UNITED STATES
CLEAR REGULATORY COMMISSIC
WASHINGTON, D. C. 20555

TO: John Cooper, Chief
Radioisotopes Licensing Section
NMSS, Region III

FROM: William O. Miller, Chief
License Fee Management Branch
Office of Administration

SUBJECT: LICENSE FEE INFORMATION

Applicant/Licensee Monsanto Enviro - Chem

City/State St. Louis, Missouri

License No. 24-01113-22

Control No. 03540

Fee Information:

Type of fee (✓) Amendment ( ) Renewal ( ) Application

Check No. no fee for term.

Amount $ X

Fee Category

Date Check Rec'd

OK to issue:

Amendment ✓

Renewal

License

Additional Fee Due

Signed Glenda Jackson
License Fee Management Branch

Date 7/2/80

faxed

JUL 2 3 1980

A/431

Form 2

319

Monsanto

ELECTRONIC PRODUCTS

MONSANTO COMMERCIAL PRODUCTS CO.
P. O. Box 8
St. Peters, Missouri 63376
Phone: (314) 272-6281
TWX (910) 760-2941

April 14, 1976

Mr. Douglas Weiss
Nuclear Regulatory Commission
License Fee Management Branch
Washington, D.C. 20555

Dear Mr. Weiss:

Our check for the required $1,000.00 fee for the radiation manufacturing license as specified in fee category 3B of Part 170 as per your letter dated April 7 is enclosed.

Thank you very much for your assistance in obtaining both licenses.

Regards,

John W. Burd

John W. Burd
Manager, Materials Technology

JWB:bh

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Form AEC-313 (2-73) 10 CFR 30

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

Form Approved Budget Bureau No. 38-R0027

INSTRUCTIONS.—Complete items 1 through 16 if this is an initial application or an application for renewal of a license. Information contained in previous applications filed with the Commission with respect to items 8 through 15 may be incorporated by reference provided references are clear and specific. Use supplemental sheets where necessary. Item 16 must be completed on all applications. Mail two copies to: U.S. Atomic Energy Commission, Washington, D.C. 20545, Attention: Materials Branch, Directorate of Licensing. Upon approval of this application, the applicant will receive an AEC Byproduct Material License. An AEC Byproduct Material License is issued in accordance with the general requirements contained in Title 10, Code of Federal Regulations, Part 30, and the Licensee is subject to Title 10, Code of Federal Regulations, Part 20 and the license fee provisions of Title 10, Code of Federal Regulations, Part 170. The license fee category should be stated in item 16 and the appropriate fee enclosed. (See Note in Instruction Sheet).

1. (a) NAME AND STREET ADDRESS OF APPLICANT (Institution, firm, hospital, person, etc. Include ZIP Code and telephone number.)

Monsanto Commercial Products Company
An Operating Unit of Monsanto Company
800 North Lindbergh Boulevard
St. Louis, Missouri 63166
(314) 694-1000

(b) STREET ADDRESS(ES) AT WHICH BYPRODUCT MATERIAL WILL BE USED (If different from 1(a). Include ZIP Code.)

03120

Electronic Products Division
P.O. Box 8
Mo. Highway 79 at U.S. Interstate 70
St. Peters, Mo. 63376
(314) 272-6281 030-11884

2. DEPARTMENT TO USE BYPRODUCT MATERIAL

Electronic Products Division
St. Peters Plant

3. PREVIOUS LICENSE NUMBER(S) (If this is an application for renewal of a license, please indicate and give number.)

None

4. INDIVIDUAL USER(S) (Name and title of individual(s) who will use or directly supervise use of byproduct material. Give training and experience in Items 8 and 9.)

Richard P. Virtue - Process Engineer
Forrest V. Williams - Quality Assurance Manager
Richard Massey - Research Technician

5. RADIATION PROTECTION OFFICER (Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9.)

Bobbie D. Stone - Engineering Fellow
Elmer W. Schramm - Safety Supervisor

6. (a) BYPRODUCT MATERIAL (Elements and mass number of each.)

Nuclides with atomic numbers from 3 thru 83 with particular emphasis to ^{32}P.

(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLICURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM THAT YOU WILL POSSESS AT ANY ONE TIME. (If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)

One (1) millicurie total of irradiated semiconductor grade silicon in form of rods and/or slices.

RECEIVER: DRA:BMB
Date 2-26-76
Time
By
From

Applicant
Check No. 006939
Amount $1000 - 36 - mfg
Date of Check 4-14-76
Date Check Rec'd. 4-19-76
Received By Quiss

Applicant
Check No. 006766
Amount $50 - 34 (32.11 dist)
Date of Check 2-20-76
Check Rec'd 2-26-76
Received By

7. DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED. (If byproduct material is for "human use," supplement A (Form AEC-313a) must be completed in lieu of this item. If byproduct material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.)

Irradiated silicon rod will be ground to exact dimensions, etched with an HNO_3HF mixture to remove surface damage, sliced into wafers with a diamond saw, and the wafers etched and subsequently polished on one or both sides. Customers may put wafer through a series of high temperature (900-1300°) diffusion steps, etch it and finally break it into chips approx. 0.020" square. Other customers will incorporate entire wafer in a rectifier after undergoing high temperature diffusions. Final end uses for devices include rectifiers and silicon control rectifiers. Uses of integrated circuits made from 0.020" square chips include computers, digital watches, calculators, radios and sound equipment.

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TRAINING ... 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
a. Principles and practices of radiation protection	See Sect. 14B of attached		Yes No	Yes
b. Radioactivity measurement standardization and monitoring techniques and instruments	supporting document.		Yes No	Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity			Yes No	Yes
d. Biological effects of radiation			Yes No	Yes

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

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
	See Section 14A of attached supporting document.			

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)
See Section 12 of attached supporting document.					

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.

Certified sealed sources or solutions containing the isotopes of interest are used to determine instrument counting efficiencies for the measurement conditions used. This will be done quarterly.

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED. (For film badges, specify method of calibrating and processing, or name of supplier.)

Eberline Instrument Corp., P.O. Box 2108, Sante Fe, N. Mex. 87501 now supplies L.F. radiation detection badge service to the St. Peters plant. Personnel receiving and monitoring irradiated silicon will be monitored with these badges.

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 ... of facility is attached. (Circle answer) Yes No See Sections 12 and 15 of attached document.

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit ... 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.

See Section 16 of attached document.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods ... be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. See Section 17 of attached ...

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 ... 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.

Monsanto Commercial Products Company
An Operating Unit of Monsanto Company

Applicant named in item 1

License Fee Category $ 50.00 (3L)

Fee Enclosed $ 50.00

By: [signature]

Manager - Materials Technology

Title of certifying official

Date February 23, 1976

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 ... to any department or agency of the United States as to any matter within its jurisdiction.

Monsanto

ELECTRONIC PRODUCTS

MONSANTO COMMERCIAL PRODUCTS CO.
P. O. Box 8
St. Peters, Missouri 63376
Phone: (314) 272-6281
TWX (910) 760-2341

February 23, 1976

Mr. Douglas Weiss
Nuclear Regulatory Commission
License Fee Management Branch
Washington, D.C. 20555

Dear Mr. Weiss:

Enclosed are two copies of our Application for a Byproduct Material License relating to the receipt, use, distribution and transfer of semiconductor grade silicon that has been doped by irradiation in a nuclear reactor. The application and supporting documentation has been prepared to conform with Title 10, Code of Federal Regulations, Part 30. We will, of course, be happy to provide any further information required in support of the application.

Our check for the required $50 fee is also enclosed.

Sincerely yours,

John W. Burd

John W. Burd
Manager, Materials Technology

JWB:bh

71279 [illegible]

SUPPORTING DATA FOR A SPECIFIC LICENSE

TO OWN, POSSESS, DISTRIBUTE AND TRANSFER NEUTRON-DOPED SILICON

Monsanto Commercial Products Company
An Operating Unit of Monsanto Company

Table of Contents

1. INTRODUCTION

The Electronic Products Division of Monsanto Commercial Products Company, an operating unit of Monsanto Company, desires to receive silicon which has been irradiated in a nuclear reactor facility to effect nuclear transmutation doping and then to distribute and transfer the silicon to electronic device manufacturers.

Although byproduct material is not functional in silicon, some may be present as a result of activation of trace level impurities.

The information in the following sections is in support of an application for a specific license to possess and use neutron-doped silicon pursuant to Section 30.33 of 10 CFR Part 30 and an application for a specific license to distribute neutron-doped silicon under the provisions of Section 32.11 of 10 CFR Part 32.

Pursuant to Section 30.32(d) of 10 CFR Part 30 a single application is being filed covering both of these activities.

2. DESCRIPTION OF SILICON

Very pure single crystals of silicon which contain carefully controlled trace quantities of selected impurities are the major starting material for the solid state electronics industry. The Electronic Products Division of the Monsanto Commercial Products Company presently produces these high purity single crystals of silicon by the float-zone and Czochralski methods. The as-grown crystals range in size up to 100 mm. in diameter and 30 inches in length. These crystals are further modified into ground rods of exact diameters and into lapped and/or polished wafers ranging in thickness from 0.010" to 0.030". Both the wafer thickness and the electrical resistivity are critical parameters in fabrication of the electronic devices in which the silicon is used. The resistivity is controlled by adding trace amounts of certain impurities and in the conventional process, these impurities are introduced during crystal growth.

A recent advance in the art of introducing controlled trace impurities into the very pure silicon is by the nuclear transmutation of a portion of the silicon into phosphorus.

3. DESCRIPTION OF INTENDED USE OF NEUTRON-DOPED SILICON

Pure single crystals of silicon doped with a few parts per billion of boron or phosphorus are manufactured by the Electronic Products Division of the Monsanto Commercial Products Company and distributed to electronic device manufacturers. The silicon, in the form of wafers, is used to fabricate mini- and microcircuits and as the active sections of silicon rectifiers. Previously, doping of the silicon has been accomplished by adding trace amounts of the desired impurities during growth of the crystals. This produces materials that are of limited uniformity on a microscale and are homogeneous on a macroscale in doping material concentration to only about ± 25%. This non-uniformity and limited precision has been acceptable in the past but will not be in the future as microcircuitry becomes smaller and more complex and higher reliability is demanded of rectifiers. It has been shown that neutron transmutation of Si to produce n-type silicon, (wherein the majority carriers are electrons), overcomes both these problems. (Ref. 2, 3.) The transmutation of ^{30}Si to ^{31}P to produce a uniform and precise doping of silicon semiconductor material to n-type material is a desirable commercial process yielding a product that is superior to material made by existing processes.

Bulk pieces or wafers are irradiated at a reactor with thermal neutrons to transmute a small amount of ^{30}Si to ^{31}Si which decays with a 2.62 hour half-life to ^{31}P.

The reaction is:

$$\underline{^{30}Si} \quad + \quad n_{th} \quad \rightarrow \quad ^{31}Si \quad \rightarrow \quad \underline{^{31}P} \quad + \quad \beta^-$$

The underlined isotopes, which are the initial and desired product, are stable. The concentration C_p of transmuted phosphorus is:

$$C_p \quad = \quad \phi \quad t \quad \sigma \quad n \quad (^{30}Si)$$

where:

ϕ = the thermal neutron flux (n/cm^2-sec)

t = the radiation time (sec.)

σ = the cross section for $^{30}Si\ (n,\gamma)$ = $0.10 \times 10^{-24}\ cm^2$

$n(^{30}Si)$ = the number of ^{30}Si atoms/cc in the sample = 1.52×10^{21} atoms/cc

The concentration $C_{ppb} = \phi\, t\, \sigma \frac{n(^{30}Si)}{n(Si)} \times 10^9$

And the resistivity after proper annealing of the silicon because of the transmuted phosphorus is:

$$R = \frac{96}{C_{ppb}} = \frac{31.1}{\phi\, t \times 10^{-18}}$$

Since the minimum desired resistivity is ∿ 4 ohm-cm, the maximum exposure will be a fluence $\phi t < 8 \times 10^{18}$ n/cm^2 sec. All material will be used in solid form in electronic devices; such as, rectifiers and microcircuits. After irradiation both bulk pieces and slices will be annealed at ≲ 1100° C to remove radiation damage. To make slices, the bulk pieces will then be sliced and polished into wafers. The wafers will be sold to electronics manufacturers who will deposit circuits on these silicon substrates and heat treat and section them. The microcircuits or rectifiers will then be incorporated into circuits or rectifiers.

4. METHOD OF BYPRODUCT INTRODUCTION

The purpose of the neutron irradiation is to produce the stable isotope ^{31}P by the (n,γ) reaction on ^{30}Si and allowing for the decay of the ^{31}Si to ^{31}P. There are, however, other reactions associated with the silicon that produce byproduct materials and there can be a few parts-per-billion impurities in the silicon which lead to byproduct material.

The following reactions on the silicon should be considered:

^{30}Si	(n,γ)	^{31}Si	2.62 hr.	$\rightarrow$	^{31}P	+	β^-	(1)
^{31}P	(n,γ)	^{32}P	14.3 d	$\rightarrow$	^{32}S	+	β^-	(2)
^{28}Si	(n, 2n)	^{27}Si	4.25 s	$\rightarrow$	^{27}Si	+	β^+	(3)
^{31}P	(n, 2n)	^{30}P	2.5 m	$\rightarrow$	^{30}Si	+	β^+	(4)
^{28}Si	(n, p)	^{28}Al	2.27 m	$\rightarrow$	^{28}Si	+	β^-	(5)
^{29}Si	(n, p)	^{29}Al	6.52 m	$\rightarrow$	^{29}Si	+	β^-	(6)
^{31}P	(n, p)	^{31}Si	2.62 hr	$\rightarrow$	^{31}P	+	β^-	(7)
^{30}Si	(n,α)	^{27}Mg.	9.5 m	$\rightarrow$	^{27}Al	+	β^-	(8)
^{31}P	(n,α)	^{28}Al	2.27 m	$\rightarrow$	^{28}Si	+	β^-	(9)

Following irradiation, the silicon is allowed to decay for several days and consequently only the combination of reactions (1) and (2) of those above results in byproduct materials. At the time of discharge from the reactor following an irradiation in a thermal neutron flux of 4×10^{12} n/cm^2-sec for 348 hours the ^{32}P activity will be about 2.2×10^{-3} μ Ci/gm. This is the highest ^{32}P activity level expected in any of the silicon and corresponds to a resistivity of about 4 ohm cm. In all cases, the irradiated silicon will be held until the ^{32}P activity is less than the exempt concentration of 2×10^{-4} μCi/gm listed in Section 30.70 of 10 CFR Part 30. Table 4-1 shows the expected initial ^{32}P level as a function of resistivity for different flux densities.

Other byproducts can be introduced by the neutron activation of trace impurities within the lattice of the single crystals and of contaminates on the outer surface. The presence of some trace impurities of only a few parts per billion in the lattice significantly affects the resistivity or minority carrier lifetime of the semiconductor material

Table 4-1

Computer-Calculated Values of Radioactivity from ^{32}P in Neutron-Doped Silicon and Times Required to Decay to NRC Exempt Levels

Silicon Resistivity (Ohm Cm)	Neutron Flux ($n\ cm^{-2}\ sec^{-1}$)	Radiation Times (Hrs)	Radioactivity at Discharge (μ Ci/gm)	Time to Decay to 2.0×10^{-4} μ Ci/gm (days)
5	2.5×10^{13}	45.0	1.70×10^{-3}	45
	1.25×10^{13}	90.0	1.65×10^{-3}	44
	4.0×10^{12}	290	1.59×10^{-3}	43
	1.0×10^{12}	1160	1.0×10^{-3}	33
11.3	2.5×10^{13}	20.0	2.37×10^{-4}	4
	1.25×10^{13}	40.0	3.37×10^{-4}	11
	4.0×10^{12}	123	2.93×10^{-4}	8
	1.0×10^{12}	493	2.37×10^{-4}	4
25	2.5×10^{13}	9.0	3.35×10^{-5}	0
	1.25×10^{13}	18.0	4.63×10^{-5}	0
50	2.5×10^{13}	4.50	5.28×10^{-6}	0
	1.25×10^{13}	9.0	8.37×10^{-6}	0
100	2.5×10^{13}	2.25	7.53×10^{-7}	0
	1.25×10^{13}	4.50	1.32×10^{-6}	0
150	2.5×10^{13}	1.5	2.34×10^{-7}	0
	1.25×10^{13}	3.0	4.27×10^{-7}	0

and therefore, manufacturing procedures have been developed to yield very pure crystals. In addition, the semiconductor silicon resistivity and minority carrier lifetime are measured prior to irradiation to verify its suitability. These measurements provide an initial test to prevent a piece of silicon containing more than trace quantities of impurities from being irradiated. Contaminates on the outer surface of the silicon will be removed prior to and following irradiation. One available cleaning method, which has been found to be very effective, is described in reference (9). Also, in nearly all cases, it is practical to etch away the surface of the silicon with a mixture of nitric and hydrofluoric acids before processing it further. This is obviously the most efficient way of removing byproduct material from the surface and this has been verified experimentally. Decontamination of the surface will be performed at the reactor facility after irradiation by one, or both, of the above techniques to the exempt concentration level before releasing the material to Monsanto.

5. INITIAL CONCENTRATION OF BYPRODUCT MATERIAL

As indicated in part 3, the byproduct materials are produced in the process of nuclear transmutation doping of silicon and are not contributors to the usefulness of the end product.

Surface contamination results in the greatest initial quantity of byproduct material. The activation products of silicon are well known with only ^{32}P being significant and then only for the high fluence irradiations. Activation of trace impurities within the crystals has not been found to result in byproduct material approaching exempt concentrations. The initial ^{32}P radioactivity level is given in Table 4-1 as a function of silicon resistivity.

6. CONTROL METHODS ON BYPRODUCT INTRODUCTION

The device manufacturers' electrical resistivity requirements for high purity silicon single crystals determine the neutron fluence, and thus, the amount of byproduct material within the silicon. The initial resistivity and minority carrier lifetimes are extremely sensitive detection measurements for electrically active and heavy metals trace impurities. These measurements are routinely performed on all silicon crystals prior to irradiation and any abnormal impurity levels would very likely be detected by these methods.

The silicon is cleaned prior to irradiation and then is wrapped in aluminum foil and heli-arc seal welded into aluminum capsules. This procedure reduces the surface contamination which makes subsequent handling easier. After irradiation the silicon is checked for surface contaminates and cleaned again at the reactor facility if contaminants are found.

Since the doping concentration is directly dependent upon the total neutron fluence, the irradiation time and thermal neutron flux are controlled to within about five percent of the desired fluence. Therefore, the activation products of silicon can be accurately calculated.

7. TIME INTERVAL BETWEEN IRRADIATION AND RELEASE FROM THE REACTOR FACILITY

Allowing about one week following irradiation for the radioactivity in the capsule to decay before opening dictates the minimum time interval between irradiation and shipment. The silicon will be held at the reactor facility until it is determined that a combination of cleaning and radioactive decay results in all isotope concentrations being less than the exempt concentrations in Section 30.70 of 10 CFR Part 30. Computer calculated decay times for a variety of resistivities and flux densities are shown in Table 4-1.

8. DETERMINATION OF THE CONCENTRATION OF BYPRODUCT IMPURITY LEVELS

All irradiated silicon will be surveyed with a good thin window G-M survey meter which has sufficient sensitivity to detect likely byproducts at the concentrations listed in Section 30.70 of 10 CFR Part 30. If no radioactivity above exempt concentrations is detected the silicon will be transferred from the reactor facility to Monsanto.

If radioactivity is detectable with the G-M survey meter, then the silicon will be monitored with a pulse height analyzer system (see Section 12) to identify the specific isotopes and to determine the concentrations. Silicon will not be transferred from the reactor facility to Monsanto unless the byproduct concentrations are within the limits specified in Section 30.70 of 10 CFR Part 30.

After receipt from the reactor facility, the irradiated silicon will again be surveyed with a good thin window G-M survey meter and with a flow-proportional counter calibrated to confirm that the concentrations of ^{32}P are within the limits specified in Section 30.70 of 10 CFR Part 30. Further processing of the neutron-doped silicon will not be performed except on material within the limits specified in Section 30.70 of 10 CFR Part 30.

9. POTENTIAL FOR CONCENTRATION OF BYPRODUCT MATERIALS

Since any byproduct materials which may be present serve no useful function, there is no incentive for anyone to attempt to separate or collect the materials.

No practical mechanism has been identified by which the byproduct materials could be inadvertently concentrated.

10. WHY A LOWER LEVEL IS NOT PRACTICAL

The resistivity of the silicon semi-conductor material is in inverse proportion to the concentration of phosphorus in the silicon. The amount of transmuted phosphorus is directly proportional to the total neutron fluence. Therefore, to reach required resistivity, a required fluence of thermal neutrons is specified. This produces a predictable amount of ^{31}Si which decays with a half-life of 2.62 hours to ^{31}P. The subsequent reaction of ^{31}P with thermal neutrons to give ^{32}P which decays with β^- emission ($t_{1/2}$ = 14.3 days) to ^{32}S is responsible for the byproduct radioactivity associated with irradiated silicon. Thus the level of initial radioactivity is inversely proportional to the desired resistivity.

With regard to impurities, the silicon stock from which the crystals are made is as pure as one finds in any industrial production and only ppb or low ppm levels of impurities are found in it. This is the state-of-the-art except for research grade material. Moreover, routine measurements made to control the quality of the silicon as a semi-conductor material serve to indicate the presence of at least some possible contaminants at the ppb level.

11. WHY THE PRODUCT IS NOT LIKELY TO BE USED IN HUMANS

The input and product of the silicon transmutation process are solids which are quite inert. These have at most only remote contact with the human ingestion cycle. All material will be parts of electronic devices which will be external to humans. The contact with humans will be similar to the glow discharge readouts on hand calculators and the fluorescent dials of watches.

After irradiation, surface contamination may be removed from the bulk or wafers by etching. This cleaning, if required, will be done at the reactor facility. All solvents will be handled by the reactor facilities procedures for handling potentially radioactive wastes.

12. DESCRIPTION OF FACILITIES

A. Silicon Manufacturing Facilities - St. Peters, Missouri

The Electronics Division of the Monsanto Commercial Products Company operates a fully integrated, high purity silicon manufacturing plant at St. Peters, Missouri. High purity polycrystalline silicon is produced by the high-temperature reduction of trichlorosilane with hydrogen. The polycrystalline silicon is then converted into dislocation-free single crystal silicon by either the float-zone or Czochralski crystal growth processes. The single crystal silicon is further processed by a variety of shaping operations to provide the entire spectrum of physical forms required by the electronic industry, i.e., ground rod, etched rod, plain slices, etched slices, lapped slices, polished slices or suitable combinations of the foregoing.

In addition to Manufacturing Line Supervision, the facility organization includes, at present, a Quality Assurance Section staffed with four professionals; a Materials Technology Group of ten professionals, and a Safety Director whose responsibility includes compliance with State and Federal (including OSHA) safety requirements.

Although it is not a nuclear facility, the St. Peters plant has the physical facilities and staff personnel to carry out a rigorous enforcement of the safety and environmental regulations related to the handling of exempt concentrations of byproduct material in a manufacturing environment.

A separate room will be maintained for the receipt of irradiated silicon from the reactor facility, checking it for byproduct radioactivity and scheduling it for further processing. All irradiated material prior to shipment will be stored in this room or in another dedicated for this purpose.

B. NUCLEAR REACTOR FACILITIES

It is anticipated that for the present, at least, the bulk of the Electronic Products Division's neutron irradiation of silicon will be performed at the University of Missouri Research Reactor located at Columbia, Missouri. These facilities are described briefly below, but it should not be implied that the neutron irradiation of silicon will necessarily be limited to this single reactor facility.

The University of Missouri Research Reactor (MURR) is the highest power, highest neutron flux reactor at a university in the U.S.A. It is a 10 MW, light water reflected flux trap reactor. The facility is operated by the University of Missouri as a University-wide facility and is located in the University Research Park, Columbia, Missouri.

The reactor was licensed by the Atomic Energy Commission on October 11, 1963. Criticality was attained on October 13, 1966, and a power level of 5 MW was attained on June 30, 1967. The present licensed power level of 10 MW was attained on July 18, 1974.

Two general locations are available in the reactor for the neutron irradiation of silicon. One of these locations is located in the graphite reflector and is capable of accomodating silicon rods or slices up to 2-inches in diameter. The second location consists of an all-aluminum fixture located in the bulk pool position and is capable of accomodating silicon rods or slices up to 3-inches in diameter. Nominal thermal neutron flux densities for these locations are given in the following Table 12-1.

Table 12-1

Thermal Neutron Flux Data

University of Missouri Research Reactor

Position	Maximum Flux (n/cm^2 - sec)	Average Flux (n/cm^2-sec.)
Graphite	2.5×10^{13}	2×10^{13}
Bulk Pool	4×10^{12}	3×10^{12}

The following analyzing equipment is available at the University Reactor facility. It will be used, as required, to assure that the byproduct levels of the irradiated silicon are within the limits for exempt concentrations and that shipments to the St. Peters facilities are within the limits for exempt quantities.

Pulse Height Analyzer

2 - 4096 Channel

1 - 400 Channel Nuclear Chicago Model 37-2, with x-y plotter, typewriter, punch tape or magnetic tape, and automatic integration

2 - 400 Channel Victoreen PIP-400, with x-y plotter, telewriter or punch tape

1 - 400 Channel Hewlett-Packard Model 5400 A, with digital printer

1 - 256 Channel Nuclear Data Model 102, with x-y plotter and telewriter

1 - 256 Channel Radiation Counting Lab Model 21003

1 - Automatic sample changer, Nuclear Chicago Model with 3' x 3' NaI detector and 100 sample capacity

1 - Automatic Picker Liquid Scintillation Detector, 200 sample capacity with telewriter and 3 channel refrigerated system

1 - Single Channel Nuclear Chicago Model 8725

2 - Single Channel General Electric Type NB53A, with scaler and count rate meter

Scalers (Health Physics Section)

1 - Nuclear Chicago Model 8166

1 - Nuclear Chicago Model 8770

1 - Nuclear Chicago Model 8775

Detectors

1 - NaI scintillation detector, 2" x 2" (flat)

1 - NaI scintillation detector, 3" x 3" (flat)

4 - NaI scintillation detector, 3" x 3" (well-type)

1 - Gas-flow Beta detector, Nuclear Chicago Model D-47

2 - Germanium (lithium) Gamma detector, Princeton Gamma Tech (horizontal)

1 - Silicon (lithium) x-ray detector, Ortec Model 7013-08 (vertical)

1 - Automatic Planchet Sample Change, Nuclear Chicago Model 1152 Spectro Shield, with Model 8703 decade scaler (Health Physics Section)

C. RADIATION INSPECTION FACILITIES AT ST. PETERS, MISSOURI

The St. Peters Silicon Plant will have an inspection facility for the measurement of all shipments and lots of irradiated silicon entering or leaving the site. The inspection facility will serve a dual function: (i) to double-check and insure that all irradiated silicon received at St. Peters contains no more than exempt concentrations of byproduct materials prior to further processing, and (ii) that all shipments of irradiated silicon from the St. Peters site contain no more than exempt concentrations and quantities of byproduct materials.

The radiation inspection facility will be under the direction of a trained radiation protection officer (see section 14) who will be responsible for strict adherence to applicable regulations governing byproduct materials in exempt concentrations. He will also be responsible for the necessary records pursuant to Section 32.12 of 10 CFR Part 32.

Radiation Detection Instruments available in the inspection facility will consist of the following:

1 - Eberline Portable Gas-Proportional Counter Model PAC-4G with AC-21B "α" probe and Audio Speaker Model SK-1

1 - Eberline Mini-Scaler MS-2 with HP-210 Geiger detector and SPA-3 Gamma probe

1 - Victoreen Thyac III, Model 489-4 survey meter

1 - Beta calibration standard

1 - Gamma calibration standard

D. OTHER MONSANTO FACILITIES

In addition to the facilities and staff at St. Peters where irradiated silicon would be received and undergo further processing, certain facilities and functions at Monsanto World Headquarters located at 800 N. Lindbergh Blvd., St. Louis County, Mo. are available to support the St. Peters endeavor. These include the laboratory operated by the Technology Planning and Evaluation Department, Applied Sciences, of the Monsanto Industrial Chemicals Company (a second operating unit of Monsanto Company). This laboratory is equipped for the preparation of research quantities of labeled compounds and in carrying out radiotracer work for a variety of groups in Monsanto. It is licensed under USAEC By-Product License 24-01113-14, Amendment 13, which allows receipt of up to 2.05 Curies of radioisotopes as irradiated specimens. These laboratory facilities are available for some radiochemical work on irradiated silicon on a contract basis and a considerable amount of such work has been carried out there. Moreover, the Radiation Officer for this Licensee, presently, Mr. Donald B. Hines, an experienced radiochemist, is available for consultation on all matters relating to radioactivity.

The following equipment is located at the Applied Science Laboratory at the 800 N. Lindbergh address and is available for special work on determining radioactivity levels in selected samples and in calibrating the survey instruments:

1 - Nuclear Measurement Corp. Flow proportional counter with a two-inch 2 π Mylar covered window

2 - Packard Model 3365 Liquid Scintillation Spectrometer

2 - Gamma Spectrometer (Single channel)

1 - Eberline PRM 4-3 equipped with Hewlett-Packard Model 210, 2" window GM tube detector

1 - Victoreen 440 Ion changer for Dosimetry

Additional corporate staff functions residing at the Lindbergh location have overall responsibility for insuring compliance with governmental and insurance carrier regulations for all of Monsanto Company. These functions include:

The Medicine and Environmental Health Department, responsible for industrial hygiene and the environmental impact of all Monsanto products;

The Safety and Property Protection Section of the Central Engineering Department, responsible for certifying the adherence of all new operations to Monsanto Safety standards; and

The Environmental Control Department of the Central Engineering Department, responsible for the design and operating efficiency of environmental control devices in operating plants.

These facilities and staff functions will be used to insure that monitoring and control procedures are adequate to meet regulatory requirements and protect the safety of Monsanto employees.

13. REFERENCES

1. Schweinler, H.C., J. Appl. Physics 30 No. 8, 1125 (1959)

2. Tanenbaum, M. and Mills, A.D., J. Electrochem Soc. 108, 171 (1961).

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4. Haas, W. E. and Schnöller, M.S. "Nuclear Transmutation Doping of Silicon", paper given at AIME conference on Preparation and Properties of Electronic Materials, Princeton University, August 25-27 (1975)

5. Electronic News, September 1, 1975, pages 1 and 24.

6. Kharchenko, V. A. and Solovev, S.P. Iz. Abad. Nauk., SSSR 7, No. 12 2137-2141 (1971) Translated by L. Ya. Karpov, Scientific-Research Physicochemical Institute, (Available from Consultants Bureau, 227 W. 17th St., New York, N.Y. 1011)

7. Kharachenko, V.A., Spirnor, B.V., Solovev, S.P. Fetisova, G.A., Voronov, I.N., and Bane, V.E., Ibid. 7 No. 12 2142-45 (1971)

8. Herrman, H.A. and Herzer, H., J. Electrochem. Soc. 122 No. 11, 1568-9 (1975)

9. Kern, W. and Puotinen, D.A., RCA Review June, 1970, pp 137-264.

10. Nozaki, T. Kawashima, T. Baha, H and Araki, H., Bull. Chem. Soc. Japan 33, 1428-30 (1960).

11. Schnöller, M. IEEE Transactions on Electronic Devices 21, 313 (1974).

12. Rosenblum, C., Benzing, W.C., Denkewalter, R.G.; West German Patent 1, 214, 789. April 21, 1966.

13. Lark-Horovitz, K., and Siegel, S. U.S. Patent Applications Serial No. 64,034, filed December 7, 1948, published June 10, 1952

14. PERSONNEL AND TRAINING

A. Individuals who are presently expected to be involved in the manufacturing operations involving irradiated silicon and/or the radiation protection program are listed along with their educational backgrounds and pertinent experience. In addition, all of these individuals have received the training described in (B) below.

Rich P. Virtue, Process Engineer, B.S.M.E. 1968, University of Missouri at Rolla, Rolla, Missouri will have initial responsibility for manufacturing operations.

Forrest V. Williams, Quality Assurance Manager, B.S. (Chemistry) 1946, Berea College; M.S. (Chemistry) University of Kentucky, 1949. Ph. D. (Physical Chemistry) Northwestern University, 1953. Formal courses included section on radioactivity in undergradual physical chemistry and a course in Atomic Physics at the University of Kentucky.

Richard Massey, Research Technician, a high school graduate, has spent approximately six weeks measuring radioactivity associated with irradiated silicon at the Technology Planning and Evaluation Department, Applied Sciences, Laboratory at 800 N. Lindbergh, St. Louis, Mo. under the direction of Mr. Donald B. Hines, radiation officer at that facility.

Bobbie D. Stone, Engineering Fellow, B.S. (Chemistry) Southern Illinois University, 1949; Ph. D. (Inorganic Chemistry) Northwestern University, 1952. USAEC Pre-Doctoral Fellow 1950-52. Formal courses included two quarters of Atomic and Nuclear Physics at Northwestern University. In addition, Dr. Stone was employed from August 1952 to November 1953 at Mound Laboratory, Miamisburg, Ohio operated by Monsanto Co. for the US Atomic Energy Commission. His experience there included about 4 months' work with milligram quantities of Actinium - 227.

Elmer W. Schramm, Safety Supervisor, B.S. (Marketing) St. Louis University, 1955. He is responsible for the compliance of all operations at the St. Peters site with all Monsanto and governmental safety regulations, including those prescribed by OSHA.

B. SPECIFIC TRAINING OF PERSONNEL

All individuals listed in (A) above have completed a 3-day radiation training seminar conducted at Monsanto Research Corporation Engineered Products Section (MRC-EP) facility at 1515 Nicholas Road, Dayton, Ohio. This section is engaged in the manufacture of neutron sources. The seminar was directed by Mr. Steve Hoadley, Health Physicist at MRC-EP. The subject matter of the seminar is outlined below.

C. RADIATION SAFETY TRAINING SEMINAR

I. INTRODUCTION - outline of activities of radiation safety seminar
- introduction to MRC personnel
- tour of MRC plant

II. HEALTH PHYSICS

A. Basic Radioactivity - n, γ, β, α

B. Units of Measurements

1. General Definitions - RAD, Rem, mRem, etc.
2. Application of above to trace quantities of isotopes

C. Personnel Safety

1. Biological effects of radiation
2. Radiation Damage limits
3. Regulatory requirements & why

D. Source Handling & Storage

1. General Information - Time - Distance - Shielding
2. Storage - locked containers - secured areas, etc.

E. Shipping

1. Brief summary of shipping requirements, transport index, etc.
2. Specific regulations and practice pertaining to trace quantities of reactor induced isotopes

F. Measurement of Radioactivity

1. Types of Devices
2. Dose Detection Devices
    - a) Dosimeters
    - b) Film Badges
    - c) Correlate use of devices to personnel safety

G. Decontamination Techniques

1. Solvents/Detergents
2. Cleaning Techniques
3. Handling of Wastes

H. State & National Regulations

1. Agreement States
2. NRC
3. Where to locate Regulations & Information available in Regulations.

III. REACTOR INDUCED RADIOISOTOPES

A. Theory - general

1. Neutron irradiation
2. By-Products

B. Application in Silicon Industry

IV. FORMAL TOUR OF MRC-EP FACILITIES

A. Demonstration of Source Handling & Safety Devices

B. Radiation Safety Laboratory

15. SPECIFIC FACILITIES FOR IRRADIATED SILICON

A specific room will be set aside at the St. Peters plant for receiving all packages of irradiated silicon returning from the reactor facility. All packages will be opened in this room and the packages and contents checked for radioactivity. An individual trained in the measurement of radioactivity will be responsible for this operation as well as scheduling the material for subsequent shaping operations. After such operations, the inventory of finished products of the irradiated material will be stored either in this room or another one set aside for this purpose and under the control of the same individual.

It is not anticipated that special shielding precautions or handling devices will be necessary since only exempt concentrations and quantities of radioactivity will be involved.

16. RADIATION PROTECTION PROGRAM

Specific activities that will be performed routinely to protect personnel from exposure to dangerous radiation levels are:

1. Monitoring of all incoming and outgoing shipments of irradiated material with appropriate detection equipment.
2. Radiation badge monitoring of the exposure of individuals involved in the activities in (1).
3. Routine monitoring of the atmosphere surrounding grinding, slicing and lapping equipment by standard air sampling techniques and subsequent counting of the filter elements from the air samples.
4. Routine sampling of the water effluent from the plant processing stream by standard techniques.

17. WASTE DISPOSAL

The St. Peters Plant uses the best practical control technology currently available to prevent the release of pollutants into the environment. The treatment results in a liquid stream containing no more than 15 parts per million non-volatile solids and solid sludge that is trucked to a landfill where it is buried promptly. Analysis of the solid sludge shows it to be no more than 2% silicon, and hence any solids resulting from sawing, lapping or grinding operations are diluted at least 50 fold by other solid wastes. Both the liquid and solid waste streams will be monitored routinely for radioactivity, but no significant level is expected due to the extremely low initial level and dilution in the waste disposal process.

FORM AEC-785 (6-74)

U.S. ATOMIC ENERGY COMMISSION

MATERIALS DAT INPUT INDUSTRIAL

5 - INDUSTRIAL BYPRODUCT
REFERENCE COPY

A. TYPE OF ACTION AND IDENTIFICATION CODES

1

- [x] NEW LICENSE
- [ ] AMENDMENT TO RENEW LICENSE
- [ ] AMENDMENT TO TERMINATE
- [ ] VOID
- [ ] NEW LICENSE AND NEW LICENSEE
- [ ] OTHER AMENDMENT
- [ ] CLERICAL CHANGE NO AMENDMENT

DOCKET NUMBER	MAIL CONTROL NUMBER	CHANGE NAME ADDRESS
030-12015	71279	

B. INDICATIVE INFORMATION:

INDIVIDUAL LICENSEES

NAME (LAST, FIRST, MIDDLE)	NAME (LAST, FIRST, MIDDLE)
NAME (LAST, FIRST, MIDDLE)	NAME (LAST, FIRST, MIDDLE)
NAME (LAST, FIRST, MIDDLE)	NAME (LAST, FIRST, MIDDLE)

ORGANIZATIONAL LICENSEES

2 ORGANIZATION NAME (ALPHABETIC SEQUENCE): Monsanto ~~Company~~ Commercial Products Company

DEPARTMENT OR BUREAU: ~~Monsanto Commercial Products Company~~

3 ADDRESS

BUILDING, STREET	CITY	STATE	ZIP CODE
800 North Lindbergh Boulevard	St. Louis	MO	63166

4

TYPE OF APPLICANT	DATE REQUEST RECEIVED	INSTITUTION CODE	PENDING PROG. CODE	ACTUAL PROG. CODE
1 [ ] U.S. GOVERNMENT AGENCY [ ] INDIVIDUAL LICENSEE [x] ORGANIZATIONAL LICENSEE	04/19/76	16931	03217	

SECONDARY PROGRAM CODES AS REQUIRED:

#1	#2	#3	#4	#5

LICENSE NUMBER	DATE LICENSE ISSUED OR ACTION COMPLETED	EXPIRATION DATE
24-16931-02E		

BYPRODUCT	CHEMICAL OR PHYSICAL FORM	POSSESSION LIMIT
	See draft	

A/112

MAIL TO:	DATE MAILED	REVIEWER	DATE COMPLETED

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MATERIALS LICENSE

MONSANTO COMMERCIAL PRODUCTS COMPANY

License No. 24-16931-02E

Pursuant to the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974 (Public Law 93-438) 10 CFR Part 30, "Rules of General Applicability to Licensing of Byproduct Material"; Section 32.11, 10 CFR Part 32, "Specific Licenses to Manufacture, Distribute, or Import Certain Items Containing Byproduct Material"; application dated February 23, 1976 and enclosures thereto from the licensee; a license is hereby issued to Monsanto Commercial Products Company, 800 North Lindbergh Boulevard, St. Louis, Missouri 63166, to distribute licensed material with atomic numbers from 3 through 83 to persons exempt from requirement for license pursuant to Section 30.14, 10 CFR Part 30.

This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and other applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect.

This license shall expire on April 30, 1981.

FOR THE NUCLEAR REGULATORY COMMISSION

ORIGINAL SIGNED BY
MELVIN W. SHUPE

Radioisotopes Licensing Branch
Division of Fuel Cycle and
Material Safety

Date APR 2 9 1976

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9402110290 3PP

9 Continue

FORM [illegible] (6-74) U.S. ATOMIC ENERGY COMMISSION

1 MATERIALS DATA INPUT INDUSTRIAL — 1 - FILE COPY

A. TYPE OF ACTION AND IDENTIFICATION CODES

1
- [x] NEW LICENSE
- [ ] AMENDMENT TO RENEW LICENSE
- [ ] AMENDMENT TO TERMINATE
- [ ] VOID
- [ ] NEW LICENSE AND NEW LICENSEE
- [ ] OTHER AMENDMENT
- [ ] CLERICAL CHANGE NO AMENDMENT

DOCKET NUMBER	MAIL CONTROL NUMBER	CHANGE NAME ADDRESS
030-12015	71279	

B. INDICATIVE INFORMATION

INDIVIDUAL LICENSEES

NAME (LAST, FIRST, MIDDLE)	NAME (LAST, FIRST, MIDDLE)
NAME (LAST, FIRST, MIDDLE)	NAME (LAST, FIRST, MIDDLE)
NAME (LAST, FIRST, MIDDLE)	NAME (LAST, FIRST, MIDDLE)

ORGANIZATION NAME (ALPHABETIC SEQUENCE)

2 Monsanto ~~Company~~ Commercial Products Company

DEPARTMENT OR BUREAU

~~Monsanto Commercial Products Company~~

	BUILDING, STREET	CITY	STATE	ZIP CODE
3 ADDRESS	800 North Lindbergh Boulevard	St. Louis	MO	63166

4	TYPE OF APPLICANT	DATE REQUEST RECEIVED	INSTITUTION CODE	PENDING PROG. CODE	ACTUAL PROG. CODE
	1 [ ] U.S. GOVERNMENT AGENCY [ ] INDIVIDUAL LICENSEE [x] ORGANIZATIONAL LICENSEE	04/19/76	16931	03217	

SECONDARY PROGRAM CODES AS REQUIRED:

#1	#2	#3	#4	#5

LICENSE NUMBER	DATE LICENSE ISSUED OR ACTION COMPLETED	EXPIRATION DATE
24-16931-02E	04 29 76	04/30/81

C. STATISTICAL INFORMATION

MEDICAL CATEGORY:

- [ ] FOR HUMAN USE ONLY
- [ ] FOR HUMAN AND NONHUMAN USE
- [ ] FOR NONHUMAN USE ONLY

POSSESSION OF THE MATERIAL IS AUTHORIZED IN ONE OF THE FOLLOWING AREAS:

- [ ] SAME AS "STATE" ADDRESS
- [ ] ALL STATES
- [ ] ALL NON-AGREEMENT STATES

AND/OR IN THE STATE(S), TERRITORY(S), COUNTRY CHECKED BELOW:

ALABAMA -AL	GEORGIA -GA	MARYLAND -MD	NEW JERSEY -NJ	SOUTH CAROLINA -SC	WYOMING -WY
ALASKA -AK	HAWAII -HI	MASSACHUSETTS -MA	NEW MEXICO -NM	SOUTH DAKOTA -SD	
ARIZONA -AZ	IDAHO -ID	MICHIGAN -MI	NEW YORK -NY	TENNESSEE -TN	AMERICAN SAMOA -AS
ARKANSAS -AR	ILLINOIS -IL	MINNESOTA -MN	NORTH CAROLINA -NC	TEXAS -TX	CANAL ZONE -CZ
CALIFORNIA -CA	INDIANA -IN	MISSISSIPPI -MS	NORTH DAKOTA -ND	UTAH -UT	GUAM -GU
COLORADO -CO	IOWA -IA	MISSOURI -MO	OHIO -OH	VERMONT -VT	PUERTO RICO -PR
CONNECTICUT -CT	KANSAS -KS	MONTANA -MT	OKLAHOMA -OK	VIRGINIA -VA	VIRGIN ISLANDS -VI
DELAWARE -DE	KENTUCKY -KY	NEBRASKA -NB	OREGON -OR	WASHINGTON -WA	
WASHINGTON,DC -DC	LOUISIANA -LA	NEVADA -NV	PENNSYLVANIA -PA	WEST VIRGINIA -WV	CANADA -CN
FLORIDA -FL	MAINE -ME	NEW HAMPSHIRE -NH	RHODE ISLAND -RI	WISCONSIN -WI	

D. POSSESSION LIMITS OF SOURCE AND SPECIAL NUCLEAR MATERIALS AND TRITIUM

SOURCE MATERIAL CEILING [ ] GRAMS [ ] KILOGRAMS — SNM CEILING [ ] GRAMS [ ] KILOGRAMS — [ ] "X" HERE IF FOR POWER REACTOR

	AMOUNT	UNIT	CONFIG.	ENRICH.	MAT.	AMOUNT	UNIT	CONFIG.	ENRICH.
U5		G / kg	S / UNS				G / kg	S / UNS	
U3		G / kg	S / UNS				G / kg	S / UNS	
PU		G / kg	S / UNS				G / kg	S / UNS	
UR		G / kg	S / UNS				G / kg	S / UNS	
TH		G / kg	S / UNS				G / kg	S / UNS	
		G / kg	S / UNS				G / kg	S / UNS	
		G / kg	S / UNS				G / kg	S / UNS	
H3		[ ] CURIES [ ] MICROCURIES [ ] MILLICURIES			RIS CODES				

U5=U235, U3=U233, PU=PLUTONIUM, UR=URANIUM, TH=THORIUM, H3=TRITIUM, G=GRAMS, KG=KILOGRAMS, S=SEALED, UNS=UNSEALED

3/31/80

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

BYPRODUCT MATERIAL LICENSE

Monsanto Commercial Products Company

License No. ______________E

Pursuant to the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974 (Public Law 93-438) 10 CFR Part 30, "Rules of General Applicability to Licensing of Byproduct Material"; Section 32.11, 10 CFR Part 32, "Specific Licenses to Manufacture, Distribute, or Import Certain Items Containing Byproduct Material"; application dated February 23 1976 ~~letters dated~~ ____________, and enclosures thereto from the licensee; a license is hereby issued to Monsanto Commercial Products Company 800 North Lindbergh Boulevard, St Louis, Missouri 63166 to distribute byproduct material with atomic numbers from 3 through 83 to persons exempt from requirement for license pursuant to Section 30.14 10 CFR Part 30.

This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and other applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect.

This license shall expire on April 30, 1981

FOR THE NUCLEAR REGULATORY COMMISSION

____
Radioisotopes Licensing Branch
Division of Fuel Cycle and
Material Safety

A/114

Date ______________