NEUTRON PRODUCTS inc

Dickerson, Maryland 20753 U.S.A.
301/349-5001 Cable: NUSWASH

December 19, 1967

U. S. Atomic Energy Commission
Division of Material Licensing
Washington, D. C. 20545

Gentlemen:

Pursuant to the Code of Federal Regulations, Title 10, Part 30, "Rules of General Applicability to Licensing of Byproduct Material", Neutron Products, Inc. (NPI) requests a Byproduct Material license to receive, possess, own, store and use 2.0×10^6 curies of Byproduct Material; and to export or transfer the material to a surface carrier for transport to any person authorized by the Commission to receive such material.

Attached, herewith, are two copies of Form AEC-313, "Application for Byproduct Material License" and the safety documentation necessary to support the application.

Certain irradiation process experiments appreciably different than those indicated in this application are contemplated. In such cases, requests for amendments to this license, accompanied by appropriate safety analysis documentation for the specified use of the material will be filed.

Very truly yours,

NEUTRON PRODUCTS, INC.

Jackson A. Ransohoff
President

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TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 *(Use supplemental sheets if necessary)*

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Please refer to Appendix I of attached safety evaluation.		Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments			Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity			Yes No	Yes No
d. Biological effects of radiation			Yes No	Yes No

9. EXPERIENCE WITH RADIATION. *(Actual use of radioisotopes or equivalent experience.)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
		Please refer to Appendix I of the attached safety evaluation.		

10. RADIATION DETECTION INSTRUMENTS. *(Use supplemental sheets if necessary.)*

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm²)	USE (Monitoring, surveying, measuring)
NMC, Model DS-IT scaler, Model PCC-IIT detector	1	α, β, γ	10^6 c/m(max)	1.0	Laboratory measurements.
Eberline, Model E-120	1	β, γ	0-50	3.0	Surveying
Victoreen, Radector III (Model 2035)	1	β, γ	$0.1-1 \times 10^6$	1 mil St. Stl. covered by 2 mil al window	Emergency monitoring
Technical Associates, Cutie Pie, Model CP-3	1	α, β, γ	0-5000	0.45	Dose rate measurements

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE. Portable survey instruments will be calibrated every 3 months and after repair or maintenance. Proportional counting equipment will be calibrated periodically using a standard Beta-Gamma check source.

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED. *(For film badges, specify method of calibrating and processing, or name of supplier.)* Film badges processed monthly by Landauer, Pocket dosimeters (Victoreen, Model 541-A 0-200 mr range) read and recorded daily. Bioassay specimens will be collected, as required, and processed by Eberline Instrument Corporation.

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) (Yes) No

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Neutron Products, Inc.
Applicant named in item 1

Date December, 1967

By: [signature]

President
Title of certifying official

SB262

WARNING.—18 U. S. C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

* U.S. GOVERNMENT PRINTING OFFICE : 1964 O—745-381

BYPRODUCT MATERIAL SAFETY EVALUATION

FOR

NEUTRON PRODUCTS, INC.

^{60}Co STORAGE FACILITY

December, 1967

NEUTRON PRODUCTS, INC.

FORWARD

Neutron Products has planned and constructed a general purpose facility for ^{60}Co storage and processing and the development of radiation processing technology. This report describes the facilities, equipment, and procedures which will be used in the transfer, handling, and storage of encapsulated ^{60}Co in the portion of the facility designed for this purpose; the loading of ^{60}Co in shipping casks for off-site shipments; and the handling of sources for certain experimental programs. The potential accidents which could conceivably be associated with these operations are also evaluated.

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I. DESCRIPTION OF THE FACILITY

A. Location

The NPI ^{60}Co facility is located on a 3.06 acre site in Dickerson, Maryland. Figure 1 shows a plot plan of the site indicating the location of the ^{60}Co facility with respect to the other buildings of the facility and the general area.

B. General Description of Facility

The principal building is a (b)(4)

(b)(4)

(b)(4)

Figure 2 shows a floor plan of both areas and indicates the location of the emergency lighting, radiation monitoring system, fire extinguishers, etc. Also shown is a 15 ton bridge crane which is mounted on existing 24 inch steel beams and will be used to handle all shipping containers into and out of the pool. The space over the bridge crane is elevated to create a high bay. The building is equipped with overhead fluorescent lighting, is heated by hot water fed space heaters, and cooled by chilled water space coolers. The north and south sides of the storage area are provided with large roller doors for vehicle entry, and the west wall contains personnel doors.

C. Processing and Storage Pool

(b)(4)

A guard rail above the curb prevents personnel from accidentally falling into the pool, and life preservers are provided on each side. The pool has neither a drain line nor an overflow line.

To provide for easy decontamination and additional insurance against leakage, a protective three-layer Amercoat coating is applied to the inner walls and floor of the pool. The coating system on the inner surfaces of the pool has the following qualities:

- Resistance to high purity water;
- Resistance to radiation;
- Easily decontaminated;
- Good adhesive properties such as hardness; and
- Abrasion resistance.

(b)(4)

(b)(4)

(b)(4)

(b)(4)

conducted. This pre-operational survey will also include an inspection and test of the radiation monitoring system and all safety interlocks on the irradiation cell, the irradiator and the irradiator loading mechanism.

F. Special Systems

(b)(4)

Personnel are required by procedure to evacuate the area any time the monitor alarms. A similar type monitor is installed in the pilot plant irradiator operating area.

Communications for off-site agencies such as fire department, police, etc., are provided by normal telephone service. Emergency lighting for the building will be provided by battery powered lamps in conformance with county and state requirements.

II.

(b)(4)

(b)(4)

sources will be shipped by truck from Consumers Power Company's Big Rock Point Reactor (BRP) in Charlevoix, Michigan to the NPI facility at Dickerson, Maryland, utilizing already tested and proven shipping containers, equipment and procedures which were authorized in accordance with the Department of Transportation Special Permit Number 5346 and Atomic Energy Commission License Number 8-12332-1.

Upon arrival at the NPI facility the shipping container will be surveyed to insure that it meets all criteria for acceptance. The container will then be unloaded by means of the bridge crane and (b)(4)

(b)(4)

As the first step in the (b)(4)

(b)(4)

The procedures for loading the cask at NPI for shipment off-site will include essentially the same sequence as that used for loading at Big Rock Point.

(b)(4)

It should be noted that NPI personnel have successfully loaded and shipped (b)(4) (b)(4) (b)(4) facility where the above operations were performed utilizing the same tools and procedures that will be used at the Dickerson Facility.

C. Leak Testing

Singly encapsulated ^{60}Co sources will be leak tested by immersion in a small volume of water which will be periodically sampled and analyzed for Co^{60} and other gamma activity. The rate and nature of activity buildup in the water indicates whether or not the source is leaking.

These tubes are used for flushing, filling and sampling the cans.

The following general procedure will be used for leak testing the capsules. Any number of capsules up to 30 may be leak tested at the same time in one can. (b)(4)

(b)(4) and sealed

and locked in place with a lock down bolt. With this cover in place, the can provides a separate water environment for the capsules than that of the pool.

(b)(4)

ctivity will be considered to result from a leaking capsule(s).

Any leaking capsule(s) will be identified by repeating the leak test procedure on one half of the original number of capsules tested. This halving procedure will continue until, by the process of elimination, the leaking capsule(s) are identified. Leaking capsules will be canned in a stainless steel tube which is sealed with a threaded end plug. The leaking capsules will be stored until they are reincapsulated or otherwise disposed of as waste.

III.

(b)(4)

(b)(4)

B. Process Design Safety

The

(b)(4)

(b)(4)

to assure that this equipment is capable of maintaining this rating without leaking.

In the remote possibility that a leak should develop

(b)(4)

(b)(4) Also, all electrical equipment in the (b)(4)

(b)(4)

Even in the unlikely event of (b)(4)

IV. RADIOLOGICAL CONTROL PROCEDURES

A. Scope

The following procedures include standards and regulations which are intended as precautionary measures to govern all work involving radiation and contamination hazards. The contents of the procedures may be revised to meet operating conditions and to conform with changes in Federal Regulations as they occur. All such changes shall be subject to prior Commission approval.

B. Responsibility

The Radiation Protection Officer is responsible for all normal Health Physics operations at the NPI storage facility. This includes advising the operating personnel on health hazards incident to the handling, use of, and exposure to radioactive materials and their

associated ionizing radiations. In addition, he will be responsible for assuring that adquate steps are taken to insure compliance with applicable Federal Regulations. Supervisors of operating personnel are responsible for assuring that personnel within their group comply with these procedures. All personnel engaged in work involving radiation or contamination shall become familiar with these procedures.

The Radiation Protection Officer will provide the necessary health physics coverage for all work involving radioactive materials.

C. Standards

1. Permissible Accumulated Dose to Personnel

a. External Exposures

The permissible accumulated dose (PAD) to the whole body, head and trunk, active blood forming organs, lens of eyes or gonads shall not exceed 1.25 rems in any calendar quarter. This quarterly dose limit may, under special circumstances, be increased to 3 rems provided it can be demonstrated that the dose, when added to the individuals permissible dose, does not exceed:

$$PAD = 5\ (N - 18)\ \text{rems}$$

where N equals the individuals age at this last birthday and is greater than 18.

The dose to the skin of the whole body in any calendar quarter shall not exceed 7.5 rems

The dose to the hands and forearms, feet and ankles shall not exceed 18.75 rems in any calendar quarter.

b. Internal Exposures

The permissible levels from intemal emitters will be consistent as far as possible with the age-proration principles above. Control of internal dose will be achieved by limiting the body burden of radioisotopes in accordance with the limits set forth in 10CFR20 and recommendations of the International Commission on Radiological Protection.

c. Radiation Exposure Status of Personnel

The radiation exposure status for each employee shall be determined and cumulative calendar quarter and lifetime exposure records maintained. The Radiation Protection Officer shall notify appropriate supervision when the radiation exposure status of any employee approaches the permissible limits.

Each employee shall be advised of his radiation exposure status at the request of the employee.

2. Permissible Working Limits

a. External Radiation Exposures

The permissible weekly dose to the most critical organ shall be limited to 100 mrem. This limit may be increased by specific authorization of the Radiation Protection Officer provided that previous exposure during the current calendar quarter permits such an increase.

b. External Contamination Limits

The beta-gamma skin contamination limit shall be 500 counts per minute when measured with a G-M survey meter, provided no contamination is smearable. This limit applies only after proper decontamination techniques have been effected.

3. Environmental Permissible Limits

a. Airborne Activity (Restricted Areas)

Concentrations above natural background of radioactive material in breathing air in restricted areas shall not exceed levels presently listed in 10CFR20, Appendix B, Table I, Column 1.

b. Airborne Activity (Unrestricted Areas)

Concentrations above natural background of radioactive material in breathing air in unrestricted areas shall not exceed levels presently listed in 10CFR20, Appendix B. Table II, Column 1.

c. Waterborne Activity

No appreciable quantities of liquid radioactive wastes are expected to be generated as a result of operations in the storage facility. However, should liquid waste be generated they will be collected in metal drums, solidified and shipped off-site for disposal by a licensed commercial waste disposal service (such as Atcor or Tracerlab).

4. Waste Disposal

Small amounts of combustible and non-combustible wastes will undoubtedly be produced. These wastes will be collected in 55 gallon drums and disposed of by a licensed commercial waste disposal service.

5. Operating Area Permissible Limits

a. Unrestricted Areas

An unrestricted area is any area access to which is not controlled be the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. The radiation level in an unrestricted area shall not exceed 2.0 mrem/hr. The beta-gamma contamination level in an unrestricted area as determined by the most sensitive appropriate detecting instruments shall not exceed 450 $\mu\mu$Ci/100 cm^2. Radioactive materials in any form shall not be used or stored in an unrestricted area.

b. Restricted Area

A restricted area is any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.

c. Contamination Area

Any area in which the smearable beta-gamma contamination level exceeds 450 μμCi/100 cm^2 will be designated and posted as a contamination area. If the beta-gamma contamination level exceeds 5000 μμCi/100 cm^2, the area will be immediately decontaminated to less than 5000 μμCi/100 cm^2.

d. Radiation Area

A radiation area is any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any five consecutive days a dose in excess of 100 millirem.

e. High Radiation Area

A high radiation area is any area, accessible to personnel in which there exists radiation originating in whole or in part within licensed material at such levels that a major protion of the body could receive in any one hour a dose in excess of 100 millirem.

f. Airborne Radioactivity Area

An airborne radioactivity area is any area in which there exists airborne radioactive materials in concentrations in excess of the applicable limits specified in Appendix B, Table I, Column 1 of 10 CFR20.

6. Protective Clothing and Equipment Limits

Protective clothing will be laundered by a licensed commercial laundry. The beta-gamma limits for clean laundry shall be:

$< 450 \mu\mu Ci/100\ cm^2$ (smearable)

< 0.1 mrem/hr (direct radiation measurement)

Contaminated tools and equipment will be appropriately identified. The limit for clean tools will be less than $450 \mu\mu Ci/100\ cm^2 (\beta\ \gamma)$ of smearable contamination. Tools with smearable radioactive contamination above 5000 $\mu\mu Ci/100\ cm^2$ $(\beta\ \gamma)$ will be decontaminated. Tools with dose rates above 2.0 mrem/hr after decontamination will be held for further disposition.

7. Personal Clothing Limits

The personal clothing limits shall be the same as the limits previously specified for clean protective clothing.

D. Radioactive Hazards Control

Hazards to personnel from radioactive materials can be divided into two main types. The first is the direct radiation hazards in which the radiation is controlled by regulating the distance between the individual and the source of radiation; by interposition of shielding between the individual and the source; and, by limiting the time the individual spends in a radiation field.

The second type is the contamination hazard in which the source of radiation is on the individual. This is more difficult because of the possibility of inhalation or ingestion of the radioactive material. Contamination is controlled primarily by strict containment of loose radioactive material and by protective clothing and equipment worn by the individual.

1. Radioactive Area Control

a. Radioactive Materials Area

Each area in which licensed material is used or stored shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words "Caution, Radioactive Material(s)".

b. Contamination Area

Contamination areas will be posted with a yellow sign bearing the radiation symbol and the words "Caution, Contamination Area."

c. Radiation Area

Radiation areas will be posted with a yellow sign bearing the radiation symbol and the words "Caution, Radiation Area".

d. Airborne Radioactivity Area

An airborne radioactivity area will be posted with a yellow sign bearing the radiation symbol and the words, "Caution, Airborne Radioactivity Area".

No individual will be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table 1, Column 1 of 10CFR20.

e. Temporary Areas

Temporary areas, in accordance with the preceeding, shall be established as required. Such areas shall be defined by radiation rope (yellow and magenta) barricades where needed, and shall be appropriately posted.

f. Area Reclassification

Radiation and contamination areas may be reclassified by approval of the Radiation Protection Officer when conditions are such that the area is no longer required. A thorough survey shall be performed prior to removal of barricades and signs.

g. Area Change Stations

Change station facilities will be set up at the entrance to restricted areas where protective clothing is required. These stations will contain all the items necessary for work in the restricted area and may include protective clothing, laundry hampers, waste containers, step-off pads, survey instruments etc.

All personnel leaving a restricted area will be completely surveyed for personal contamination prior to leaving the area.

2. Access to Restricted Areas

In order to insure that the proper precautions are observed while working in a restricted area, each worker will be instructed in the hazards present and the precautions to be taken prior to commencement of work in a restricted area.

3. Radiation Surveys

The word survey, in Health Physics usage, means an evaluation of radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentration of radioactive material present. These surveys are taken to assure that areas are properly designated, and that no individuals are exposed to an unknown radioactive hazard.

a. Types of Surveys

In general, four main types of surveys will be made: radiation, surface contamination, air and water. Radiation surveys will be made to evaluate the direct radiation present in any area. One or both of the following instruments will be used:

a-1 G-M Survey Meter - An Eberline, Model E-120, portable G-M survey meter will be used primarily for personnel contamination surveys and general radiation and contamination level measurements. The instrument is equipped with an external side-window G-M probe and an audio speaker.

a-2 ION Chamber Survey Meter - A Technical Associates "Cutie Pie" will be used for exposure rate measurements for routine and special radiation surveys. Working time limits, if required will be based upon the results of the ion chamber readings.

Contamination surveys (also called smear survey) will be performed by rubbing a small filter paper over the area to be surveyed. The paper will then be counted in a gas flow proportional counter for beta-gamma radiation.

a-3 Internal Gas Flow Proportional Counter

An NMC, Model DS-IT+PCC IIT, internal proportional counter is available for counting smears, air samples, and water samples. A background and efficiency check of this instrument will be made frequently.

Air surveys will be performed by passing a known volume of air through a filter paper using a high volume air sampler. The paper will then be counted for beta-gamma radiation in the same manner that smears are counted.

Contaminated water surveys will be performed by collecting a known volume of water, evaporating it to dryness in a planchet, and counting for beta-gamma activity in a proportional counter.

b. Frequency

Surveys in restricted areas will be performed as deemed necessary by the Radiation Protection Officer. The nature of the work and the degree of hazard will be considered in making this judgement.

c. Results

The results of all surveys will be recorded. Results of surveys indicating improper or hazardous conditions will be immediately forwarded to department supervision so that immediate corrective action may be taken. If hazards become excessive, the work will be terminated and personnel evacuated from the restricted area until the hazard is re-evaluated.

4. Personnel Monitoring

Personnel monitoring devices shall be provided for each individual who enters a restricted area and is likely to receive a dose in any calendar quarter in excess of 25 percent of the applicable values specified in Section 20.101 of 10 CFR 20.

Each individual who enters a restricted area and meets the above specified conditions will be provided with a beta-gamma sensitive film badge and a self-reading pocket dosimeter (0-200 mr range). The film badges will be processed quarterly by Landauer Corporation and the pocket dosimeter readings will be recorded daily.

In order to assure that personnel working in a restricted area wear film badges and pocket dosimeters, personnel monitoring devices will be stored on racks conspicuously mounted at the entrance to the pool storage area. In addition, all operating

procedures will require their use for work in a restricted area. All personnel will be instructed in the importance of wearing film badges and how and when they are worn. Ultimate responsibility for wearing personnel monitoring devices will rest with the individual and the Radiation Protection Officer.

Results of the exposures recorded on film badges and pocket dosimeters will become a part of each employee's Radiation Exposure Record. Cumulative quarter and lifetime exposure totals will be kept for each person who is issued a film badge. Personnel receiving exposures in excess of the applicable limits shall be notified in writing of the nature and extent of the exposure.

a. Bioassay Program

It is felt that the form of radioactive materials being handled under this license and the nature of the work involving this material does not warrant a routine bioassay program. However, in any instances where an individual has been exposed or is suspected of having been exposed to internally deposited radioactive material, an appropriate bioassay specimen will be collected and evaluated by Eberline Corporation. The results will become part of the individual's radiation exposure record.

5. Personnel Regulations

a. Personnel Surveys

Each individual working in a restricted area will be surveyed for personal contamination after removing his protective clothing at the change station and prior to leaving the area. These surveys will be performed by the individual.

If personnel (skin) contamination is detected, decontamination of the affected area will be performed under the direction of the Radiation Protection Officer until the specified limits are met.

b. Eating, Smoking or Drinking

Eating, smoking or drinking in restricted areas is strictly prohibited.

c. Restricted Area Injury

Any injury received during work or presence in a restricted area is assumed to be contaminated until proof to the contrary is obtained. Such injuries must be brought to the attention of operating supervision and the Radiation Protection Officer immediately and the following procedure must be instituted if contamination is detected.

c-1 The injury shall be flushed immediately with the nearest source of cold running sanitary water continuously for at least 5 minutes.

c-2 Decontamination of the injury and injured shall be effected as soon as possible.

c-3 Competent medical authority shall be informed at once so that medical personnel can come to the injured to provide treatment if necessary. Since the welfare of the injured is of prime importance, medical should be summoned to the individual if immediate attention is necessary. In most cases, flushing should not be interrupted to take the employees to medical aid.

d. Restricted Work

If an injury is of such a type that work in a restricted area would be hazardous, or subject the injured to possibilities of absorption of radioactive materials, the person will not be permitted to work in a restricted area.

6. Protective Clothing

The purpose of protective clothing is to protect the wearer from receiving contamination on his personal clothing or body. Protective clothing provides each individual with an easily removed outer surface, so that if contamination is received on the clothing, the wearer is no longer affected by it after removal of the clothing.

Protective clothing and equipment are available which give protection from contamination to the head, hands, body or feet. Respiratory protection is also available. Protective clothing will be specified for all work in restricted areas. Protective clothing may not be worn outside of a restricted area.

Laundered protective clothing is always contamination free, hence no regulation or order is necessary in donning the clothing. However, since protective clothing may be worn only in a restricted area, it will be donned at the change station established at the entrance to the restricted area immediately prior to entry.

Protective clothing will be removed from the body in such a manner as to prevent contamination of the skin or articles of clothing worn underneath. Individual techniques may be developed by personnel, but certain basic procedures must be followed. It is recommended that clothing be removed in the following sequence; shoe covers, cap, respirator, gloves, and coveralls.

Protecive clothing may be reworn provided it does not exceed the contamination levels previously specified.

7. Equipment Control

The purpose of equipment control in restricted areas is to prevent the spread of contamination to unrestricted areas and to reduce contamination hazards in restricted areas. The following rules will generally apply:

a. Tools and equipment within a restricted area will be assumed to be contaminated until they are surveyed and their actual status determined.

b. No material, tools or equipment may be removed from a restricted area without being surveyed for contamination. Clean items will be released and may be used in unrestricted areas without further radiation or contamination control.

c. Contaminated items which are not to be disposed of will be decontaminated in restricted areas only.

E. Radioactive Waste Disposal

1. General

Restricted areas creating radioactive wastes will be furnished with 55 gallon metal drums for discarding dry radioactive waste.

All stored wastes will be clearly labeled at all times, with pertinent and accurate information about the contents as well as the person who is responsible.

Procedures for handling special or high level radioactive wastes will be worked out in consultation with the Radiation Protection Officer prior to the production of such wastes.

2. Non-Radioactive Wastes

There will be no control by Health Physics for disposal of non-radioactive, non-contaminated wastes other than to insure that contaminated waste is not put in non-radioactive waste containers.

3. Dry Radioactive Wastes

All solid radioactive wastes will be collected in metal drums and shipped off-site for disposal by a licensed vendor. All radioactive waste containers will be marked with a sign bearing the radiation caution symbol and the words "Caution, Radioactive Material", Additional signs may be present to clearly define the type of wastes.

4. Liquid Radioactive Wastes

As previously stated, the volume or radioactive liquid waste should be minimal. All liquid waste generated will be collected in metal drums and shipped off-site for disposal. If high level liquid wasted (wastes in excess of the applicable discharge limits) happen to be generated, they will be solidified and shipped off-site for disposal as solid wastes.

5. Packaging

The metal drums used for collection of dry wastes will be used for shipping the waste off-site for disposal. After the drums have been sealed, surveyed and properly labeled, they will be stored in a restricted area to await shipment.

The packaging of waste for disposal will be such that the waste and any contamination contained therein are enclosed in a suitable container to prevent the release of any contamination.

6. Identification

All waste containers sealed prior to disposal will bear a label stating the activity, contents of the container, dose rates at the surface and at 1 meter from the container, date packaged, and the signature of the individual who made the survey.

F. Transportation of Radioactive Materials

1. Receiving

The Radiation Protection Officer shall be notified upon receipt of any radioactive or contaminated material at the NPI facility.

All incoming radioactive or contaminated shipments shall be surveyed immediately upon receipt so that the relative hazards may be evaluated and proper precautions established for safe handling of the shipment.

All vehicles transporting radioactive materials onto the NPI site shall be surveyed prior to release.

2. Off-Site Shipments

The Radiation Protection Officer shall be notified prior to the release of any radioactive material for shipment from the NPI site. A radioactive shipment record will be prepared for each shipment and will accompany the shipment. This form will list the safety precautions to be followed during shipment.

All shipments of radioactive or contaminated material shall be surveyed prior to release. All off-site shipments will conform to all applicable AEC and ICC regulations and the required labels and placards shall be affixed.

All vehicles used for transportation of radioactive or contaminated materials off-site shall be surveyed. Vehicles belonging to common or contract carriers will be free of contamination before release from the site.

G. Records, Reports, and Notification

Records and reports required by Sections 20.401, 20.402, 20.403, 20.404, and 20.405 of 10CFR20 will be prepared and maintained by the Radiation Protection Officer.

V. NORMAL OPERATING AND EMERGENCY PROCEDURES

A. Norman Operating Procedures

1. Radiation Protection Surveys and Inspections

a. Before the NPI process irradiation installation is placed in routine operation a radiation survey shall be made by the Radiation Protection Officer.

b. The Radiation Protection Officer shall re-survey or re-evaluate when changes have been made in shielding, operation equipment or occupancy of areas adjacent to the radiation levels. The Radiation Protection Officer should be consulted in case of doubt.

c. The facility shall not be assumed to conform with the provisions of this application until a radiation survey has been made by the Radiation Protection Officer and the report of the survey has been placed on file at the facility.

d. The radiation hazards that may be found in the course of the survey shall be eliminated before the installation is used routinely.

e. Reports of all radiation surveys shall be retained together with a record of the action taken with respect to the recommendations they contain.

f. A radiation protection survey shall include the following procedures:

f-1 The facility shall be inspected to verify or determine the present and expected occupancy of the adjacent areas; the operation of audible warning signals, interlocks, mechanical or electrical restrictions of the position of the radiation source and other devices that have a bearing on radiation protection.

f-2 Radiation exposures shall be measured in all adjacent areas that can be occupied. The measurements shall be made under practical conditions of operation that will result in the greatest exposure at the point of interest.

g. All radiation shields, interlocking switches and other safety devices shall be inspected periodically as scheduled by the operations supervisor. Inspection shall be made by a competent person but not necessarily by the Radiation Protection Officer. Defective shields and barriers shall be promptly repaired and inspection shall be repeated to determine whether the original degree of protection as been restored. If there is doubt about the adequacy of the repair the Radiation Protection Officer shall be consulted. Inspection of protective devices is not a substitute for a radiation protection survey.

h. When the operating conditions have changed so that there is a probability that the exposure of any person may be increased, a radiation survey or re-survey or evaluation shall be conducted. In case of doubt, the Radiation Protection Officer shall be consulted.

The Radiation Protection Officer shall be qualified by training or experience to carry out his duties as indicated below:

h-1 Insuring that the process irradiator is operated within the limitations of this application and within the limits of the appropriate radiation protection survey reports.

h-2 The instruction of personnel in safe working practices and the nature of injuries resulting from overexposure to radiation. Such instructions will include a review of the basic fundamentals of radiation protection.

h-3 Investigating any case of abnormal exposure to personnel to determine the cause and to take remedial action.

h-4 Assuring that interlock switches, warning signals and signs are functioning and located where required.

2. Administrative Procedures

Responsibilities with respect to the handling, use of, and exposure to radioactive materials are delegated by the President of the corporation according to the organization chart shown in appendix II.

The following procedures shall apply to the loading, operation and unloading of the irradiator.

a. Supervision of the loading and unloading of the source holder with cobalt capsules will be the responsibility of the Operations Manager. These operations may be completed by competent personnel, but only in accordance with detailed operating procedures. A copy of these written procedures will be available in the area for reference.

b. Authority to operate the source drive mechanism will be limited to those persons designated as users in this application.

c.

(b)(4)

d.

s

e. All personnel entries into the pilot plant cell when the irradiator is on will be coordinated with the (b)(4) Manager who will control the key to the cell door.

(b)(4)

shall be reported to the Radiation Protection Officer so that conditions can be re-evaluated and remedial action taken, if necessary.

g. All work in the pilot plant operating area when the irradiator is on shall be pre-planned in order to minimize radiation exposures. Working time limits may also be established for exposure control if required.

h. All operating personnel and personnel in the immediate area must wear film badges and pocket dosimeters.

B. EMERGENCY PROCEDURES

1. Purpose

The purpose of this procedure is to have a plan of action to be followed under emergency conditions under which calm planning is difficult. The following paragraphs describe the alarm system used at NPI. Also described are categories of emergency conditions and prescribed action for each, emergency notification and drills that will be practiced at NPI.

2. Alarm System

A condition of high radiation above a preset level in an area monitored by the NPI "Area Radiation Monitors" (b)(4)

after making a thorough radiation survey to determine whether the alarm is real or false.

3. Categories of Emergencies

a. High Radiation Levels

This procedure shall apply whenever an area radiation monitor alarm sounds, unless the alarm is anticipated because of the nature of the work involved and appropriate radiation level measurements are being made.

a-1 All personnel in the area of the monitor which is alarming must evacuate the area immediately.

a-2 Notify the following personnel who will then initiate emergency plan:

Personnel	Office Phone
J.J. Hairston	948-9588
H. W. Calley	296-8850
J.A. Ransohoff	948-9588

(b)(6)

a-3 The Radiation Protection Officer will:

(1) Close off the radiation area.

(2) Begin immediate radiation survey of area with mapping to determine radiation levels.

(3) Direct remedial action in the event of a real alarm.

(4) Attempt to determine circumstances which caused the incident and take corrective measures to ensure that a future similar incident does not occur.

a-4 Personnel dosimeters of personnel who evacuate the area shall be read and recorded immediately. Film badges of personnel suspected of receiving an excessive exposure will be sent to the vendor for emergency processing.

a-5 Personnel may re-enter the area only by authorization of the Radiation Protection Officer.

b. Fire

The areas of the NPI facility which contain radioactive materials are essentially of fire-proof construction. However, fire extinguishers are located in the storage pool area and the pilot plant irradiator for combating small fires. Detection of a fire of sufficient magnitude to endanger personnel or one that involves radioactive materials will be considered an emergency and the following procedure shall apply:

b-1 Evacuate the area

b-2 Notify the following immediately:

Personnel	Office Phone	
Dickerson Fire Dept.	424-3111	
J. J. Hairston	948-9588	(b)(6)
H. W. Calley	296-8850	
J. A. Ransohoff	948-9588	

b-3 Fire fighting from the radiological control standpoint will be directed by the Radiation Protection Officer.

b-4 No attempts to combat fires in radiation areas will be made without adequate radiation monitoring during all phases of the operation.

4. Notification of Authorities

Any accident which is defined as reportable by appropriate sections of 10CFR20, shall be reported to the Atomic Energy Commission

5. Practice Drills

In order to insure that each employee is aware of and understands his individual responsibilities during an emergency, practice drills will be conducted at intervals not to exceed one year.

VI. RECORDS AND ^{60}Co CAPSULE IDENTIFICATION

A. Cobalt Inventory

An inventory card as shown in (b)(4)

B.

(b)(4)

C.

D. Shipping Records

At the time of shipping ^{60}Co capsules off-site, the appropriate records, as required by 10CFR 71 and ICC regulations, shall be supplied to the transferee. Duplicate records shall be maintained by NPI. The normal NPI records used when shipping radioactive material shall also be maintained for each shipment.

VII. ACCIDENTS

This section is devoted to an analysis of credible accidents in the transfer and storage operations. The accidents are discussed as to their probability, cause, hazards and safeguards taken to prevent them.

A. Transfer Operations

The cask, as designed, is capable of dissipating the decay heat generated by the ^{60}Co without benefit of a primary coolant. It can, therefore, be stored fully loaded for an indefinite period of time without consequence to the integrity of the encapsulated ^{60}Co. The loss of cask coolant and subsequent release of the activity is not considered credible. In addition, a loaded cask will not normally be stored outside of the pool for extended periods of time.

B. Cask Loading and Unloading

There is no feasible set of circumstances which could occur during loading or unloading of the cask which would result in excessive radiation levels or the release of radioactivity to the uncontrolled environment. These operations are performed in the pool and the cask cover is never removed while there is ^{60}Co in the cask except when the cask is in the pool.

C. ^{60}Co Storage and Handling

1. Pool Drainage

(b)(4)

(b)(4)

2.

water which would be remedied by normal clean-up of the pool and isolation of the affected sources, and would not represent a significant hazard to personnel.

Although the probability of an accident of the assumed severity is very slight, the following rules and regulations shall nevertheless be strictly enforced by group supervision:

a. Access to the building will be limited to personnel directly concerned with the operations taking place.

b. No work will be done over the storage racks except capsule handling and transfer. The weight of the items involved in these operations, if dropped, is not sufficient to serously damage a capsule.

c. No equipment, casks, or other items will be transported over the capsule storage racks.

d. Good housekeeping practices will be enforced to eliminate items which could possibly be knocked into the pool or accidentally dropped onto the capsules.

D. Electrical Failure

(b)(4)

E. Loop Cooling Water Failure

F

(b)(4)

It should be emphasized that while these major leaks are a theoretical possibility, the probability of their occurrence is extremely remote, and in view of the fact that the catalyst is not inherently mixed with the reactants, the hazards here should be even lower than in the conventional latex polymerization industry.

G. Fire

As mentioned earlier, in order to have fire, you must have fuel, air, and heat (i.e., spark). Design considerations have been such that a combination of all three of these is incredible.

The areas involved in this process would be completely isolated in the case of fire, thus limiting the amount of oxygen available to support combustion.

(b)(4)

(b)(4)

H. Explosion

Although the occurrence of an explosion is unlikely, the process system is equipped with

(b)(4)

(b)(4)

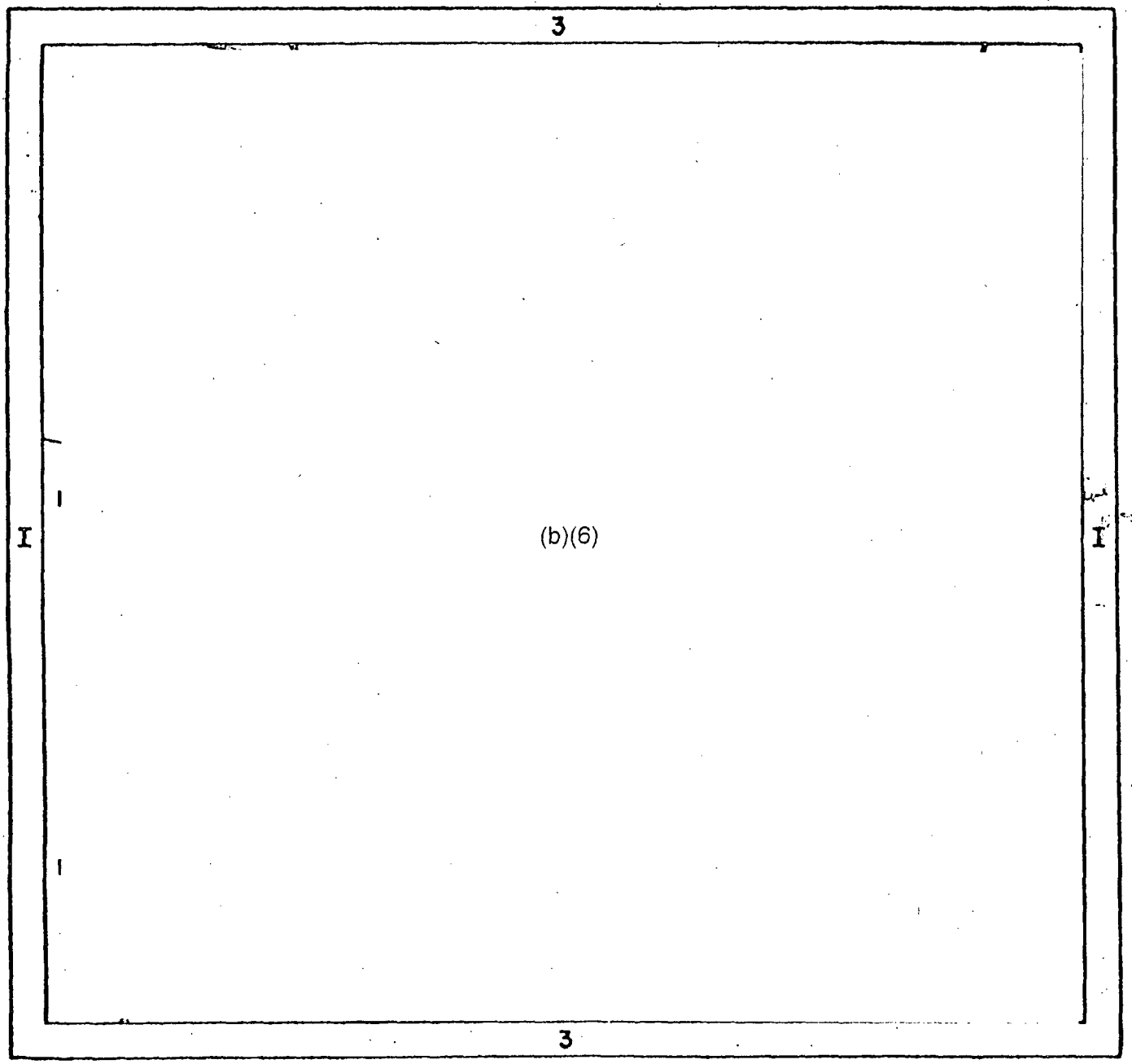

Figure 1 - NPI Site Location and Surrounding Area - Dickerson, Maryland

(b)(4)

Figure 6 - ^{60}Co Source Drive

(b)(4)

(b)(4)

Figure 7 - NPI ^{60}Co Sources

NPI COBALT-60 INVENTORY CARD

FUEL ELEMENT NO._____ TOTAL ACTIVITY (Ci)_____

DATE REMOVED FROM REACTOR_____

DATE RECEIVED AT NPI_____

Zr Tube Position in Fuel Element	Zr Pin Number	Cask Position	Activity (Ci)	Quantity and Size of Co-60 Capsules	Pool Storage Position	Date Shipped
1A						
1K						
11A						
11K						

REMARKS:

Figure 8 - Cobalt Inventory Card

APPENDIX I

TRAINING AND EXPERIENCE OF INDIVIDUALS NAMED IN

ITEM 4 OF FORM AEC-313

I. MR. HARRY W. CALLEY, JR. - NUS CORPORATION

Employer: NUS Corporation, Washington, D.C., 1966-1967

Duties: Evaluation of radiological safety aspects of space applications of nuclear power.

Prepare radiological control procedures for handling radioisotopes.

Review and evaluation of commercial and military power reactor facilities and operations with regard to radiological hazards, environmental safety and compliance with applicable radiation protection regulations.

Prepare license applications and supporting documentation for Byproduct, Source and Special Nuclear Materials.

Employer: Westinghouse - Bettis Atomic Power Laboratory, 1964-1966

Duties: Provided technical direction of the health physics aspects of the Shippingport pressurized water reactor modification. Responsibilities included reviewing the contractor's health physics program and procedures on a continuous basis throughout the modification to insure compliance with accepted health physics practices and applicable codes and regulations.

Directed and performed radiological control activities in fuel processing and fabricating areas at the laboratory. Responsible for the collection, processing and disposal of radioactive liquid waste.

Provided control of toxic materials through comprehensive routine industrial hygiene survey program.

Employer: Westinghouse Astronuclear Laboratory, 1962-1964

Duties: Evaluated hazards incident to the handling, use of, and exposure to radioactive or otherwise toxic materials associated with the NERVA testing and operations programs.

Assisted in preparation of Hazards Report for initial series of NERVA reactor experiments including analysis of credible emergency situations.

Prepared engineering review, including activation analysis and shielding calculations, of experiments and experimental programs associated with extensive radiation effects program to determine radiobiological hazards.

Designed shielded containers for the shipment of irradiated components.

Employer: Westinghouse Testing Reactor, 1958-1962

Duties: Assisted in initially formulating Health Physics program including preparation of hazards control standards, regulations and procedures.

Directed and performed normal health physics functions associated with operation of the reactor, hot cells and radiochemical laboratories.

Provided technical review and council in preplanning and performance of radiation work. Specified and provided protective clothing and equipment. Provided personnel monitoring service.

Prepared or reviewed engineering specifications for radioactive waste effluent systems, hot laboratory design, shielding including activation analysis, waste handling facilities and equipment, radiation control instrumentation and radiation sources.

Assisted in engineering review with respect to hazards aspects of design changes to the plant, operations programs, experiments and experimental programs.

Prepared applications, including hazards analysis, for licenses from federal, commonwealth and other regulatory agencies, for radioactive materials, radioactive transportation, and waste disposal. Reviewed licenses and prepared amendments as required. Reviewed compliance with applicable licenses and regulations and initiated corrective action as required.

Provided disposal service for radioactive wastes and irradiated reactor fuel. Service included transfer, storage, processing and shipment.

Performed equipment, area and personnel decontamination.

Employer: Westinghouse Atomic Power Department, 1956-1958

Duties: Performed routine Health Physics radiation and contamination control surveys. Collected and processed air, gas and water samples. Operated liquid waste disposal system and counting room. Developed process for disposal of chelated radioactive liquid wastes.

NAME: HARRY W. CALLEY, JR. COMPANY: NUS CORPORATION, WASHINGTON, D.C.

Type of Training	Where Trained	Duration of Training	On Job		Formal Course	
			Yes	No	Yes	No
1. Principles and practices of radiological health safety	Westinghouse Electric Corporation	1957-1966	X		X	
2. Radioactivity measurements standardization and monitoring techniques and instruments	Westinghouse Electric Corporation	1957-1966	X		X	
3. Mathematics and calculations basic to the use and measurement of radioactivity	Westinghouse Electric Corporation	1957-1966	X		X	
4. Biological effects of radiation	Westinghouse Electric Corporation	1957-1966	X		X	
5. Actual use of radioisotopes in the types and quantities for which application is being made, or equivalent	Westinghouse Electric Corporation	1957-1966	X		X	

ISOTOPE HANDLING EXPERIENCE

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Mixed fission products and activated corrosion products	MEGACURIE	Westinghouse	1957-1966	Health Physics Coverage
Radium-226	0.3 curie	Westinghouse	1958-1962	Calibration

APPENDIX I

TRAINING AND EXPERIENCE OF INDIVIDUALS NAMED IN ITEM 4 OF FORM AEC-313

II. JAMES J. HAIRSTON, JR. - NEUTRON PRODUCTS, INC.

Employer: Neutron Products, Inc. 1967 to present.

Duties: Manager of Operations - Supervise all operations concerning:

Cobalt-60 handling, processing, uses, and shipping.

Employer: NUS Corporation, Washington, D.C., 1966

Duties: Senior Technical Associate

Responsible for consulting activities concerning nuclear plant construction and equipment fabrication.

Employer: Bechtel Corporation, 1965

Duties: Construction Engineer

Responsible for field construction engineering of nuclear power plants.

Employer: National Bureau of Standards, 1961-1965

Duties: Chief Nuclear Engineer

Responsible for final design and construction of a 20 MW Heavy Water research reactor and associated facilities.

Employer: Advanced Materials Services, Inc., 1959-1961

Duties: Vice-President

In charge of all nuclear consulting activities in Europe. Consisted of consulting contracts involving ship-board reactors, central power stations, research reactors, and hot cell facilities.

Employer: ACF Industries, Inc. 1957-1959

Duties: Chief of Operations

Responsible for construction and start-up of all nuclear reactors sold by corporation.

Employer: Combustion Engineering, Inc. 1955-1957

Duties: Testing Supervisor

Responsible for construction, start-up, and operation of two nuclear critical facilities.

Employer: Oak Ridge National Laboratory, 1947-1955

Duties: Development Engineer

Developed methods for ion-exchange seapration of curie quantities of mixed fission products from desolved reactor fuel.

Responsible for construction and certain operations of the Low Intensity Test Reactor.

Responsible for shift operations of Homogeneous Reactor Experiment including decontamination, remote dismantling of highly radioactive components, fuel unloading, and radioactive waste treatment. The fuel handling operation involved mega-curie quantities of mixed fission products in solution.

NAME: JAMES J. HAIRSTON, JR. COMPANY: NEUTRON PRODUCTS, INC.

Type of Training	Where Trained	Duration of Training	On Job		Formal Course	
			Yes	No	Yes	No
1. Principles and practices of radiological health safety	Oak Ridge National Laboratory Oak Ridge, Tennesee	1947-1955	X		X	
2. Radioactivity measurements standardization and monitoring techniques and instruments	Oak Ridge, National Laboratory Oak Ridge, Tennesee	1947-1955	X		X	
. Mathematics and calculations basic to the use and measurement of radioactivity	Oak Ridge National Laboratory Oak Ridge, Tennesee	1947-1955	X		X	
4. Biological effects of radiation	Oak Ridge National Laboratory Oak Ridge, Tennesee	1947-1955	X			X
5. Actual use of radioisotopes in the types and quantities for which application is being made, or equivalent	Oak Ridge National Laboratory Oak Ridge, Tennesee	1947-1955	X		X	
	NPI	6 weeks	X			X

ISOTOPE HANDLING EXPERIENCE

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Mixed Fission Products in Solution	$\sim 10^8$ curies	Oak Ridge Nat'l Lab. Oak Ridge, Tennesee	1948-1955	Reprocessing
Cobalt-60	500,000 curies	Big Rock Point Nuclear Plant	6 weeks	Storage, handling & shipment
Cobalt-60	300,000 curies	Westinghouse Waltz Mill, Pennsylvania	4 weeks	"

APPENDIX I

TRAINING AND EXPERIENCE OF INDIVIDUALS NAMED IN

ITEM 4 OF FORM AEC-313

III. J.A. RANSOHOFF - NEUTRON PRODUCTS, INC.

Employer: Neutron Products, Inc., 1959 to present

Duties: President of Neutron Products , Inc.

Design of reactor components, processes for producing radioisotopes, design of thermo-electric devices, and general consulting on reactor technology.

Consulted for a number of clients on the use of thorium as a fertile material, rare earths as control rod poison, the recycle of U-233, and has several inventions in the field of reactor control.

Devised techniques and process innovations for the commercial production of Co-60, Np-237, Pu-238, and other isotopes. Economics of by-product recovery from spent fuel processes.

Employer: NUS Corporation, (80% owner of Neutron Products, Inc.) 1963-1965

Duties: Senior Technical Associate

Responsible for various analyses of fuel cycle technology and economics.

Employer: Self-employed, 1956-1959

Duties: Consultant to various companies on reactor technology in general, utilization of rare earths and thorium, radiolytic gas production and recombination, reactor hazards.

Employer: U.S. Army, 1953-1956

Duties: Stationed at U.S. Atomic Energy Commission, Army Reactors Branch.

Headed group responsible for technical phases of project initiation.

Employer: Oak Ridge National Laboratory, 1951-1953

Duties: Development Engineer

Responsible for test operation and start-up of recombiners for Homogeneous Reactor Experiment; member HRE start-up and operations crew.

Responsible for development work on advanced catalytic combiners.

NAME: J.A. RANSOHOFF COMPANY: NEUTRON PRODUCTS, INC.

Type of Training	Where Trained	Duration of Training	On Job		Formal Course	
			Yes	No	Yes	No
1. Principles and practices of radiological health safety	Oak Ridge Nat'l. Lab. U.S. Army Neutron Products, Inc.	2 years 3 years 8 years	X X X		X	 X X
2. Radioactivity measurements standardization and monitoring techniques and instruments	ORNL U.S. Army Neutron Products, Inc.	2 years 3 years 8 years	X X X		X	 X X
3. Mathematics and calculations basic to the use and measurement of radioactivity	ORNL U.S. Army Neutron Products, Inc.	2 years 3 years 8 years	X X X		X	 X X
4. Biological effects of radiation	ORNL U.S. Army	2 years 3 years	X X			X X
5. Actual use of radioisotopes in the types and quantities for which application is being made, or equivalent	Neutron Products, Inc.	2 years	X			X

ISOTOPE HANDLING EXPERIENCE

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Cobalt-60	300,000 Ci	Westinghouse, Waltz Mill, Pennsylvania	1 week (1967)	Decanning, unloading, and calibration
Mixed Fission Products	Megacurie Quantities	ORNL	1952-1953	In plant handling of irradiated fuel

APPENDIX I

TRAINING AND EXPERIENCE OF INDIVIDUALS NAMED IN

ITEM 4 OF FORM AEC-313

IV. MARVIN M. TURKANIS - NEUTRON PRODUCTS, INC.

Employer: Neutron Products, Inc., Washington, D.C., 1966 to present

Duties: Consult on the applications of large gamma sources, including radiological safety.

Employer: Nuclear Materials and Equipment Corporation
Apollo, Pennsylvania, 1960-1966

Duties: Designed and fabricated sealed sources, including kilocurie Cobalt-60, RaBe, PuBe, and AmBe sources.

Processed kilogram quantities of plutonium metal.

Supervised service irradiations including radioprocessing of ton quantities of potatoes.

Prepared numerous amendments to Byproduct License.

Named user on NUMEC's Byproduct and SNM License for Leechburg facility.

Employer: M&C Nuclear, Attleboro, Pennsylvania, 1957-1960

Duties: Performed metallurgical evaluations of uranium metal and oxide of all enrichments.

Employer: Massachusetts Institute of Technology,
Cambridge, Massachusetts, 1953-1955

Duties: Performed tracer studies under AEC contract.

NAME: M.M TURKANIS COMPANY: NEUTRON PRODUCTS, INC.

Type of Training	Where Trained	Duration of Training	On Job		Formal Course	
			Yes	No	Yes	No
1. Principles and practices of radiological health safety	M.I.T. M&C Nuclear Nuclear Materials & Equip. Corporation	Part of Radiochem. 1957-1960 1960-1966	 X X		X X X	
2. Radioactivity measurements standardization and monitoring techniques and instruments	M.I.T. M&C Nuclear Nuclear Materials & Equipment Corporation	Part of Radiochem. 1957-1960 1960-1966	 X X		X X X	
Mathematics and calculations basic to the use and measurement of radioactivity	M.I.T. M&C Nuclear Nuclear Materials & Equipment Corporation	Part of Radiochem. 1957-1960 1960-1966	 X X		X X X	
4. Biological effects of radiation	M.I.T. M&C Nuclear Nuclear Materials & Equipment Corporation	Part of Radiochem. 1957-1960 1960-1966	 X X		X X X	
5. Actual use of radioisotopes in the types and quantities for which application is being made, or equivalent	M.I.T. M&C Nuclear Nuclear Materials & Equipment Corporation	Part of Radiochem. 1957-1960 1960-1966	 X X		X X X	

ISOTOPE HANDLING EXPERIENCE

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Co-60	400 Ci	Nuclear Materials & Equipment Corporation	2 weeks	Source fabrication
Ra	2 Ci		1 month	"
Pu	10 kg		6 years	
Ag-110	mCi	M.I.T.	2 years	Tracer source fabrication
Am-241	10 g	Nuclear Mat. & Equip Corporation	2 years	

APPENDIX II
NEUTRON PRODUCTS
ORGANIZATION CHART