buildup.

- One 3-gallon water-filled bucket for powder cleanup is allowed to be stored an approved floor storage location. Up to four 3-gallon containers with bung holes may be stored in approved floor storage (net weight < 11.6 kgs per can) for waste oil (geometry and mass controls).

Radiological Safety:

Radiological safety in this area is based on containment of UO_2 powder in ventilated equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accordance with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accordance with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Air effluents are treated through a permitted HEPA Filter System.

Chemical Safety:

Normal operation of the presses does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exist in this area.

Industrial Safety:

Normal OSHA practices and regulations are followed. Employee safety is maintained by complying with electrical and mechanical safety applications pertaining to the Press Area.

D.3 PELLET SINTERING (Continues)

Process/Equipment Description:

Furnace boats are received and queued in the Furnace Area. As the boats pass through the furnace in a controlled temperature and reducing atmosphere, the pellets are sintered to a target sintered density. Upon discharge from the furnace, the furnace boats are stored on the slab-roller conveyor system prior to entering the Pellet Grinding Area.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- The existing fabrication process areas from sintering through rod loading are approved for heterogeneous UO_2 up to 5.0 w/o U-235 enrichment.

- The movement and storage of loaded furnace boats in the furnace room is on the safe slab conveyor system (geometry). Physical barriers prevent the stacking of boats above the safe slab height and administrative controls are used where physical barriers are impractical.

- To prevent boat stacking inside a sintering furnace, active engineered controls ensure automatic shutdown of the boat pusher system if excessive pressure is required for movement. In automatic mode, logical limit switches prevent acceptance of skid unless a skid is discharged. Administrative controls limit operations to use only approve furnace boat designs.

- Metal canopies are installed above the safe slab height occupied by the furnace boat feed and discharge conveyors at each sintering furnace to deflect any water released through the fire sprinkler system and to prevent accumulation of water in loaded furnace boats (moderation control)

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in a pellet form. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Air effluents are treated through a permitted HEPA Filter system.

Chemical Safety:

Normal operation of the furnaces does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

- An inert gas supply is used to purge air from the furnaces prior to startup and to purge combustible gases from the furnaces after shutdown.
- Furnace operating personnel monitor the combustible process atmosphere to ensure safe operation. The furnaces are also equipped with alarm systems which sound if the combustible atmosphere supply is interrupted.
- The furnace will automatically switch to an alternate process atmosphere if the combustible process atmosphere supply to the furnace is interrupted during normal operation.
- Pilot flames are used at ports on the furnaces that are routinely open during normal operation. An alarm will sound if there is no flame at these ports during operation of the furnaces.
- A water-based hydraulic fluid is used in the hydraulic cylinders to minimize the possibility of fire due to a hydraulic leak.

Industrial Safety:

Applicable OSHA practices and regulations are followed.

D.4 PELLET GRINDING (Continues)

Process/Equipment Description:

Sintered pellets are processed through grinders to obtain uniform pellet diameter. The grinding is done without liquid coolant. Pellets to be ground are received in furnace boats and are transferred from boats to the feed system for grinding. Capture ventilation is used for the feed system and grinder wheels to direct dust to containment and filters. As pellets are ground to the specified diameter, they are inspected and placed on metal corrugated trays. Loaded trays of pellets are transferred via a cart to controlled storage cabinets prior to the Rod Loading operation.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

The existing fabrication process equipment within the pellet grinding area are demonstrated favorable geometry and approved for heterogeneous UO_2 up to 5.0 w/o U-235 enrichment.

- Pellet trays are favorable geometry and limited to a safe mass and are free draining. Grinder feeder hoppers or flat feeder systems must not extend above a 4 inch safe slab height (geometry) and remain in an enclosed hood (moderation control).
- Grinder is interlocked to stop operation if a) delta-p across apitron filter or HEPA above apitron exceeds 4 inches of water, or b) swarf vacuum drops below 0.5" of water, or c) swarf can is not in its proper position on the can lift and the lift in the raised position, or d) hardscrap can not in position or exceeds 25 kgs gross weight.
- The pellet transfer cart is a vertical array of shelves spaced a fixed distance apart (geometry). Physical barriers prevent the stacking of pellet trays more than one high on the shelves. The units effectively cover the tray and exclude any moderation.
- Grinder swarf and/or pellet hardscrap are collected in safe geometry 3-gallon containers and limited to a safe mass quantity.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Air effluents are treated through a permitted HEPA Filter System.

Chemical Safety:

Normal operation of the grinders does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exist in area.

Industrial Safety:

Applicable OSHA Practices and regulations are followed.

Standard industrial safety practices for items related to electrical and mechanical safety are applied to the Grinding Area.

D.5 ROD LOADING, OUT-GASSING, AND WELDING (Continues)

Process/Equipment Description:

Pellet trays are removed from the storage cabinets to one of the fuel rod loading stations. The fuel pellets are placed on mock-up fuel column channels, weighed, and measured to required specifications. The column of pellets is pushed into an empty zircaloy tube previously welded at one end with a pre-numbered end plug. The loaded tubes are placed in rod trays and held in temporary storage prior to being transferred to the rod out-gas ovens.

Trays of rods are inserted into horizontal ovens for final removal of moisture. An inert atmosphere is maintained in each oven throughout the operation. The rods are treated at a specified temperature, vacuum, and time. After the rods are cooled, the rod trays are transferred to one of the final endplug welders.

Individual rods are inserted into a controlled atmosphere weld box. The inside of the rod is evacuated and then back-filled to positive pressure with inert gas. The endplug is then inserted and welded.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- The existing fabrication process equipment within the rod load/outgas/rod weld area are demonstrated favorable geometry and approved for heterogeneous UO_2 up to 5.0 w/o U-235 enrichment.

- The manual or auto rod load stations are limited to a single layer of pellet trays and beakers containing not more than a safe mass quantity. Pellet trays are limited to 6x5" stainless steel rod trays, contain less than 88 loaded rods per tray, and must be free draining.

- The pellet storage cabinet is a vertical array of shelves spaced a fixed distance apart and are under geometry and moderation control. The cabinet is noncombustible and the doors are designed to minimize the probability of in-leakage of water due to a fire and associated water spray. The cabinet is designed to prevent pellet spillage from shelf-to-shelf. Only approved pellet trays may be used within approved pellet cabinets and must not contain moderators except for labels/travelers. The cabinets are stainless steel and water resistant construction (though they have been demonstrated safe under optimum moderation conditions).

- The outgas ovens are limited to one 6x5" stainless steel rod tray per oven. Rod trays are limited to not more than 88 loaded rods per tray, and must be free draining (geometry and moderation).

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in pellet form and localized ventilation at the rod load stations. Respiratory protection, radiation work permits, and protective clothing are used in accord with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

Air effluents are treated through a permitted HEPA Filter System.

Chemical Safety:

Normal operation of these stations does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exist in area.

Industrial Safety:

Applicable OSHA practices and regulations are followed. Standard industrial safety practices for items related to electrical and mechanical safety are applied to the Rod Loading through Welding areas.

D.6 GADOLINIA SHOP (Continues)

Process/Equipment Description:

A separate adjacent shop is operated to produce fuel containing gadolinia, a non-radioactive nuclear poison, that controls the burn-up rate of fuel once it is placed into a reactor. UO_2 is received from the powder production area and blended with the required quantity of gadolinia. The process steps are isolated from, but follow the same process flow as described previously for UO_2 pellets (i.e.: pressing, sintering, grinding, and rod loading). Solid waste streams containing gadolinia are processed through the URU solvent extraction to remove gadolinium and the recovered uranyl nitrate product is fed to the UCON process for conversion to UO_2 on line 5.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

Criticality safety controls for the gadolinia shop are very similar to those global controls described above for the UO_2 shop pellet manufacturing, grinding, rod load, outgas operations and are therefore not repeated here.

Radiological Safety:

Radiological safety controls for the gadolinia shop are very similar to those global controls described above for the UO_2 shop pellet manufacturing, grinding, rod load, outgas operations and are therefore not repeated here.

Environmental Protection:

Air effluents are treated through a permitted HEPA Filter System.

Chemical Safety:

Normal operations of these stations does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exists in area.

Industrial Safety:

Applicable OSHA practices and regulations are followed. Standard industrial safety practices for items related to electrical and mechanical safety are applied to these processes.

D.7 FUEL BUNDLE ASSEMBLY(Continued)

Process/Equipment Description:

Fuel rods in trays are removed from the storage cabinets. UO_2 fuel rods are individually scanned for U-235 content using an active scanner that employs a neutron source and appropriate gamma radiation detectors. UO_2 rods containing gadolinia are scanned for U-235 on a passive scanner.

Based on the rod enrichment requirements of the fuel bundle design, the required rods are removed from the storage trays and transferred to another tray that is used to accumulate all the rods for a specific fuel bundle. The rods are then transferred to an assembly table, cleaned, and visually inspected. These rods are then assembled into a single specific fuel bundle

The bundle assembly operation is performed by an automated assembly machine. There are also several additional manual assembly stations. After assembly, the bundle is moved by an overhead crane to the leak test and final inspection station.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- Finished fuel rods are stored in a noncombustible covered rod storage cabinet is designed to prevent moderation by water spray (though this storage configuration has been demonstrated as favorable geometry under optimum moderation conditions).

- Only approved 6x5" stainless steel rod trays are permitted. Rod trays are limited to not more than 88 loaded rods per tray, and must be free draining (geometry and moderation).

- Movement of rods in this area is in rod trays with a height of five inches. Rod processing, inspection, and bundle assembly operations are conducted at a constant height and confined to safe geometries (e.g., all ramps limited to single layer of rods each). If rods are removed from trays, the number or configuration is controlled so that criticality control conditions are satisfied.

- During fuel bundle assembly, a maximum specified quantity of rods are handled at a time at each work station. Assembled bundles and those being assembled are processed on a fuel rod batch basis of one bundle at a time.

- During fuel bundle assembly, moderators must be limited to types and quantities necessary to operate the facility (e.g., cluster separators or 4 mil max. plastic). Bulk storage of extra moderators is not allowed.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in sealed fuel rods. Respiratory protection and protective clothing are not required. External worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

There are no special environmental considerations at this part of the process.

Chemical Safety:

Normal operations of these stations does not require th ise of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exists in area.

Industrial Safety:

Applicable OSHA practices and regulations are followed. Standard industrial safety practices for items related to electrical and mechanical safety are applied to these processes.

D.8 FUEL BUNDLE LEAK TEST/FINAL INSPECTION

Process/Equipment Description:

Assembled bundles are leak tested in a vacuum chamber. After the bundle is inserted, the chamber is closed and evacuated. If there is a leak in the fuel rods, it will be detected by a helium mass spectrograph. Following leak tests, the bundle is removed from the chamber and placed in an inspection fixture where it is inspected for conformance to various design requirements.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- The assembled fuel bundle is a specifically licensed as a safe geometry for heterogeneous UO_2 up to 5.0 w/o U-235.
- All units within this process area are demonstrated safe geometry units and are under moderation control.
- Visual inspection stations are limited to two bundles. Leak check station is limited to single fuel bundle or 88 fuel rods, but not both.
- Bundles shall not contain moderators with the exception of plastic rod separators.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in sealed fuel rods. Respiratory protection and protective clothing are not required. External worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

There are no special environmental considerations at this part of the process.

Chemical Safety:

Normal operation of these stations does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exists in area.

Industrial Safety:

Applicable OSHA practices and regulations are followed.

Standard industrial safety practices for items related to electrical and mechanical safety are applied to the Fuel Bundle Leak Test and Final Inspection areas.

D.9 BUNDLE FOREST STORAGE(Continues)

Process/Equipment Description:

Following the leak test, bundles are moved directly to a final inspection station or to a vertical bundle storage rack (bundle forest), and each bundle is wrapped, but not sealed at the bottom, with a plastic dust cover. The purpose of the storage racks is to provide a staging area of the completed fuel assemblies prior to packaging for offsite shipment. The storage area consists of two racks with two rows each of storage locations. The racks are rigidly constructed of steel girders on 48-inch centerlines.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- Criticality safety of the bundle forest storage array is maintained by the fixed spacing provided by the storage rack. The fuel rods in individual assemblies are in fixed positions leaving well-defined air spaces within the assembly which could conceivably be occupied by water from overhead sprinklers. For this reason, the criticality safety analysis assumed optimum interspersed moderation to be within the interstices as well as between the assemblies.

- The fuel assembly storage racks are rigidly constructed steel frameworks which securely hold the bundles in their designated positions. Loading of the rack with more than one assembly per storage position is physically impossible.

- The bundle forest is limited to 3 full rows of 56 bundles per row and one interior row of 28 bundles in alternate position with the 2 center positions not used. All positions in which fuel bundles are not permitted must be physically blocked to prevent use.

- Bundles stored vertically in the forest shall not contain moderators with the exception of plastic rod separators (e.g., individual or cluster separators) or plastic bundle covers are permitted but must be open and unsealed at the bottom.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in sealed fuel rods. Respiratory protection and protective clothing are not required. External worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

There are no special environmental considerations at this point of the process.

Chemical Safety:

Normal operation of the Fuel Bundle Storage area does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No special fire safety hazards exist in area.

Industrial Safety:

Applicable OSHA practices and regulations are followed.

Standard industrial safety standards for items related to electrical and mechanical safety are applied to the Fuel Bundle Storage area.

D.10 FUEL BUNDLE/LOOSE RODS PACKAGING FOR TRANSPORT (Continues)

Process/Equipment Description:

Released fuel bundles are packed with individual or cluster separator plastic spacers between rods in each direction to prevent rod movement or damage during transportation. Fuel bundles are moved by an overhead crane to the inner metal containers of the GE RA-series shipping package. This container is designed to hold no more than two bundles and are loaded in a vertical position. The loaded container is then sealed, and placed inside he outer GE RA-series shipping container. The cover of the outer container is bolted in position. According to a predetermined shipping schedule, the containers are transferred to the transport vehicle for shipment to an authorized receiver.

Individual fuel rods are packaged for shipment in the RA-series shipping container. Each rod is placed in a plastic sleeve and rods are bound together as a group. Fuel rods with an average U-235 enrichment greater than a specific value are placed in a schedule 40 stainless steel pipe. Up to two groups of rods are loaded in each metal inner RA container for shipment.

This existing operation will continue as licensed. GE-Wilmington will perform an Integrated Safety Analysis for this operation in accordance with a mutually agreeable schedule developed by GE-Wilmington and the NRC.

Criticality Safety:

- All loaded containers must be stored in a designated areas.
- Arrays of package containers must be limited as follows:
  - RA outer, loaded/empty limited to five high (max.), otherwise unlimited.

- RA inner, loaded, limited to three high (max.), otherwise unlimited.

- RA inner/outer mixed, limited to three high (max.), otherwise unlimited.

- BU's, 7A loaded/empty, loaded/empty limited to five high (max.), otherwise unlimited.

- Loose rods are placed in a 5" stainless steel pipe or bundled to a safe diameter prior to loading into an RA-inner container.

- Packaging operations are conducted in compliance with 10 CFR Part 71. The RA-series packages, as authorized by NRC Certificate of Compliance USA/4986/AF as Fissile Class I containers for the transport of fissile radioactive material in the form of reactor fuel such as BWR fuel assemblies and fuel rods. The package satisfies criticality safety requirements based on postulated drop, puncture, fire, and immersion conditions possible during transport.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in sealed fuel rods. Respiratory protection and protective clothing are not required. External worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Protection:

There are no specific environmental considerations at this point of the process.

Chemical Safety:

Normal operation of the Fuel Bundle Packaging area does not require the use of chemicals that pose a significant safety concern.

Fire Safety:

No specific fire safety hazards exists in area.

Industrial Safety:

Applicable OSHA practices and regulations are followed.

Standard industrial safety standards for items related to electrical and mechanical safety are applied to the Fuel Bundle Packaging area.

E. EXISTING FACILITY-TO-DCP INTEGRATION

Process/Equipment Description:

Associated with the new Dry Conversion Process (DCP) is the need to connect the material flows to and from that facility with the current and continuing operations. This involves the transfer corridor, pellet press feed stations, and the GAD Shop. The recycle of material will also be facilitized in the current FMOX area directly adjacent to DCP.

The processing and handling of uranium powder requires strict adherence to certain quality and safety requirements. One requirement that is of primary importance is the restriction of nuclear moderators such as water. Certain features described in this section contain references to Moderation Restricted Areas (MRAs) which are areas in which the primary criticality safety control parameter is moderation, thus prohibiting accidental addition of hydrogenous material (e.g., water) is of prime importance.

The rooms will have supply air and exhaust systems designed to prevent liquid from entering these areas through the ductwork. The existing systems will be analyzed to determine the adequacy of the systems and modifications required to ensure moisture and humidity control and alarms are in place or will be installed. Controls will be installed between the units and the DCP Control Room to alarm in case moisture setpoints are reached. HEPA filtered exhaust will be installed from each room and the hallway maintaining the air balance requirements of FMO/FMOX. Air balance will be provided between FMOX and the DCP to prevent loss of controls of either facility.

Modifications and additions required necessary to these new integration facilities will be made in the accordance with internally established nuclear safety design criteria.

These integration modifications will be operated in accordance with license requirements. GE-Wilmington will perform an Integrated Safety Analysis (ISA) for these modifications. The ISA will be completed prior to operational start-up.

The integration of the new DCP facility to the current FMO operation has the four following primary interrelated parts: 1) DCP generated UO_2 powder will be transferred in bulk unicone or bicone storage containers along a north-to-south mezzanine transfer corridor in the FMO/FMOX building; 2) the UO_2 rotary press feed station and bicone storage area; 3) the GAD powder transfer/additive vibromill station and associated unicone storage area; and 4) the dry recycle integration facility in which dry sintered UO_2 is converted to U_3O_8 powder. Please note that with the exception of the transfer corridor, these new integration components will comply with design requirements of a Moderation Restricted Area (MRA). At a minimum, each MRA room will be constructed of water-tight siding and roofing. The existing building structural systems will be analyzed to ensure that they will carry the loads of the new structures and equipment plus the weight of the materials being transported through the corridor area. Each of the integration components are discussed below.

Transition will take place beginning in May of 1997 after the process lines have been checked out and released for operation with enriched materials. This applies to the integration parts also. The lines will be brought up to rate one at a time and the whole process should take approximately three months. As the new process comes on line, the old process will go off line. We expect to be at full production rate with the new process in July 1997 and should no longer require the ADU lines after December 1997.

- **Transfer Corridor (FMO/FMOX)**

  A new transfer corridor will connect the new DCP Facility and the FMO areas where powder will be required. MRAs will be constructed off this corridor to support necessary powder storage and manufacturing operations. The corridor will be approximately 10 feet wide and will extend from the DCP to the GAD shop integration area and will be moderation controlled. All existing equipment within the corridor and the new MRA areas will be relocated or removed.

- **GAD Shop Integration**

  The gadolinia (GAD) shop integration factuality includes a large container storage room (MRA); a powder transfer/gadolinium additive room (MRA) with associated storage room, equipment and conveyors; a powder pre-compaction process that includes a slugger, granulator, associated feed/discharge system and conveyors. The physical location of this part of the integration is the south end of the FMO press warehouse. The remaining portion which includes a roll tumbler operation and the removal and replacement of two hydramet presses with a rotary press and associated take-off system is located in the existing GAD Shop.

  The GAD shop modifications will be accomplished in three phases as follows: phase I equips the existing GAD shop with a powder pre-compaction process; phase II consists of replacing two hydramet presses with a single rotary press design; phase III of the project will provide the GAD shop with a process for feeding DCP powder from unicones to the DM-10 vibroblender within an moderation restricted area (MRA) and access doors and a conveyor run into the existing gadolinia shop.

- **Press Feed Stations/Bicone Storage**

The UO_2 press feed transfer station consists of a MRA bicone storage room and a MRA room housing the press feed stations; transfer stations relocation; associated powder metering equipment; floor penetration and press relocation on the first floor.

The existing rotary press powder transfer stations will be modified to accommodate bicone feed containers carrying granulated UO_2 from the DCP facility to the rotary presses. Mode of operation will be similar to the existing press operation with the exception of the large powder feed containers. Press blends will consist of one or more bicones, each carrying a blend quantity of granulated UO_2. The bicone container will be transported down the FMOX moderation-controlled corridor to the press transfer stations. The bicone will be positioned in place on the recessed opening in the floor and connected to the transfer equipment that feeds the presses below.

The existing can hood/transfer station will be removed and a recess cut into the floor to accommodate the powder feeder. Slots/stops will be installed for the bicone feed container to position the bicone directly over the powder transfer tube. An inflatable sealing device will be installed to connect the powder transfer pipe to the bicone outlet.

The bicone valve will be opened and the UO_2 will be directed to the powder feeder installed directly below the valve. Flexible hoses are present above and below the powder feeder. In the event of a breach in the flexible hose, the UO_2 powder will be contained in the recess and can be vacuumed clean.

- **Vibromill /Gd_2O_3 Additive Station and Unicone Storage**

The new vibromill MRA station GAD Shop will receive blended UO_2 powder from the DCP facility in unicone containers via the transfer corridor on motorized pallet trucks. The unicone containers will be staged in designated floor storage positions within the MRA. The unicones will be lifted by monorail and the powder will be metered into a DM-10 vibroblender using weight readings to control discharge. Necessary Gd_2O_3 or acrawax additions will be made and the vibromill blend cycle completed to ensure product homogeneity. When the unicone feed containers have been emptied, they will be checked for gadolinia contamination, reweighed, and then returned to the DCP Facility via th transfer corridor.

The discharge of the vibroblender will feed into 3 gallon containers, which will be enclosed in a hood to provide containment. These containers will be transported to the expanded GAD Shop via a conveyor system, where the containers may be placed either in storage or taken to the pre-compaction station. The UO_2 powder is metered into a pre-compacter. The compacts are then granulated and the UO_2 granules placed into 3 gallon containers, which may be routed to storage or to the roll tumbling operation after which they are stored until pellet press.

- **Dry Recycle Integration**

  The purpose of the dry recycle integration facility is to convert clean, sintered UO_2 scrap into U_3O_8 powder. The U_3O_8 powder will have specific characteristics allowing it to be added into the UO_2 powder produced by the new DCP facility such that acceptable fuel pellets can be produced. The five main processes of the dry recycle facility include recycle collection, storage, oxidation, particle size reduction, and blending.

  The dry recycle integration facility includes modifying a portion of the first and mezzanine levels of the FMOX building directly adjacent to the DCP. The integration facility will meet MRA design standards; contain conveyors for 3 and 5 gallon cans; a furnace; screening and milling equipment; large container transfer/handling equipment; and a vibromill blender(s).

  For further details on Dry Recycle integration refer to Section C.2 of this document.

Criticality Safety - Integration Facilities:

- The UO_2 press feed transfer station, vibromill/Gd_2O_3 additive station and dry recycle areas with associated unicone/bicone storage areas will be constructed to moderation restricted area (MRA) design standards. At a minimum, the MRA containment structure will provide water-tight siding and roofing to provide additional structural integrity to prevent water from entering the rooms.

- The minimum criticality safety moderation control requirements within the MRA for various modes of operation for the given integration process shall comply with the double contingency principle. The order of preference for control is passive, active, and administrative.

Radiological Safety:

Radiological safety in this area is based on containment of the nuclear material in the equipment and enclosures. Respiratory protection, radiation work permits, and protective clothing are used in accordance with the license commitments and as documented in internal procedures. Radiological conditions and worker exposures are monitored and assigned in accord with the radiation safety program, including the requirements of ALARA.

Environmental Safety:

There are no environmental impacts from these operations.

Chemical Safety:

There are no chemical operations to be considered in these areas.

Fire Safety:

There will be no sprinkler protection in the moderation controlled transfer corridor and the defined integration component moderation restricted areas. Fire protection will be provided by individual wall-mounted fire extinguishers in each room and throughout the transfer corridor and limiting the amount of combustibles in the areas. Smoke detectors and rate-of-rise temperature detectors will be installed in each individual room and throughout and these units will be tied into the existing centralized fire alarm system.

Sprinklers will be removed from the first floor dry recycle integration area in FMOX and the associated transfer corridor to the DCP.

PROCESS & EQUIPMENT LAYOUT DRAWING REFERENCE TABLE

PROCESS/EQUIPMENT	DRAWING REFERENCE LOCATION
A.1 ADU CONVERSION OPERATIONS:	
UF_6 Receipt, Handling, & Storage	2L, 3B2, 3A13
UF_6 Cylinder Storage Pad	2L
UF_6 Cylinder Dock	3B2
UF_6 Vaporization Area	3C1: A, B, C
UF_6 Vaporization Chambers	3C1: A & B
UF_6 Cold Trap	3C1C
Hydrolysis	3C2: A & B
Precipitation	3C6, 3C12
Dewatering Centrifuges	3C23: A & B
Clarifier Centrifuges	3C7: A & B
Calciners	3C8: A & B
Calciner Recycle Feed	3C24: A & B
UO_2 Powder Pre-treatment (Mill, Slug, Granulate)	3C9, 3C25, 3C20: D & E
UO_2 Powder Storage	3C17B, 3C20A, 3C27
Pellet Press Feed	3E3
UO_2 Powder Blending	3C20: A, B, C
LoE Blender	3C26
B.1 URANIUM RECOVERY & WASTE TREATMENT OPERATIONS:	
65,000 Gallon Surge Tank	13B
Ion Exchange Process	3A3A
Ammonia Recovery	1C1
100,000 Gallon Surge Tank	1C2
Overflow Clarifier (CaF_2)	1C8
Fluoride Final Basin	1B2
Rad Waste Treatment	3A7:A, B, C, D
Rad Waste Final Process Basin	1B2
Nitrate Waste Treatment	3A2:A, B, C, D
20,000 Gallon Surge Tank	13B
Nitrate Quarantine Tanks	3A5E
20,000 Gallon Settling Tank	1C3
Secondary Nitrate Waste Storage Basin	1C3 & 1A1

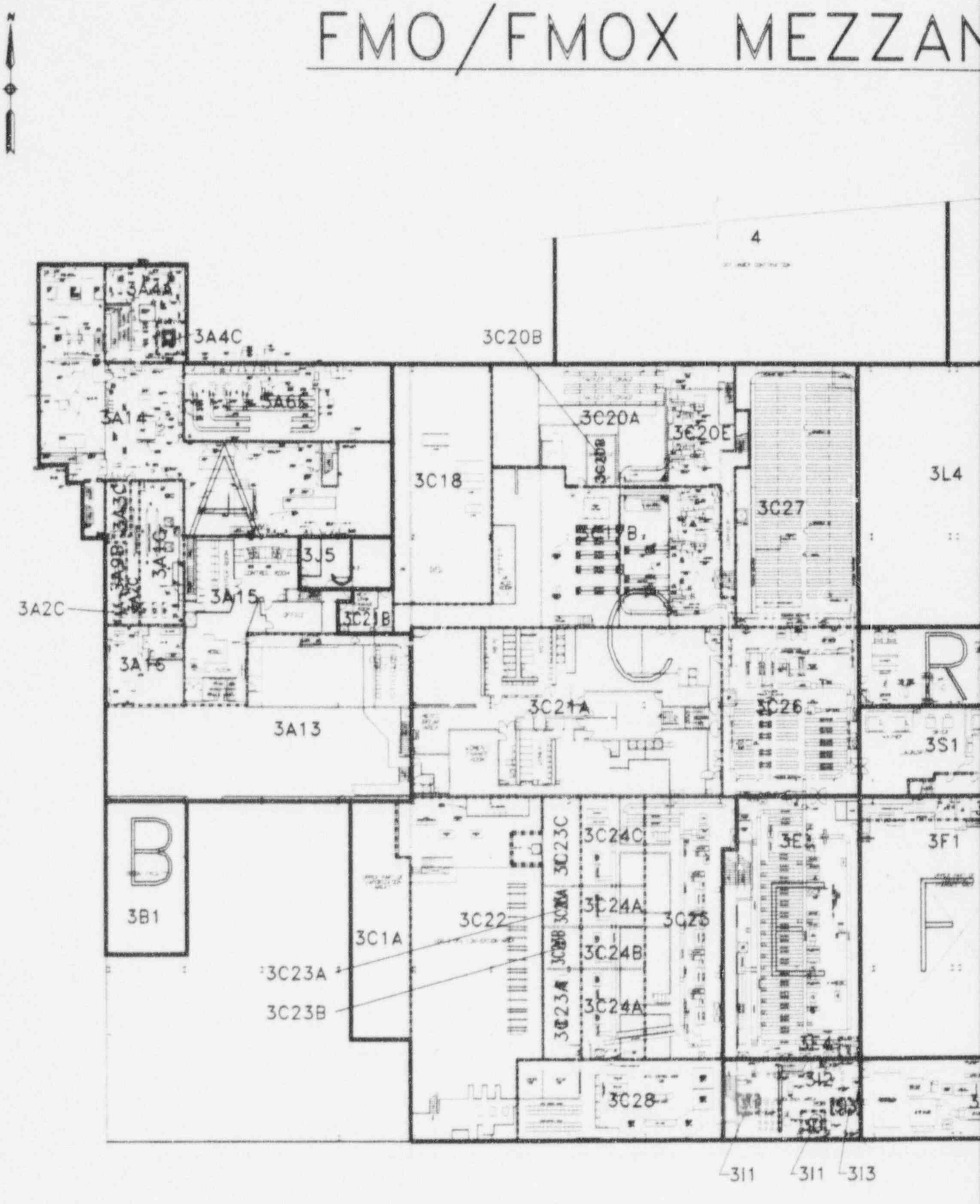
PROCESS & EQUIPMENT LAYOUT DRAWING REFERENCE TABLE

PROCESS/EQUIPMENT	DRAWING REFERENCE LOCATION
B.2 SCRAP RECOVERY (URU) OPERATIONS:	
Oxidation Process	3A8
Dissolution Process	3A6: A, B, C, D, E
NO_X Absorber	3A4C
Leaching Process	3A6D
Head-End Concentrator	3A5A
Solvent Extraction Process	3A4A
NO_X Scrubber	3A4C
DI Water Break Tank	3A9B
Solvent Extraction Feed Tanks	3A5: B, C, D
Solid Contaminated Waste	3B1
Noncombustible Solid Waste	3B1
Fill Box Monitor	3A7
Scrap Recovery Product Storage	3A12
Uranyl Nitrate Feed Storage	3C4C
Uranyl Nitrate Precipitation	3C4B
Line 5 Dewatering Centrifuge	3C23
Line 5 Calciner	3C8C
URLS:	
Settling Tank	1A1
Leaching Operation	1A2
Solvent Extraction	1A3
Chemistry Lab	1A10
HVAC System	1A9
Sludge Transfer & Storage System	1A1
Leaching/Filtration	1A2
Solvent Extraction/Scrubbing/Stripping	1A3, 1A4, 1A5
Uranium Precipitation/Filtration	1A4
Raffinate Treatment	1A6

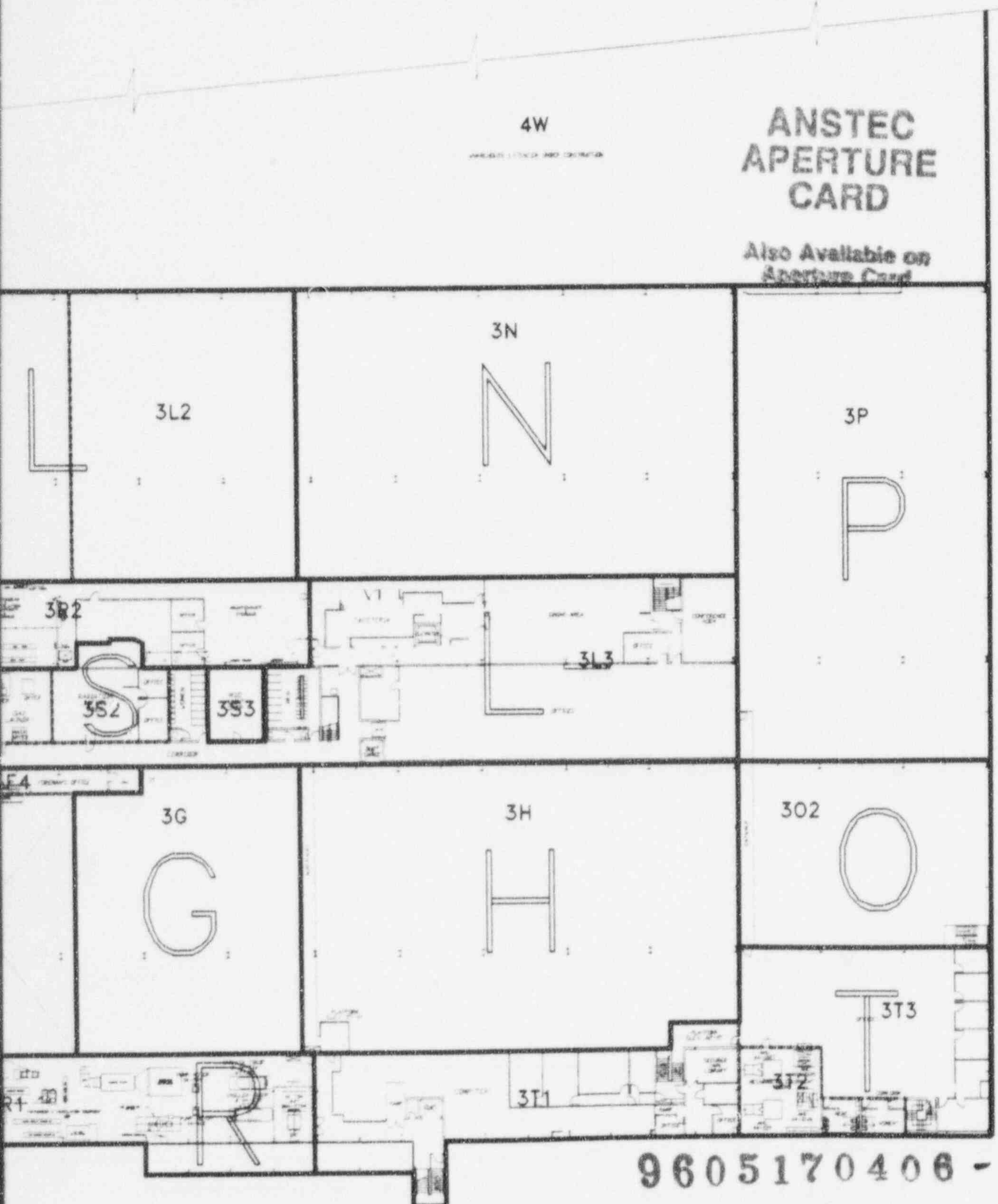
PROCESS & EQUIPMENT LAYOUT DRAWING REFERENCE TABLE

PROCESS/EQUIPMENT		DRAWING REFERENCE LOCATION
C.1	**DRY CONVERSION:**	
	UF_6 Vaporization	4V
	Conversion	4C
	Powder Cooling	4P
	Sieving & Homogenization	4H
	Blending-through-Lubrication	4G & 4B
	HF Treatment & Storage	4D
D.1	**PRESS WAREHOUSE**	3E3
D.2	**PELLET PRESSING OPERATIONS**	3E1 & 3E2
D.3	**PELLET SINTERING**	3F1
D.4	**PELLET GRINDING**	3G1
	Pellet Storage Cabinets	3G2
D.5	**ROD LOADING, OUT-GASSING, WELDING**	3G3, 3G4, 3G5
D.6	**GADOLINIA SHOP**	3I: 1-11
D.7	**FUEL BUNDLE ASSEMBLY**:	
	Rod Storage Cabinets	3H1
	Rod Active Scanner	3H4
	Rod Passive Scanner	3H6
D.8	**FUEL BUNDLE LEAK TEST & FINAL INSPECTION**	3H8
D.9	**FUEL BUNDLE STORAGE**	3H8
D.10	**FUEL BUNDLE PACKAGING**	3O1

FMO/FMOX MEZZAN



NINE FLOOR PLAN



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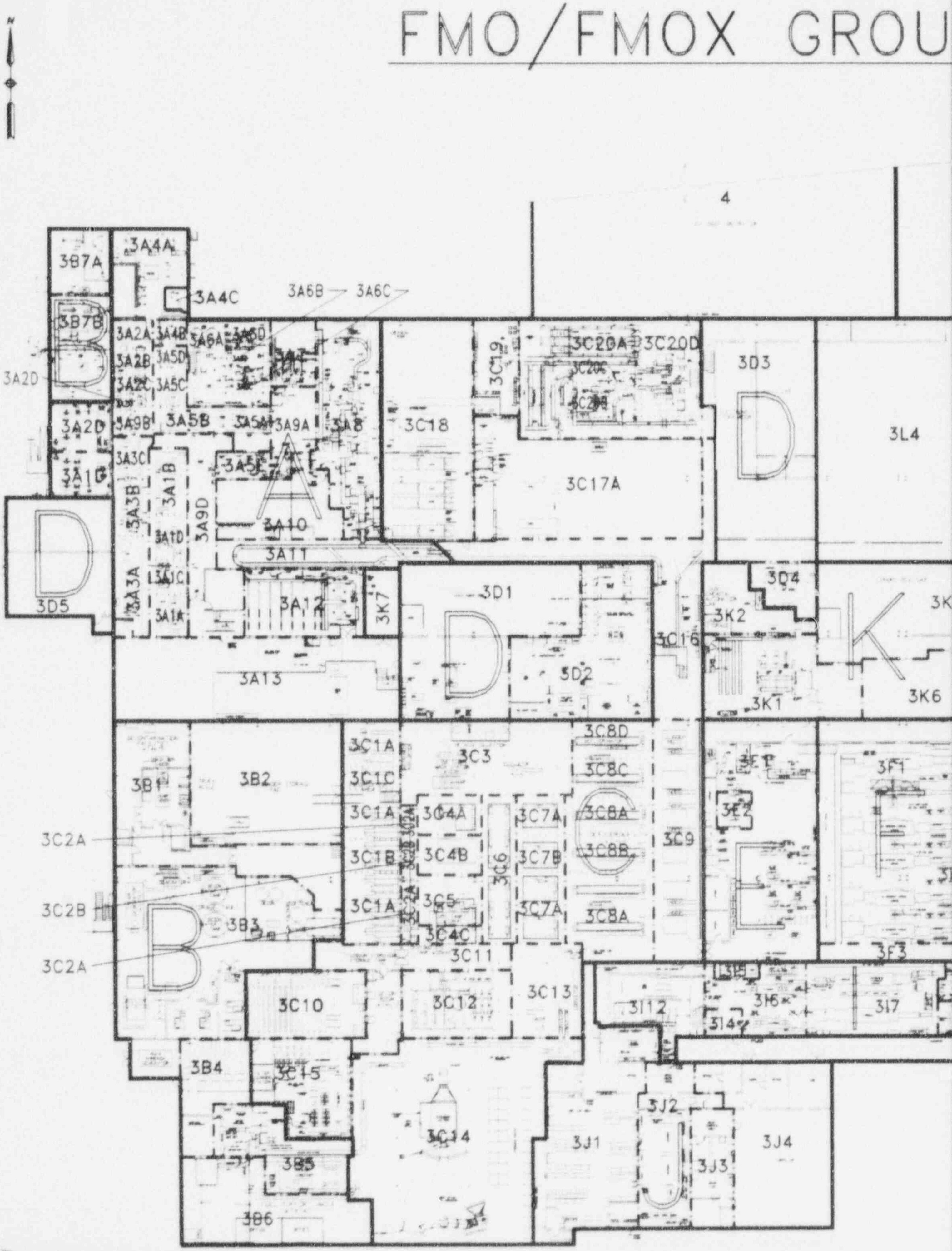
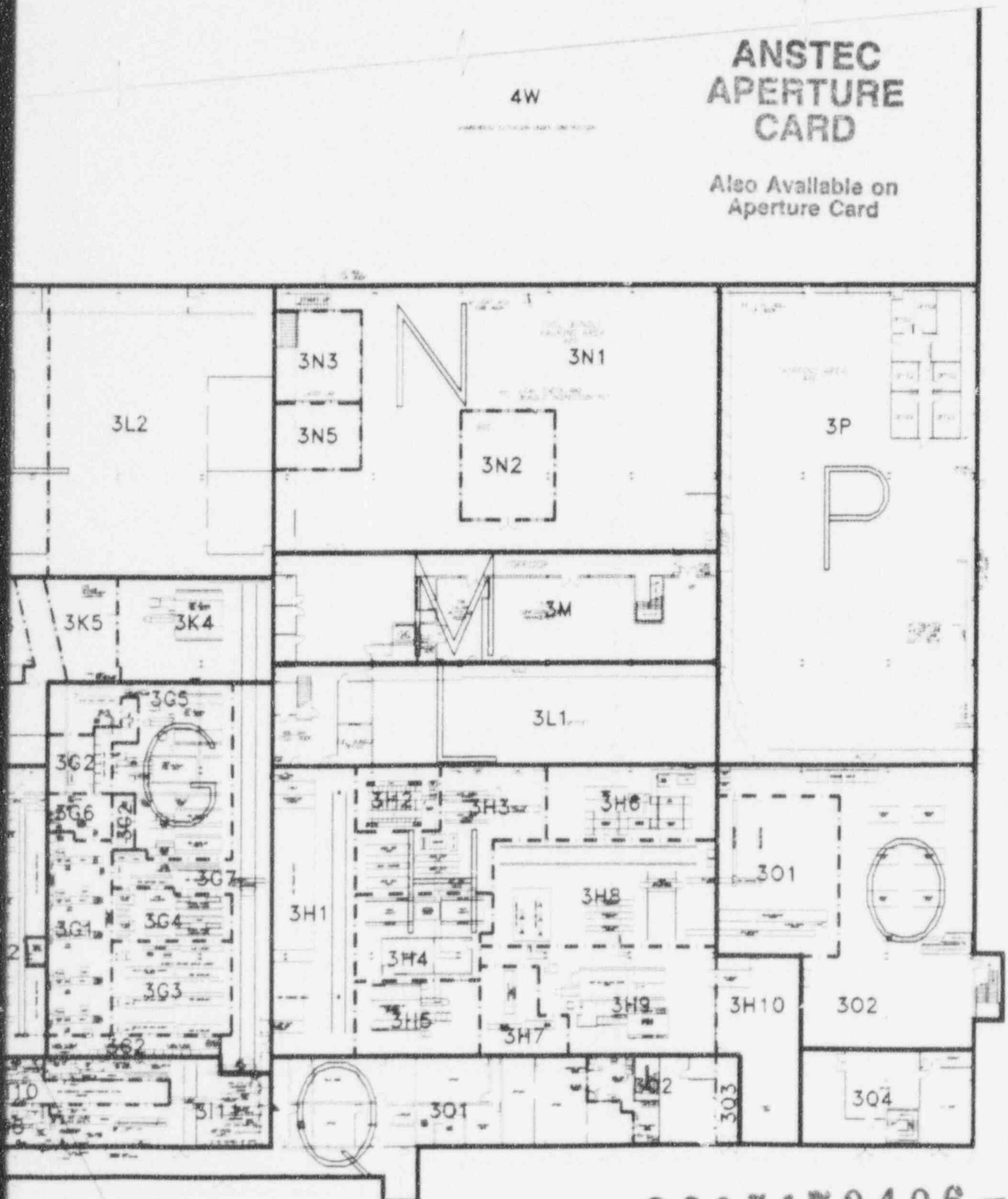
LAYOUT 1
DRAWING No. 7038A94
REVISION No. 4
DATE: 9-20-95

FMO/FMOX GROU



ND FLOOR PLAN



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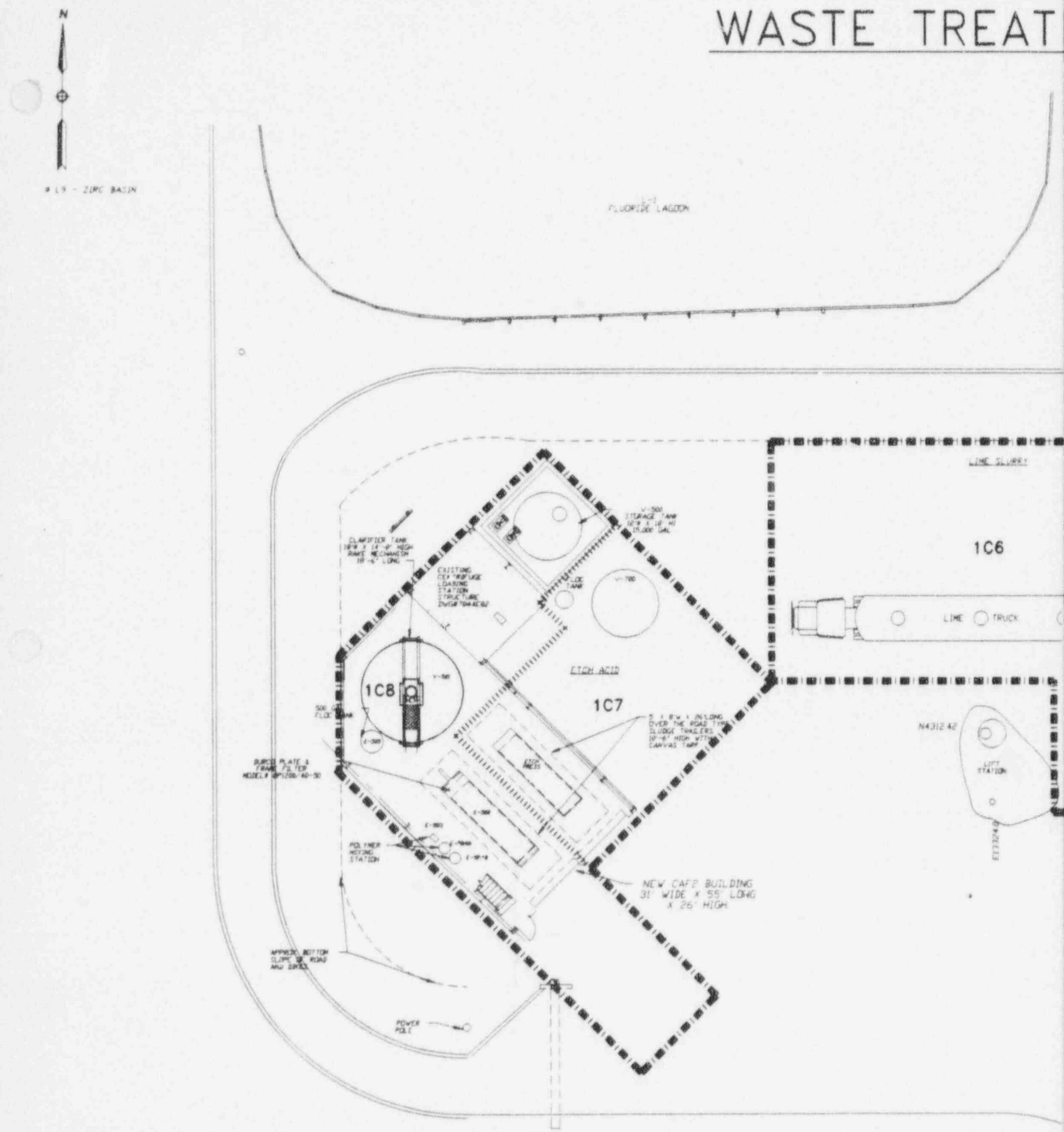
LAYOUT 2
DRAWING No. 7037A94
REVISION No. 7
DATE: 3-28-96

WASTE TREAT

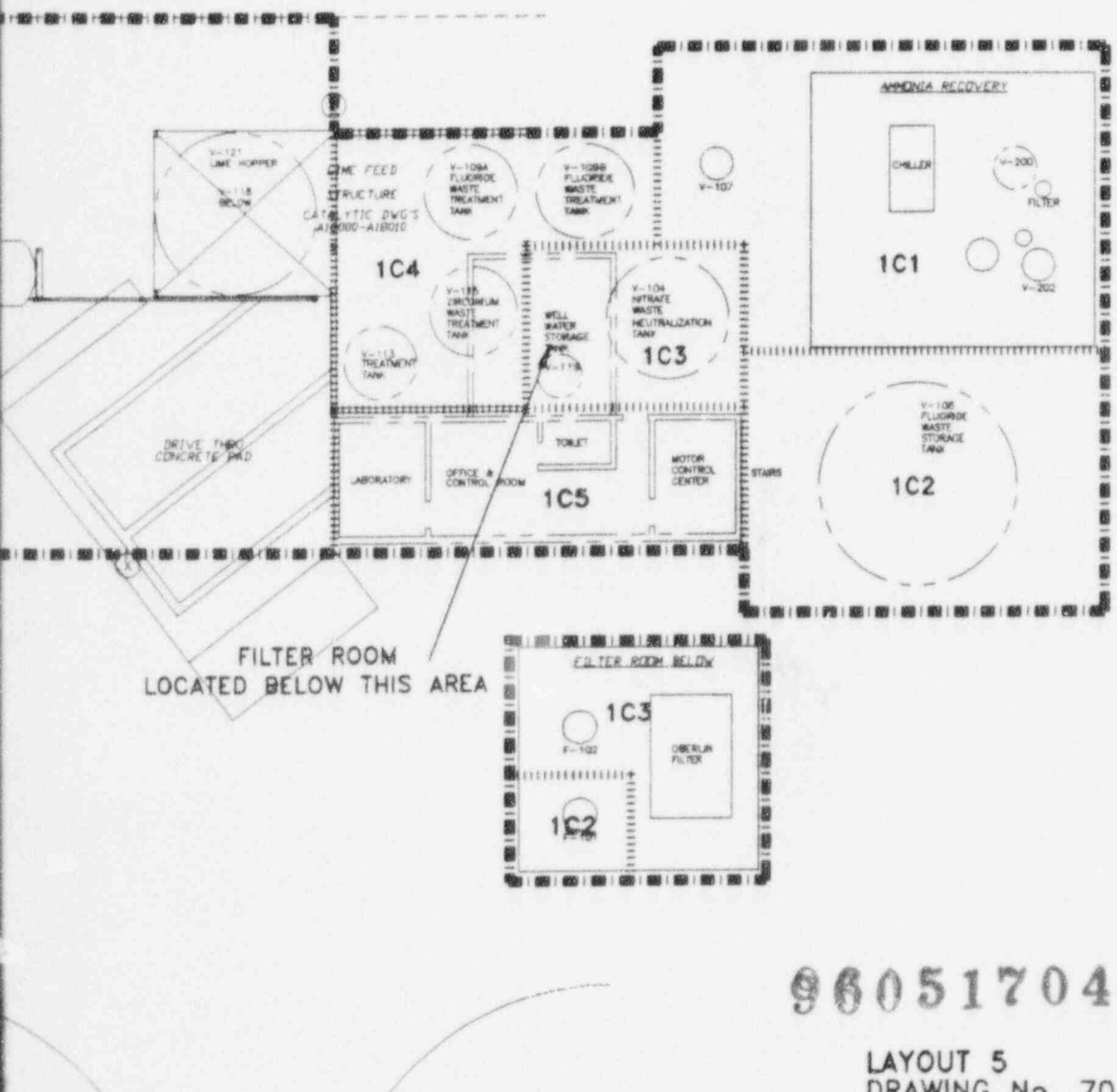


N
FLUORIDE LAGOON
LIME SLURRY
1C6
LIME
TRUCK
1C8
1C7
ETCH ACID
V-500
STORAGE TANK
V-700
CLARIFIER TANK
RAKE MECHANISM
EXISTING
LOADING
STATION
STRUCTURE
5 x 8 W x 26 LONG
OVER THE ROAD TYPE
SLUDGE TRAILERS
CANVAS TARP
POLYMER
MIXING
STATION
NEW CAF2 BUILDING
31' WIDE X 55' LONG
X 26' HIGH
POWER
POLE
LIFT
STATION
N431242

MENT PLAN

ANSTEC APERTURE CARD

Also Available on Aperture Card



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LAYOUT 5
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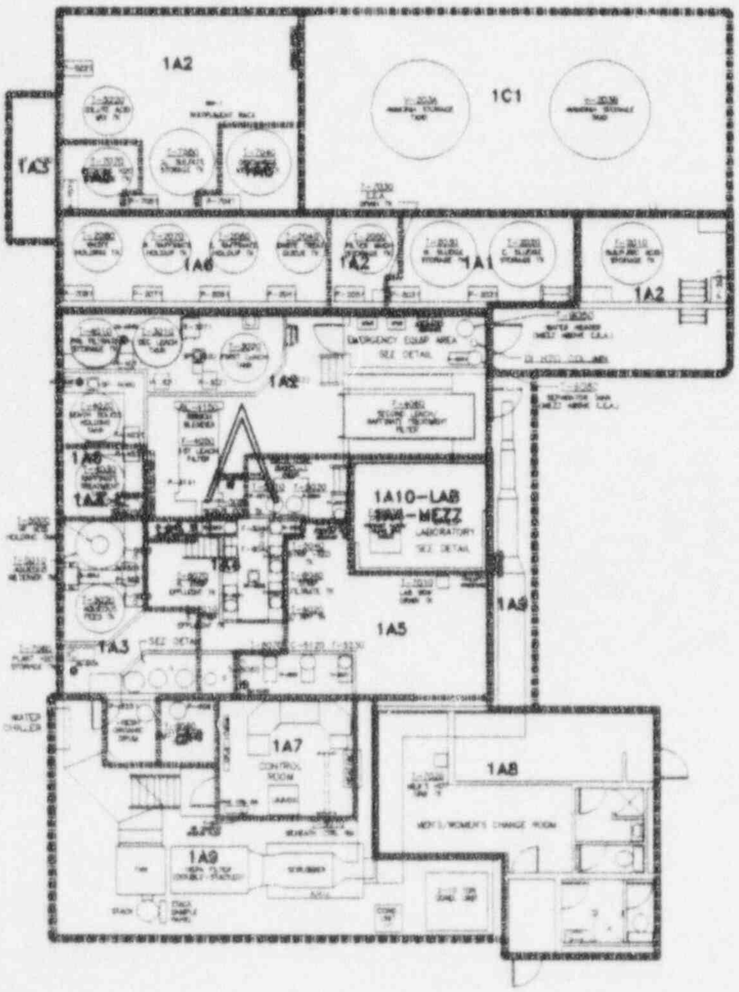
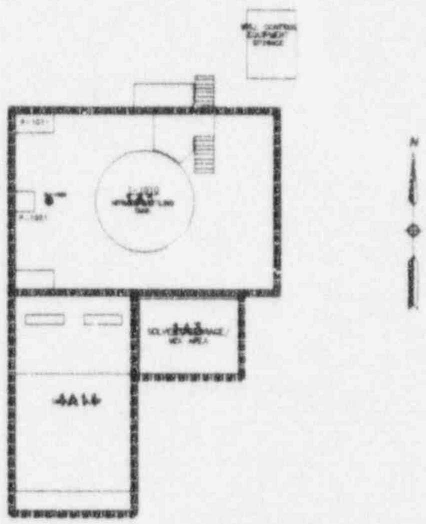
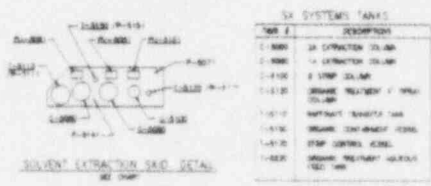
REVISION No. 2
DATE: 11-18-94





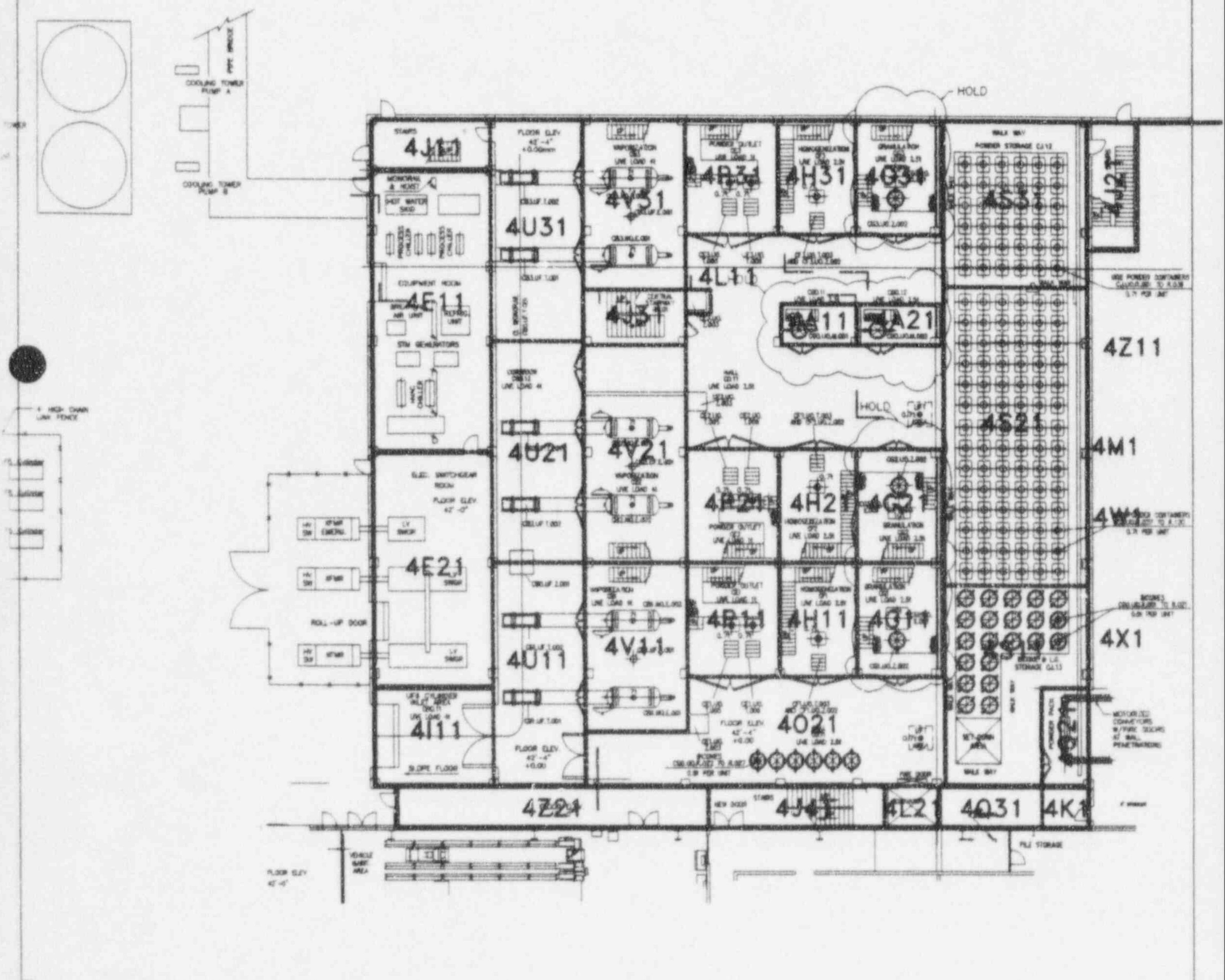


URLS FLOOR PLAN

LAYOUT 3
DRAWING No. 7039AS4
REVISION No. 2
DATE: 11-18-94

DCP FIRST FLOOR LAYOUT

DRAWING No. 7013A96
REVISION No. 0
DATE: 5-3-96



DCP SECOND FLOOR LAYOUT

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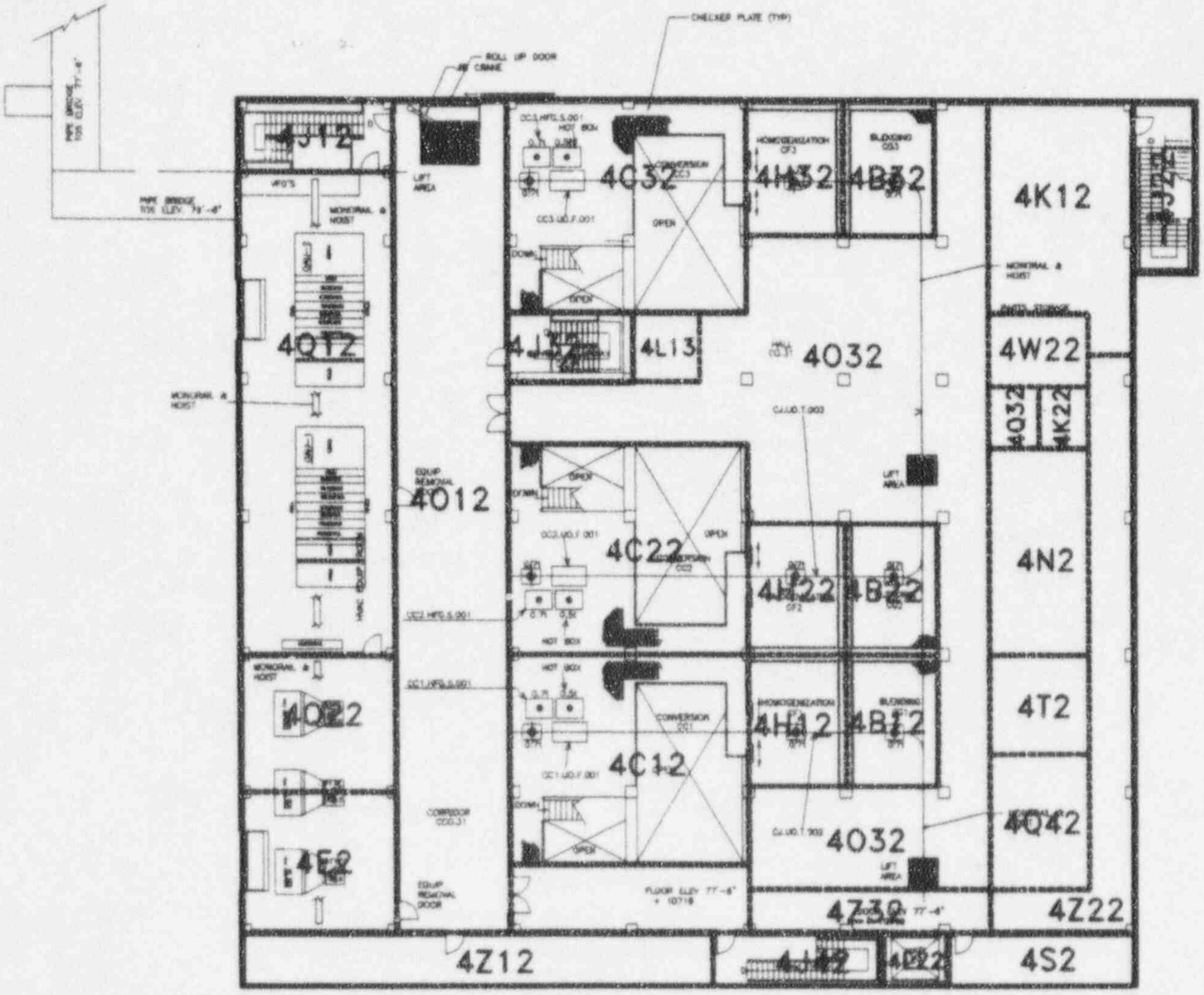
REVISION No. 0
DATE: 5-3-96



DCP THIRD FLOOR LAYOUT

DRAWING No. 7015A96
REVISION No. 0
DATE: 5-3-96