UNITED STATES ATOMIC ENERGY COMMISSION

SAFETY ANALYSIS BY THE IRRADIATED FUELS BRANCH

DIVISION OF MATERIALS LICENSING

IN THE MATTER OF

MARTIN-MARIETTA CORPORATION

BYPRODUCT LICENSE NO. 19-1398-29 RENEWAL

QUEHANNA RADIOISOTOPES PILOT PLANT

SUMMARY

By a letter dated April 15, 1964, the Nuclear Division of the Martin-Marietta Corporation made a timely application for renewal of Byproduct License No. 19-1398-29, to authorize continuance of the operation of their Pilot Plant at Quehanna, Pennsylvania, which has been engaged in the manufacture of strontium-90 heat sources. To replace all previous submissions supporting requests for the various facets of the existing license, a new document "Radioisotopes Pilot Plant - Facility Design and Safety Evaluation," MND-3137 was submitted. A substantial portion of the isotopic heat source production work under the renewed license is to be in new equipment in a new arrangement in different cells. MND-3137 incorporates descriptions of the site, the plant, the equipment, the ventilation and waste disposal systems, the utilities and services, and the strontium-90 process. The report also includes a safety evaluation and information regarding administrative controls, the health physics program, and emergency control measures. As indicated under Contents of Submittal, below, some corrections and revisions have been submitted as replacement pages for MND-3137.

The renewal application does not include a request for authorization to decommission contaminated equipment in Cells 1 and 2 that will no longer be used. This has been authorized by Amendment 15 pursuant to an application dated May 15, 1964. The proposed renewed license should incorporate an authorization to carry this decommissioning of superseded equipment to a conclusion.

We have completed a review of the material submitted in connection with the application for a license renewal, and upon the basis of the information therein we have concluded that the proposed operations with strontium-90 and its associated impurities can be carried out without undue risk to the health and safety of the public. Our review took into consideration the major processing steps; the arrangement and containment of the new equipment; reappraisal of personnel qualifications, and a reevaluated maximum credible accident.

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CONTENTS OF SUBMITTAL

The following items reviewed in the preparation of this safety evaluation constitute the material submitted as, or in support of, the subject license renewal.

Letter, Martin to USAEC-DML, 4-15-64, requesting renewal of license 19-1398-29, and submitting Form AEC 313; document MND-3137; and Drawings N-0009744 and N-0009748.

Letter, Martin to USAEC-DML, 4-16-64, submitting restricted reagent data.

Letter, Martin to USAEC-DML, 6-5-64, submitting revised pages 35, 41, 89, 91, 97, 98, 100, 119, 150, 152, 171, 171A, 171B, 172, 179, 179A, 180, 184, and 193, for MND-3137.

Letter, Martin to USAEC-DML, 6-23-64, submitting revised pages 26, 47, 86, 87, 95, 96, 106A, 108, 112, 115, 133, 134, 135, 137, 248, 249, 250, 251, 251A, 251B, 251C, 252, 252A, 253, 254, and 255, as well as Tables 6.3 and 6.4 and Figures 6.5, 6.6 and 7.2 for MND-3137 and also supplying for information purposes only Preliminary Print N-0009001, sheet 2 of 6.

Letter, Martin to USAEC-DML, 8-27-64, transmitting Monsanto data characterizing Pydraul hydraulic fluid.

DESCRIPTION OF RADIOISOTOPES PILOT PLANT

The Quehanna plant was constructed by the Curtiss-Wright Corporation in 1957 in a relatively isolated location near the juncture of Elk County, Cameron County, and Clearfield County in the Appalachian Plateau Province of central Pennsylvania. It is at an elevation of nearly 1,900 feet above sea level, not far from the 300 foot deep canyon of Meeker Run which drains into Mosquito Creek, a tributary of the Susquehanna River. The surrounding area is primarily state forest and state game land. It is 7½ miles to the nearest village.

Water is supplied to the facility from Meeker Run by a 100 gpm pump which discharges into a 135,000 gallon reservoir on a hillside adjacent the plant. The elevation of the reservoir is sufficient for water to flow into the plant by gravity. However, both process and fire water systems utilize pumps and pneumatically cushioned pressure tanks to maintain suitable heads for the respective uses. The radioactive liquid waste system discharges into Meeker Run a few yards below the water supply pump crib. The pitch of the stream bed is sufficient to prevent recycling waste back into the plant.

The radioisotopes Pilot Plant utilizes the support facilities of a pool type research reactor, which is presently not being operated. These facilities are leased from Pennsylvania State University and contain a half dozen hot cells, a fuel storage pool, radioactive waste system, laboratories, shop, offices, and a utilities plant.

The main building is fabricated of insulated aluminum paneling mounted on structural steel framework. The radioactive liquid waste system, pumps, evaporator, and dilution tank are located in a small building near by, above the 4 underground collection tanks. Also near by and within the fenced restricted area are two new metal frame and siding buildings, one is used to store supplies and the other to shelter packaged radioactive waste awaiting disposal.

In a portion of the main building segregated from the reactor, the hot cells are located in a row within an access controlled area. Separate air locks admit personnel via the clothing change room to the normally uncontaminated Operating Gallery on one side of the row of cells or to the Cell Service Area on the other side.

The Cell Service Area is high bay, spanning the cells, the isolation rooms attached to each cell, and a sizable work area through which access to the cells may be attained via their respective isolation rooms. The fuel storage pool and a cask storage space are also located in the Cell Service Area. A 15 ton bridge crane spans the Cell Service Area. A radiochemistry laboratory and a decontamination room open off the high bay section and are included in the access controlled zone of the Cell Service Area, where contamination may be permitted.

The isolation rooms serve as vestibules for their respective cells. Their walls are of 8-inch thick pre-cast reinforced concrete. The ceilings are 5 inches thick. Twelve inch thick steel doors hung from an overhead rail are provided to close the doorway from each isolation room into its adjacent cell.

Beneath the row of isolation rooms is a basement in which cell exhaust ventilation equipment is located. The basement may be entered through a hatch in the Cell Service Area floor, and so access to the fans and filters is controlled.

In other portions of the main building, outside the access controlled areas, there are a number of offices and laboratories to support the isotopic fuel production work. A utility wing houses water pressurizing equipment, a heating plant, and propane fueled emergency engines.

The new processing arrangement will utilize Cell 4 for the preparation of isotopic fuel capsules, Cell 5 for testing, storage and packaging the products, and Cell 3 for waste collection and packaging.

The Cell 4 shield door is to be left open and the containment attribute of Cell 4 will extend a few feet into Isolation Room 4 to where a solid concrete block partition has been erected accross the isolation room.

In this Cell 4 extension will be located the 250 liter water cooled Feed Material Storage tank within a secondary liquid containment vessel shielded by a lead brick cubicle. The process vessel vacuum system pump will also be located here.

The primary cell exhaust filters and process box inlet filters will be located in the Cell 4 doorway. A metal slab shield erected far enough inside Cell 4 to permit duct work to pass into the doorway between it and the cell wall will shield personnel who service the filters.

A light weight door is provided at one end of the concrete block partition accross Isolation Room 4 to admit personnel to the extension of Cell 4 space for changing filters and servicing the vacuum pump. When the door is closed, Cell 4 make up air is drawn from the isolation room through an AEC type filter mounted in the wall above the door.

Description of the Process

Strontium 90 is not produced at this plant. It is received as a feed material in shielded shipping casks, which may contain as much as ½ megacurie in the form of $SrCO_3$.

Casks of feed material are received via motor truck. The trucks are unloaded adjacent the building. A crane is used to transfer the casks to a specially built pallet slung low between small sturdy wheels. On this pallet a cask is moved through an air lock into the Cell Service Area of the building, and thence into the cask unloading position in Isolation Room 4.

An expendable polyvinyl chloride cupola equipped with glove ports will be fitted to each feed material cask so that transfer line connections can be made and broken in a containment equivalent to a dry box. This cupola remains in place during the unloading of the feed material. It is ventilated through AEC type filters into the atmosphere of Cell 4.

Nitric acid is used to dissolve the received $SrCO_3$ in the cask. The acid is poured via a valved funnel into Acid Addition tank T-10, located above the shipping cask in Isolation Room 4. From T-10, calculated quantities of nitric acid are carefully metered through one of the connected lines, into the shipping cask. The dissolution takes place at pressures below atmospheric, the cask vent line being connected to the process vacuum system, which has greater pumping capacity than the gas evolution rate possible at the maximum acid addition rate of 0.3 moles per minute. The resulting solution of $Sr(NO_3)_2$ is transferred from the cask by vacuum into the 250 liter water cooled, lead shielded Feed Material Storage Tank located in the Cell 4 extension on the opposite side of the concrete block partition.

Except for a 100-liter filtrate tank, a 50-liter vacuum surge tank, a 5-liter metering tank, and the associated piping, the equipment in Cell 4 is contained within a two compartment stainless steel process box that nearly fills the cell. Each compartment has a window aligned with one of the two shielding windows between Cell 4 and the Operating Gallery. A pair of Model 8 master slave manipulators is mounted in the cell wall above each window. These enter the process box via ports that are sealed by manipulator boots. Replacement boots can be installed through the cell wall manipulator apertures before worn boots are removed by pushing them into the process box.

In compartment A of the process box in Cell 4, metered quantities of $Sr(NO_3)_2$ feed solution will be mixed with reagents in a 50 liter conical bottomed vessel to form a Sr 90 precipitate. The produced slurry will be transferred to a filter-crucible housing by vacuum for filtration, and subsequently the filter cake will be removed in the crucible to an electric furnace for drying. Manipulators will be used to perform all work in the process box such as operating the process stream valves, opening the crucible housing, and transferring the crucible.

In some cases the strontium precipitate will also be calcined in the electric furnace, by raising the temperature after drying has been completed. Size reduction of dried and calcined material will follow in a mill or blender. The fine powder will then be densified into pellets or into a fuel container by a 250 ton hydraulic press located in compartment A. Some of the powdered compounds will be sintered by returning compacted forms to the electric furnace, which is rated to operate at temperatures up to 1500° Centigrade for sustained periods.

Compacted fuel compounds will be sealed into containers by welding, before they are removed from compartment A. Following preliminary decontamination by submersion in an ultrasonically agitated bath, the fuel container capsules are transferred through a lock into compartment B of the process box in Cell 4.

In compartment B, helium leak detector tests are performed, and final decontamination is carried out. Sealed source surface contamination limits should be specified as a license condition.

The encapsulated product is transferred through an air lock in the cell wall into the adjacent Cell 5, where calorimetry may be performed. Moderate term storage, additional leak testing, and packaging into electrical generators are also accomplished in Cell 5. If encapsulated material is to be stored for a long period, a secondary stainless steel container will be seal welded around the primary capsule and leak tested, and the doubly encapsulated material will be transferred from Cell 5 to the storage pool located in the Cell Service Area.

Cell 3 is used primarily for packaging heavily contaminated wastes. A drum bag-out station located in Cell 3 is connected by an overhead transfer duct with shielded doors to both compartments of the process box in Cell 4. This Stationary Overhead Transfer System (SOTS) is also used to introduce solid reagents, supplies, and replacement equipment into the Cell 4 process box.

In Isolation Room 3 there is located a 100-liter Waste Hold Tank, shielded by a lead brick cubicle. Process filtrate and other liquid waste is transferred from this tank into shielded drums brought into Isolation Room 3. The liquid is solidified by cement preplaced in these drums, to simplify shipment. Also located in Isolation Room 3 is a glove box enclosed sampling station. The sampling station is provided with AEC type filters and has its own exhaust fan that discharges to the Cell 3 exhaust.

Description of Cell Ventilation

In addition to filters at the intakes of the exhaust ducts in the cells, two AEC type filters in series and an exhaust fan are provided for each cell. These are located in the basement room beneath the isolation rooms. If the static pressure in any cell is insufficient, as determined by a pressure sensor, an auxilary dual filter train and blower will commence operation via a separate trunk duct from the affected cell. Another trunk duct branches into each cell

and is used for exhausting the process box through a separate dual AEC type filter train and blower. This process box exhaust system also has auxiliary filtration and fan equipment that will automatically take over upon failure of the normally operating unit. Particulate samplers are connected into the exhaust streams between each pair of tandem filters, as well as at the outlet of each blower.

Makeup air is supplied to the Cell Service Area, and flows from this region of limited contamination into zones of progressively greater contamination potential. Normally the inches of water gauge negative pressure in the respective spaces relative to that in the operating gallery will be approximately:

Process Box in Cell 4	- 0.6
Inner SOTS	- 0.55
Cell 4	- 0.5
Outer SOTS	- 0.45
Cell 3	- 0.4
Isolation Room 3	- 0.4*
Isolation Room 4	- 0.3
Service Area	- 0.05
Operating Gallery	- 0.00

* Cell 3 door will normally remain open.

SAFETY EVALUATION

To determine if the licensee is qualified to use strontium 90 for the purpose requested in the license renewal application in a manner that will protect health and minimize danger to life or property, the renewal application has been reviewed with respect to the quantity of byproduct material to be authorized in various forms, containment of the material, shielding, qualifications of personnel, suitability of procedures, and the consequences of hypothetical accidents.

Material Limits

The possession limit requested is 6 million curies of strontium 90. This also implies the possession of an equal activity of yttrium 90 the daughter radio nuclide that will be in equilibrium with the Sr^{90}. Authorization is also requested for possession of the following radioisotopes as unseparated impurities that are likely to be associated with the strontium 90 when it is received:

Strontium 89	1,800,000 curies
Cerium 144	30,000 curies
Other gross fission products	30,000 curies

The application places the following limits on the curies of strontium 90 to be authorized in various steps of the process, and in storage facilities:

LOCATION	FORM	QUANTITY
Feed Material Shipping Cask	Carbonate or Nitrate	500,000 curies
Feed Material Storage Tank	Nitrate Solution	750,000 curies
Process Box Compartment 4A	Material in Process	150,000 curies
Process Box Compartment 4A	Material in Process but not fully compressed or densely packed into a fuel container	100,000 curies
Process Box Compartment 4B	Solid, sealed in metal containers	100,000 curies
Cell 5 Storage	Solid material sealed in metal containers	1,000,000 curies
Storage Pool	Solid material in double metal containers, each sealed	5,000,000 curies
At Plant	Waste, packaged in not more than 500 containers	22,000 curies

The renewal application requests authorization to prepare other solid strontium compounds in addition to strontium titanate, which was previously approved by License No. 19-1398-29. In view of the possibly corrosive characteristic of some strontium compounds a license condition should be imposed excluding compounds other than strontium titanate from submersed storage in the pool until the results of tests of the corrosion susceptability of specific encapsulation materials have been submitted to the Division of Materials Licensing and authorization granted for pool storage thereof..

Containment

For this plant revision Martin-Marietta has maintained their original design concept that double containment should be provided for the radioactive materials which will be processed at the plant. In addition, possibly contaminated service areas will be access controlled and will be isolated from "clean" operating areas. The design revision has regrouped the processing operations into a more compact arrangement which permits a more direct transfer of material.

Vessels, capsules, or a process box serve as the first line of containment during the processing operations. The cells, specifically Cells No. 3, 4, and 5, act as the second line of containment. Cell entrances are separated from the service areaby isolation rooms, thereby reducing the likelihood of contaminating the access controlled service area. Ventilation, as previously stated, produces a flow of air from "clean" to progressively more radioactive areas to aid in maintaining the radioactive material within its containment. The greatest air pressure differential, -0.6" water gauge, exists between the operating gallery and the process box.

The items of major concern from the containment point of view are the process box in Cell No. 4 and the Stationary Overhead Transfer System (SOTS) used to connect Cells No. 3 and 4.

The stainless steel process box is a sealed, dual compartment, window equipped structure which is fitted with master slave manipulators operated from outside the cell, and which is supplied with a separate ventilation exhaust system. A backward flow of contaminated liquid out of the process box into the operating gallery through reagent lines which penetrate the cell and the process box is guarded against by check valves and siphon breakers. An outward flow of activity through manipulator ports to the operating gallery is guarded against by the air pressure differential and booting.

The SOTS located above and connecting Cells 3 and 4 is a housing 5 feet wide by 7 feet high by 20 feet long, fabricated from 1/16" thick aluminum. The ceiling of the cells on which the SOTS is mounted is formed by steel or steel and aluminum plates. Motor actuated trap doors of steel or steel and aluminum provide for passage of material through downcomers from the SOTS into Cell No. 3 or into either compartment of the process box in Cell No. 4. The SOTS is equipped with a two ton hoist on a monorail which is operated remotely during transfer of materials between Cells 3 and 4. The air in the SOTS is maintained at a static pressure between that in Cell 4 and the process box atmosphere.

The SOTS secondary containment spans Cells 3 and 4, enclosing the metal shield used to replace their original concrete slab ceilings. The walls of the secondary containment are of concrete blocks. The cover, and access doors at the ends are of sheet metal. The SOTS secondary containment is vented via an AEC type filter to the Cell 3 atmosphere, which is 0.1 inches water gauge greater than the Cell 4 static pressure.

The ventilation system is basically the same as that previously used. Fresh air is introducted into normally occupied zones and extracted via successive stages of filtration through the isolation rooms, hot cells, and unoccupiable containments within the cells. Both automatic and manual emergency controls are arranged to cut off the supply air. Essentially dual systems are provided to reinforce and provide continuity of exhaust from both the hot cells, and from the lower pressure containments which may be employed within the hot cells. Both the inner containment exhausts and the cell exhausts are provided with roughing and AEC type filtration at their inlets to minimize duct work contamination. In addition, two AEC type filters in series are located ahead

of each of the respective exhaust blowers. These discharge into a manifold leading to a 50-foot high exhaust stack. Average effluent concentrations monitored by filter paper samplers during the past two years of operation have ranged from 10^{-14} to 10^{-13} $\mu c/cc$.

The major modification in the ventilation system is the elimination of a fan supply of makeup air to the isolation rooms from the service area via duct work. Makeup of the isolation room air, which flows subsequently into the respective cells, will now be accomplished by infiltration. We consider this a better arrangement, particularly since it increases velocity through the access doors into the isolation rooms, when they are open.

We conclude that the containment provided by the facilities and equipment is adequate to protect personnel from contamination and to retain the byproduct material within the restricted area in accord with standards of 10 CFR 20.106(b and c).

Shielding

The walls of Cells 4 and 5 are 2 feet thick, providing 1 foot less shielding than the walls of Cells 1, 2, and 3. The results of calculations submitted in MND-3137 indicate that the shielding is adequate for the quantities of Sr^{90} and attendant impurities that are to be authorized.

We calculated the radiation that would penetrate the 2-foot thick windows of Cell 4 from 150,000 curies of Sr^{90} accompanied by the specified amount of radioactive impurities and determined that the exposure of a manipulator operator would be approximately 3 mr/hr from this amount of material at a point in the cell where he could work with it.

The cell walls are of the same thickness, as the windows, but the concrete is of greater density than the leaded glass. Thus we conclude that the proposed limits of 150,000 curies in compartment A and 100,000 curies in compartment B of the Cell 4 process box are low enough to permit conduct of the work without danger of excessive exposure to personnel.

Local shields are employed within the cells and isolation rooms as necessary to permit time limited occupancy in these controlled access areas. The calculated dose rates appear to be sufficiently low to permit the execution of the work to be accomplished. Adjustment of source quantities, shielding, and occupancy time may be made by the licensee to limit exposures to personnel in accordance with the standards of 10 CFR 20.

Waste Handling

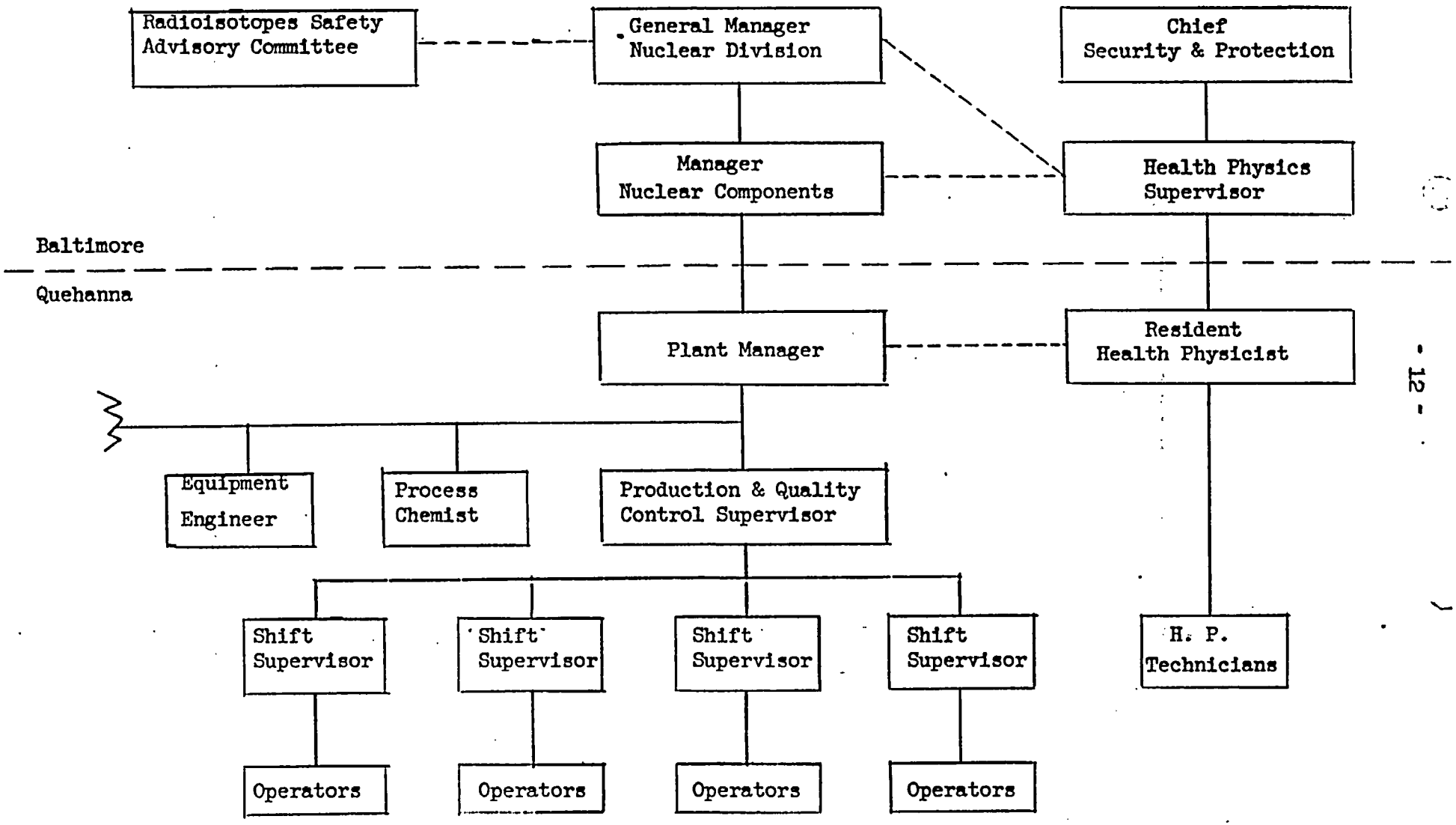
The waste disposal system remains unchanged. Essentially all radioactive material and contaminated items discarded as waste are shipped to authorized land burial sites under ICC approval. The Bureau of Explosives has approved the shipment of drums containing up to 100 curies each. Specially shielded drums are employed for encased units of greater activity. During the operation of the plant with 10,000 curie batches, shipments of about 125 drums were made approximately every other month, totaling from 1,000 to 3,000 curies per shipment. A newly erected aluminum siding on steel frame building (20 feet x 60 feet) has been provided within the restricted area to accommodate up to 500 drums of packaged waste. This shelter will retard weathering of containers. Local placement of concrete block shielding will be applied as necessary to control radiation dose rates at the restricted area fence and in occupiable plant areas.

High activity liquid wastes are solidified and packaged before removal from the production or laboratory area where they originate. A plant for the collection and treatment of low level liquid waste is located within the restricted area. Four 3,000 gallon stainless steel tanks are buried underground. One pair collects "suspect" liquids from such places as personnel decontamination facilities. The other pair collects low activity effluents from the chemistry laboratory and decontamination room. The equipment for circulating, sampling, treating, diluting, and discharging the collected fluids is housed in a small building. This equipment includes an evaporator unit and a gravity head tank with a monitor controlled drain valve for releasing sampled and approved concentrations of waste water through a plastic pipeline to Meeker Run. Releases of waste liquid in concentrations of less than 10^{-7} $\mu c/cc$ have been made in batches containing from 5 to 9 microcuries of Sr^{90}. These releases are executed under the auspices of Pennsylvania State University to verify conformance with the provisions of 10 CFR 20.106(b).

Personnel Qualifications

In Chapter 4, MND-3137 describes the organization of the Radioisotopes Pilot Plant operational staff, delineates responsibilities assigned at each level, and specifies the minimum experience and training requirements for the respective positions. The organization chart is as follows:

Quehanna Radioisotopes Pilot Plant Organization



The renewal application does not identify any individuals. Instead, it specifies the minimal training and experience qualifications that will be required for the respective operations and health physics positions. It states that operating personnel are to be trained not only in specific operational procedures, but also in health physics and radiochemistry, with special consideration being given to dealing with emergency situations. Emphasis on fire control training of all personnel, is also indicated.

We are of the opinion that the experience and training requirements stipulated for the responsibilities specified for the respective positions will assure that the licensee's personnel have adequate training and experience to safely use the licensed material in accordance with the regulations.

Procedures

Management is specifically charged with the overall responsibility for radiological safety. The responsibilities assigned to each position include a system of reporting and record keeping, and responsibility overlaps are specified between levels to provide checks on important functions. The organizational arrangement permits health physics personnel to audit the radiological safety performance of operating personnel, and at the same time support the operation with specialized services such as the promulgation of radiological safety practices, radiological safety indoctrination, HP instrument maintenance and calibration, and the handling of protective clothing and respiratory protection equipment.

The Nuclear Division Radiological Safety Advisory Committee, located in Baltimore, is charged with reviewing the radiological safety criteria generated by line organization, and carrying out periodic surveillance of operations. However, it should not be construed as serving the function of the Isotope Committee described in 10 CFR 30.24 (d)(3) that approves proposals for the use of radioisotopes in research and development work.

The health physics program delineated in Chapter 10 of MND-3137 described survey, monitoring, and access control procedures which we deem to be adequate to enable health physics personnel with the stipulated qualifications to evaluate the radiological safety of the personnel at the plant, and to determine the degree of compliance with the standards of 10 CFR 20. Procedures for utilizing respiratory protection equipment and for controlling access to high radiation areas by a lock and key system instead of with an alarm device were included. The use of respiratory protection devices conforms with the standards of 10 CFR 20.103 (c)(3). And the substitution of a lock and key system for an alarm has been previously authorized for controlling access to high radiation areas. Therefore license renewal should include conditions authorizing the utilization of the stipulated procedures and equipment.

Chapter 11 of MND-3137 is devoted to emergency control measures, and lists emergency procedures for dealing with spills, high air contamination, high radiation levels, pool leakage, and accidental releases of radioactive material into the atmosphere. Specific procedures are prescribed for fire fighting.

In the process description, Chapter 3 of MND-3137, general procedures are incorporated in describing a number of the processes. These procedures relate to: Preparation for and Removal of Material from a Shipping Cask; Metering and Precipitation of Feed Solutions; Drying, Calcination, Blending (grinding), and Compaction of Preciptation Products; and Encapsulation, Decontamination, and Storage or Radioisotope Heat Source Units. These procedures allow for some flexibility in process sequences, choice of reagents, and the selection of operating temperatures and pressures, but it is our opinion that they provide sufficient technical specifications to govern the operation to be licensed.

Accident Analysis

The exclusion of flammable liquids from the process box and improved venting of the manipulator ports to the cell atmosphere have eliminated the previously postulated causes for dispersal of material from the cell. Hence the previously postulated accidents are no longer a basis for limiting the activity of materials in a dispersable form in process at one time.

Flammables permitted in the process box will be limited to necessary electrical insulation, manipulator boots, polyethylene reagent bottles, and cloth decontamination swabs. The limited quantity and flammability of these materials preclude the occurrence of a flash combustion which could expel air borne contaminants from the process box.

The hydraulic fluid (Monsanto Pydraul) piped into the process box to operate the 250 ton press is reported to have an open cup flash temperature of 470°C and a fire point above 675°C. Manufacturer's data indicate that Pydraul spray does not flash when passing through a flame. The tubing feeding the press is screened from the furnace in the process box by the precipitator vessel. Should a hydraulic fluid leak develop, the fluid cannot spray onto a hot portion of the furnace. Therefore the accidental presence of this fluid will not alter the limited flammability character of the materials permitted in the process box.

The process vessel vent system discharges into compartment A of the process box within an inch or so of the exhaust filters located in the floor of the box. The sweep of ventilation air into these filters is expected to entrain any radiolytic hydrogen which may be expelled through the vessel vent, and so prevent a combustible accumulation of this gas in the upper region of the process box.

The licensee presents an analysis which shows that a manipulator can not pump air into the Operating Gallery because the maximum rate that it is physically possible to retract the arm is only about one tenth the speed necessary to expell air from the manipulator boot as fast as air flows into the cell between the process box and cell wall with the minimum pressure differential maintained between the Cell 4 atmosphere and the Operating Gallery. He further states that smoke tests have shown that if any air could issue from the Cell 4 manipulator ports, it would be drawn immediately into the ventilation system intake directly above the ports. A constant air monitor intake is located at the center of this ventilation system inlet at Cell 4. The lag time for sampled air to reach the filter at the detector is reported to be two seconds. This will assure a prompt warning of a release into this occupiable area, although without the possibility of an explosion in Cell 4, we don't see how contaminants can be expelled into the Operating Gallery.

The recirculation and ventilation system serving the shop and Operating Gallery will remain as it has been heretofore. A few hundred cfm may spill over from this area through weighted louvres into the Cell Service Area. The 5,700 cfm circulated by this system exhausts to the outdoors without benefit of filtration, the discharged quantity being dependent upon the temperature controller demand. The air monitor sampling the air picked up by the intake near Cell 4 is normally set to trigger an alarm and shutdown the fan when a sample burden of 3.6×10^{-9} curies collects. If the activity on the monitor sample accrued slowly, it would shut down this unfiltered ventilation system by the time it had discharged 4 microcuries (assuming the full flow discharged, with no recirculation).

If it were assumed that sufficient activity to trip the monitor were collected in one second, the concentration being sampled would be 1.5×10^{-6} $\mu c/cc$. Presuming that it would take 15 seconds to shut the system down, and that the dampers were calling for 100% exhaust, a total of 61.5 μc would be expelled in a release of 2.25×10^{-5} c sec m^{-3}. If a person could be exposed to this undiluted exhaust,he could inhale 7.8×10^{-9} curies. This would not produce an integrated bone dose exceeding 280 mrem.

The automatic shutdown provision for this normally uncontaminated exhaust system, we believe, is adequate to prevent the escape of hazardous quantities of airborne radioactive particulates under either low concentration conditions or under circumstances of an accidental dispersal of contaminants into the Operating Gallery atmosphere.

The maximum release accident studied hardly appears credible. It assumes that the process box ventilation train retains its integrity, but that the filtration of cell exhaust ventilation completely fails. A release rate of 3×10^{-4} curies per second is derived by postulating the simultaneous leakage of the feed material storage tank into its secondary containing vessel (which is vented into the cell atmosphere) and the failure of both the process storage tank water cooling system and the auxilliary water cooling system and pump, so that a full charge of 750,000 curies dissipates its 4,725 watts of heat soley by boiling away the feed material solution which initially has a 3 curies per cc concentration. Entrainment in the vapor is estimated to be 10^{-4}. This assumption is based on chemical experience, and correlates with some performance data in the waste evaporator at the site.

Our independent calculations confirm the licensee's tabulated results, and indicate that with the licensee's chosen meterological conditions, the maximum concentration down wind would be about 10^{-7} μc/cc. Under the meteorological conditions suggested in Appendix A of 10 CFR 100.11, the maximum concentration would occur at distance of about 500 meters, and would be approximately three times this value. An individual would have to remain exposed in this concentration for about 1.6 hours to inhale sufficient Sr^{90} to acquire a life time dose of 25 rem to the bone.

It is our opinion that such a release would not go undetected, and that hunters or fishermen who might inadvertently be in the range of such a concentrated exhaust plume could be notified and evacuated before they incur such a dose. We consider it highly probable that corrective measures would be instituted to terminate the postulated release in less than 1.6 hrs.

The land usage and population density around the site have not changed significantly, but access control has been reduced so that the forest outside the fence surrounding the plant is now accessible to the public. It is expected that picnickers will not pass the access road barrier about 800 meters distant from the plant, but hunters and fishermen may traverse the intervening public forest.

Our safety evaluations of the pilot plant operation have not been contingent upon the relatively insoluble character of the strontium titanate product. Hence a switch to the fabrication of isotopic fuel sources employing other strontium compounds would not increase the danger to released material beyond that already considered.

The licensee reviewed a number of credible accidents including a feed material cask connection line failure releasing 280 curies on the Isolation Room floor, a ventilation system failure simultaneously with a check damper failure, a manipulative error during process box boot changes allowing the occurrence of an unbooted manipulator port in the process box, and leaks from the various process vessels. In each of these cases redundancy of containment and equipment prevents escape of radioactive material to normally occupied areas.

In evaluating possible accidents related to the storage of encapsulated Sr^{90} in the pool, the license renewal application considers the dropping of a cask on capsules already in the pool to be incredible. The revised presentation indicates that the maximum temperature of ½ dozen capsules left unattended in a dry transfer cask would not exceed 100°F. The possibility of a capsule's leaking into the storage pool is still considered credible, but prompt detection of such an event is assured. We have concluded that accidental releases to the soil (such as might be postulated to be attendant the development of a leak in the fuel storage pool, if it contained contaminated water) cannot affect neighboring water supplies.

Our previous authorization of the use of the pool for sealed source storage considered various accidents (Safety Analysis dated February 24, 1964), including the destruction of the building, and concluded that the facilities were adequate and that the plant staff were qualified to deal with the postulated emergencies that might develop in connection with submerged storage in this pool.

Not only do the equipment, facilities, and procedures appear adequate to minimize the incidence of radiological accidents throughout the plant, but it appears that such accidents as may occur can be dealt with in these facilities by personnel having the specified qualifications, in a manner that will protect health and minimize danger to life and property.

PROPOSED LICENSE CONDITIONS

It is recommended that the following be made conditions of a license renewal authorizing the manufacture of strontium 90 heat sources at the Quehanna Radioisotopes Pilot Plant.

1. Byproduct material shall be used only at the licensees pilot plant at Quehanna, Pennsylvania.

2. The licensee shall be subject to the provisions of Title 10, Part 20, Code of Federal Regulations, Chapter 1, "Standards for Protection Against Radiation," all other applicable rules, regulations, and orders of the Atomic Energy Commission now or hereafter in effect, and to the conditions of this license.

3. Except as specifically provided otherwise by this license, the licensee shall possess and use the byproduct material described in items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in his application dated April 15, 1964, and document MND-3137, as revised and amended by the following items submitted in support of the application.

A. Restricted Reagent Data, Submitted April 16, 1964.

B. Revision pages (for MND-3137) listed in attachment to letter dated June 23, 1964.

C. Letter dated May 11, 1964.

D. Letter dated August 27, 1964.

4. Each sealed source fabricated by the licensee shall be tested for contamination and/or leakage after fabrication and prior to transfer to an authorized recipient. If the test reveals the presence of 0.05 microcurie or more of removable contamination upon a test wiper, the licensee shall repair and/or decontaminate and retest the source.

5. In lieu of the control device specified in paragraph 20.203(c)(2) of Title 10, Part 20, Code of Federal Regulations, Chapter 1, access to high radiation areas shall be restricted by a "Special Absolute Integrity Locking System" as described in Sections 10.4.2 through 10.4.4.3.4 inclusive, of MND-3137.

6. Pursuant to Section 20.103(c)(3), of Title 10, Part 20, Code of Federal Regulations, the licensee is authorized to utilize respiratory protection equipment to control the exposure of personnel to air borne radioactive material in accord with the representations in Sections 10.6.12, 10.6.13, 10.7, 10.7.2, 10.7.3 (including Table 10.2), and 10.8.4 through 10.8.4.6 inclusive, of MND-3137.

7. Byproduct material shall not be placed in the storage pool except in chemical compounds specifically authorized by this license. The storage of strontium titanate in the pool is specifically authorized. An application requesting authorization to store other compounds in the pool should incorporate the results of tests conducted with the proposed compounds to establish the corrosion resistance of the materials to be used for encapsulating the respective compounds.

A. E. Aikens, Jr.

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Irradiated Fuels Branch
Division of Materials Licensing

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