

~~CONFIDENTIAL~~
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OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED
EXCEPT WHERE SHOWN
OTHERWISE

UNITED STATES GOVERNMENT

Memorandum

Class. & Ext. By *SP-1 GSK/IRBG*
Reason - FCIM II, 1-2.4.2
Date of Review *2/7/82*

~~SECRET~~
DATE: *1/20/79* *5/13/82*

8-25-98
431525

DIRECTOR, FBI (117-2564)

TO
FROM
SUBJECT

SAC, PITTSBURGH (97-123) (P)

DR. ZALMAN MORDECAI SHAPIRO
(U) IS - ISRAEL; (S)
ATOMIC ENERGY ACT

Classified by *5628 SLD/KR*
Declassify on: *OADR*
EXEMPTION FROM AUTOMATIC
DECLASSIFICATION
AUTHORITY DERIVED FROM:
FBI AUTOMATIC DECLASSIFICATION GUIDE
EXEMPTION CODE: *25X(1)*
DATE *COMP 2008*

ReBullets to Pittsburgh dated 11/13/68 and 12/10/68;
New York airtel to Bureau dated 11/29/68; San Francisco letter
to Bureau dated 11/26/68; and Pittsburgh letters to Bureau
dated 10/22/68 and 11/29/68.

Enclosed for the Bureau are five copies and the
other listed offices two copies of LHM dated and captioned
as above.

Enclosed LHM is being classified "Secret" since an
unauthorized disclosure of a FBI investigation of the subject
could be detrimental to the national security interests of
this Government. *(S)(u)*

It should be noted that [redacted]
[redacted] at NUMEC, Apollo, Pa., moved to [redacted]
[redacted] on or about [redacted]. The information, document, and
copy of NUMEC publication, referred to in enclosed LHM, were
received by SA [redacted] through the mail from [redacted]
on 11/25/68.

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Concerning the NUMEC publication mentioned above,
the issue furnished by [redacted] contained no information per-
taining to this investigation. ~~Further~~ copies of this
publication are being sought through [redacted] a reliable
source who has previously furnished information in this matter.

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On 1/4/69, [redacted] reported that on that date
a [redacted] attempted to contact subject. [redacted] when
informed subject was not at home, advised that he would
attempt to contact him at a later date. To date, this
individual is not known to have contacted subject at his
residence. However, in all probability, [redacted] has been in
contact with subject at NUMEC, Apollo, Pa. *(S)(u)*

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- 3 - Bureau (Enc. 5) (RM) (C)
- 2 - New York (105-75538) (Enc. [redacted])
- 2 - Washington Field (97- [redacted])
- 2 - Pittsburgh (97- [redacted])

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Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

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PG 97-123

It is noted that [redacted]

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(U) Cambridge, Mass., reportedly attended the meeting held at subject's residence on 11/3/68. ~~(S)(C)~~

(U) With reference to the business propositions discussed with subject during his recent visit to Israel, referred to in enclosed LHM, it is recalled that subject has previously discussed business ventures of this type. ~~(S)(C)~~

(U) On 10/26/68, subject expressed interest in a chemical facility which is being built in Israel by the Allied Chemical Company. ~~(S)(C)~~

(U) It appears that if subject can raise a million dollars or so within the next few years, he would not hesitate to move to Israel and establish some business in that country. ~~(S)(C)~~

The information attributed to [redacted] was furnished to SA [redacted]

by IC [redacted] Credit records at Pittsburgh, Pa., were checked

Source

Location

First source and third source are

(U) [redacted] ~~(S)~~

Second source

[redacted] ~~(S)~~

PG 97-123-229, 147

Fourth source is

[redacted] ~~(S)~~

PG 97-123-1A-42

(By request)

LEAD

PITTSBURGH

AT PITTSBURGH, PA. (ALLEGHENY COUNTY)

Will continue to report activities of subject.

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UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF INVESTIGATION

EXEMPTED FROM AUTOMATIC
DECLASSIFICATION
AUTHORITY DERIVED FROM:
FBI AUTOMATIC DECLASSIFICATION GUIDE
EXEMPTION CODE 25X(1,6)
DATE 12-22-2008

In Reply, Please Refer to
File No.

Pittsburgh, Pennsylvania
January 20, 1969

Class. & Ext. By SP-1 GSK/RBG
Reason - FCIM II 1-2.4.2
Date of Review 5/13/82
217,822

ALL INFORMATION CONTAINED
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EXCEPT WHERE SHOWN
OTHERWISE

DR. ZALMAN MORDECAI SHAPIRO

~~431-525
CLASSIFIED BY 8204 JMB/CLG
DECLASSIFY ON: 25X 1
8-25-98~~

(U) Investigation was instituted at the request of the Attorney General to establish the nature and extent of Zalman Mordecai Shapiro's relationship with the Government of Israel. This could be connected with, or in addition to, or as a result of, his association with Israeli officials and sympathizers in the United States. [initials]

(U) On October 10, 1968, a source, who has furnished reliable information in the past, advised that subject mentioned that he was in contact with [redacted] (phonetic) on that date. During the course of this contact, according to source, subject revealed that while in Washington, D. C., September 30, 1968, he spoke with Hermoni and Begun and that although there were problems, both were anxious to move ahead. Subject explained, according to source, that they must first determine if the materials are available for exportation; and in this connection, he sent a letter a few days ago to the Commission (Atomic Energy Commission) (AEC) requesting general information as to the availability of the materials for domestic as well as foreign applications. Source went on to say that he also inquired as to what the cost would be and if the metal was available as well as the oxide and things of that sort. Subject reportedly stated that he further indicated in the letter that the Commission urgently give consideration of the matter in view of the fact that it not only affects the possibility of customers, but also affects their desire to do development work on their own. [initials]

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This document contains neither recommendations nor conclusions of the FBI. It is the property of the FBI and is loaned to your agency; it and its contents are not to be distributed outside your agency.

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GROUP 1
Excluded from automatic
downgrading and
declassification

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CLASS. BY
DATE
Camp # 204, 451

~~56685418
7-7-82
8-27-82
SP-4 JMB/CLG
11/20/89 2,3
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DR. ZALMAN MORDECAI SHAPIRO

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~~(S)~~ a second source.

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~~(S)~~ second source advised

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During November, 1968, the Security Office, AEC, Washington, D. C., made available a copy of a letter dated October 8, 1968, from subject to Dr. Glenn T. Seaborg, Chairman, United States Atomic Energy Commission, Washington, D. C., which reads as follows:

"Dear Dr. Seaborg:

"NUMEC (Nuclear Materials and Equipment Corporation) has been receiving a number of requests from potential domestic and foreign customers to furnish them with microwatt and milliwatt thermoelectric generators powered by Pu-238. The number of these inquiries has increased since the official A.E.C. announcement indicating the availability of Pu-238 for commercial applications.

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DR. ZALMAN MORDECAI SHAPIRO

"However, despite this announcement, we have found it impossible to make any firm proposals for the supply of these units because we have not been able to get definitive answers to questions put to the A.E.C. regarding availability of the material in metallic form, purity, encapsulation cost, schedule and possible restrictions on use for domestic and foreign applications. More specifically, we must know:

- "1. Whether the material will be equally available for foreign applications as well as domestic applications. If this is not the case, what the specific restrictions are on foreign sales.
- "2. Whether there are any restrictions on the amount of Pu-238 in any particular device, assuming it can be licensed.
- "3. Whether any special criteria are to be employed in the design of the capsule and the device in which the capsule is located from the standpoint of licensing for domestic or foreign use.
- "4. What the minimum purity of the oxide will be.
- "5. Whether the material will be made available as metal as well as oxide since the oxide is unfit for many applications. Also, what will the minimum purity specifications and price on the metal be if it is supplied.
- "6. What maximum tolerance can be expected on the specified thermal and radiation output.

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DR. ZALMAN MORDECAI SHAPIRO

- "7. Whether the A.E.C. will encapsulate the material and, if so, what the cost will be.
- "8. Whether the customer will be expected to supply the capsule parts or whether the A.E.C. will want to supply them.
- "9. What the basis will be for establishment of delivery schedules and whether these can be considered firm for quotation to potential customers.

"We urgently request that these matters be resolved as quickly as possible so that we can make definitive replies to our potential customers as well as determine whether we should continue our own private development of devices for commercial sale. It would be especially helpful if we could obtain immediate resolution of Items 1, 5, 7, and 9."

During December, 1968, the Security Office, AEC, Washington, D. C., made available a copy of a letter dated November 20, 1968, from Glenn T. Seaborg, Chairman, United States Atomic Energy Commission, Washington, D. C., to subject, which reads as follows:

"Dear Zal:

"This is in response to your letter of October 8, 1968, containing various questions pertaining to plutonium 238 for commercial applications. I am heartened by the increasing interest in the use of plutonium 238 as mentioned in your letter, and I want to be of assistance in any way I can in the encouragement of the beneficial use of this isotope and other Commission products. In the interest of clarity and to be sure I have responded to all your questions, I am answering the letter in the same format as you sent it to me.

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DR. ZALMAN MORDECAI SHAPIRO

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"In answer to your first question, the 500 grams of plutonium 238 made available in April 1968 may be used for foreign applications as well as domestic applications. Overseas distribution within the free world is made on a non-discriminatory basis by (1) direct purchase through the U. S. Atomic Energy Commission by means of a formal request from the overseas customer to the Division of International Affairs, U.S. Atomic Energy Commission, Washington, D.C., or (2) by direct purchase from any private source, subject to applicable rules and regulations of the Atomic Energy Commission for the export of special nuclear materials.

"With regard to your second question, and in the context of your request, i.e., plutonium 238 for microwatt and milliwatt thermoelectric generators, there are no restrictions on the amount of plutonium 238 in a single device, assuming it can be licensed. Criticality is the only concern in terms of the amount of plutonium 238 that can be used in any particular device.

"The answer to your third question is that from the standpoint of licensing for domestic or foreign use, there are no special criteria to be employed in the design of the capsule and the device in which the capsule is located.

"Concerning your questions 4., part of 5., and 6., we have enclosed a very recent compilation of plutonium 238 data which has been accumulated by the Mound Laboratory over a number of years. While there is no material specifications, as such, for the commercially available plutonium oxide, these data should be helpful in answering your questions concerning the characteristics of the isotope in oxide, metal and other forms on the basis of average values. The heat source specification which was developed for the cardiac pacemaker and in which you are currently participating, may be considered typical of the metal which the AEC could supply.

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DR. ZALMAN MORDECAI SHAPIRO

"With regard to the remainder of question 5., and questions 7., 8., and 9., conversion from the oxide to other forms, such as the metal, and encapsulation services are available through AEC laboratories at additional cost but only if they are not available from private industry. Members of our staff have had discussions with the following companies which have indicated some capabilities in these areas: Atomics International, Donald W. Douglas Laboratory, General Nuclear Incorporated, Monsanto Research Corporation, and the Vallecitos Atomic Laboratory of the General Electric Company. As stated by Dr. Herman M. Roth, Director, Laboratory University Division, Oak Ridge Operations Office, in his letter dated October 29, 1968, to Mr. C. H. Whitmire of your company, if these or other commercial sources are not responsive to your needs, the work you wish to have done can be requested through the Isotopes Sales Department of the Oak Ridge National Laboratory. The criteria for the AEC performing this work are essentially those which Dr. Roth enumerated. Namely, your request should be accompanied by a list of the commercial firms you have contacted, their reasons and yours for not providing the services, and any other information which would be useful in evaluating your request. The description of the work you wish to have done should include the quantity of isotope fuel, the fuel form, thermal wattage per source, capsule design, encapsulating materials, and total number of heat sources to be fabricated. Only after this information has been received can the costs of your work, which would be based on full cost recovery, be established. At that time, delivery schedules could be established on a non-interfering basis and a determination made as to whether NUMEC or the AEC laboratory would supply capsule parts.

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DR. ZALMAN MORDECAI SHAPIRO

"I hope this information has been helpful to you and that I have answered all your questions concerning the use of plutonium 238 in milliwatt and microwatt thermoelectric generators. I would be happy to have you discuss these matters further with Commission personnel if you so desire. In this regard I suggest that you call [redacted] and [redacted] for programmatic and licensing discussions, respectively, and they will be glad to arrange to meet with you."

On November 22, 1968, [redacted] Lawrence Radiation Laboratory (LRL), Livermore, California, advised that about three years earlier he had partial responsibility for a project in the Special Materials Group of the Laboratory involving a research and development contract with subject's firm, Nuclear Materials and Equipment Corporation, for processing of nuclear material. [redacted] of the Special Materials Group, handled details of the contract; and [redacted] only met the subject briefly when subject was at the Laboratory on business. [redacted] had no knowledge of any connections of the subject with the Israeli government. The subject and his firm had been a source of concern to [redacted] while the contract was in existence. Under the contract, the Laboratory furnished Special Nuclear material to NUMEC for processing. Accountability for such material is strict because of its cost and toxicity poisonous. Past experiences had established average percentages of loss of material during processing of the type done by NUMEC and the loss by the firm seemed excessive to [redacted].

The equipment used by NUMEC was government owned and furnished by the Laboratory. Upon completion of the contract, the firm tried to persuade the Laboratory to leave the equipment where it was on the grounds that it would be cheaper to leave it than to return it to Livermore and decontaminate it. In support of this argument, the firm furnished lists of equipment it claimed had been contaminated. Subsequent inspection by [redacted] showed that some of these items had never been used at all. This led [redacted] to suspect NUMEC of trying to get the equipment free and created further distrust of this firm.

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DR. ZALMAN MORDECAI SHAPIRO

[] did not have details concerning the NUMEC contract since he did not work directly on it. He did not know how the contract was finally terminated because he received a new job assignment at the Laboratory prior to its completion. (S)(u)

On November 29, 1968, [] El Al Israel Airlines, John F. Kennedy (JFK) International Airport, New York City, advised that subject departed JFK aboard El Al Israel Flight #256 at 10:00 p.m. on November 28, 1968, for Tel Aviv, Israel, with scheduled arrival in Tel Aviv at 6:30 p.m., November 29, 1968. (S)(u)

[] advised that subject had return reservations from Tel Aviv, Israel, on December 12, 1968, aboard El Al Israel Flight #255, arriving New York City at 5:40 p.m., December 12, 1968. (S)(u)

(U) [] On December 15, 1968, first source advised that on that date subject briefly discussed his recent visit to Israel with Joseph Swartz, an attorney and a long time personal friend and business associate of subject. According to this source, subject informed Swartz that his trip to Israel was satisfactory but very hectic and that he obtained no rest during his visit. Subject said, according to source, that besides appointments with Israeli people, he attempted to conduct some NUMEC and ISGRAD business at the same time. (S)(u)

(U) Subject indicated to Swartz, according to this source, that he is seriously considering the possibility of settling in Israel within the next four or five years. Subject said he has not definitely decided on the type of work he will pursue when he moves to Israel, but that during his recent visit he was offered a professorship, which subject indicated was not what he desired at this time. Subject advised, according to source, that the Israeli government is presently very interested in converting their technology in the nuclear field into commercial enterprises. Subject added, according to source, that other interesting business opportunities were discussed during his visit, but to take advantage, he must raise approximately \$1,000,000. (S)(u)

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DR. ZALMAN MORDECAI SHAPIRO

(U) Source said Swartz informed subject that he plans to visit Israel on or about December 22, 1968. Subject remarked, according to source, that if Swartz needed telephone numbers of people in Israel, Swartz should obtain the numbers from his wife, Evelyn Shapiro. ~~(S)~~ ~~(S)~~ ~~(C)~~ X

On December 18, 1968, [redacted] receptionist, Credit Bureau, Inc., 415 Smithfield Street, Pittsburgh, Pa., advised that her records show Joseph Swartz and wife, Reva L. Swartz, reside at 415 Braddock Road, Pittsburgh 21, Pa., and have resided at that address since approximately 1952. The records show Swartz has been a self-employed attorney since 1953, and that his office is located at 1231 Frick Building, Pittsburgh, Pa. Reva Swartz is shown to be employed as an Assistant to the Dean of Nurses School, University of Pittsburgh, Pittsburgh, Pa., and has been employed in this position since approximately 1958. He is shown to have been born January 13, 1911, and that both he and his wife maintain a satisfactory credit standing with that bureau. ~~(S)~~ ~~(S)~~ ~~(C)~~

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By letter dated November 3, 1966, AEC furnished a summary of the foreign activities of NUMEC, which states in part that "NUMEC is a sales agent for the Government of Israel through its Ministry of Defense, Division of Supplies, 830 Third Avenue, New York 22, New York. In this connection, NUMEC has an arrangement with the Israel Atomic Energy Commission to do biological work on insect control and assist in establishing facilities for the irradiation and preservation of citrus fruits. In this latter connection, NUMEC and the Government of Israel (represented by the Israel AEC) have formed a company in Israel called Isotopes and Radiation Enterprises Ltd. (ISORAD) which is an organization to do experimental and commercial work in irradiation processing of foodstuffs and other commodities." ~~(S)~~ ~~(S)~~ ~~(C)~~ X

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DR. ZALMAN MORDECAI SHAPIRO

104
[On that date, subject discussed his recent trip to Israel with Oscar Gray, an attorney from Washington, D. C., and Vice President of NUMEC. According to source, subject informed Gray that although his two-week visit to Israel was hectic, it was also very fruitful in that he gained a better understanding of the current political situation in Israel and in addition, was furnished information concerning several business opportunities of mutual interest to the Israeli government and himself. Subject, according to source, revealed that he was led to believe from discussions held with people in the Israeli government, that they were at that time very disorganized and discouraged; that they continue to remain skeptical about receiving Phantom F-4 fighter planes from the United States; that William Scranton's recent visit to the Middle East was at the direction of President-elect Richard M. Nixon who preconceived Scranton's approach and the fact that Scranton held no authority to make final decisions. Subject continued, according to source, that the Israeli government is now of the opinion that they cannot trust anyone. Israel, continued subject, is currently in the need of help and particularly large sums of money. Subject advised, according to source, that Israel is capable of actually building their own fighter planes as far as airframes and electronics are concerned, but that they lack the knowledge for designing the planes, which necessitates new technologies currently unavailable to them. ~~SECRET~~

(U) Subject further informed Gray, according to source, that individuals in the Israeli government proposed several business ventures which they believed to be mutually profitable to both the Israeli government and himself. Subject said the proposition he is particularly interested in and will attempt to follow through with involved the building of a testing laboratory in Israel of the Pittsburgh Testing Laboratory and the State of Washington Batelle Laboratory type. Subject said, according to source, that the Israeli government is willing to guarantee \$2,500,000 for the construction of this laboratory if subject can raise \$500,000. Although subject did not believe it would be any easy task to accomplish, he indicated that he was going to attempt to raise the money. Subject continued, according to source, ~~SECRET~~

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DR. ZALMAN MORDECAI SHAPIRO

(U) by mentioning that the Israeli government wants to put in an aluminum extrusion plant; this facility could be started with a \$2,000,000 investment and the Israeli government would be willing to make concessions so that an investor could get one half of the extrusion plant for a million dollars. ~~(S) (C)~~

(U) Subject also discussed, according to source, the need for a complete aluminum industry in Israel. This would be a \$30,000,000 plant with the country (Israel) using at least 50 per cent of the plant's production with the remainder for export. The acquisition of raw materials for such a plant would present some problems, but subject believed, according to source, these problems could be overcome. ~~(S) (C)~~

(U) Source advised that subject revealed that Israel is anxious to convert their technologies in nuclear centers to commercial business, but that subject indicated he was not interested in devoting all of his time to this type of work. ~~(S) (C)~~

(U) Subject further revealed that Israel has a technique for drilling holes in diamonds, which is not accomplished by the use of a "laser," and that this technique has numerous commercial possibilities. Source advised that subject did not elaborate further on the above. ~~(S) (C)~~

(U) Source advised that subject reiterated that of all of the propositions discussed during his visit to Israel, the building of a laboratory sounded most appealing to him and added that it would take approximately eighteen months to organize the business. Subject said that both the defense and industrial branches of the Israeli government are anxious to have this laboratory in operation although before commencing he would secure contracts from all Israeli government services to insure their use of the laboratory. Subject, according to source, stressed the fact that Israel desperately needs money and anyone with a little money and desire could accomplish plenty in Israel at this time. ~~(S) (C)~~

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DR. ZALMAN MORDECAI SHAPIRO

(U) Subject went on to say, according to source, that concerning ISORAD they are currently attempting to get an irradiator built and have eight or nine bids outstanding. Subject indicated that a Canadian outfit has currently made the best bid to date. According to source, subject added that he brought back to the United States a couple of bids to review and to determine if the basis for their analysis is realistic. (S)(C)

(U) [On December 15, 1968, a third source, who has furnished reliable information in the past, advised that on that date subject contacted [redacted] an employee at NUMEC, and that during the course of the conversation, [redacted] inquired about subject's recent visit to Israel. According to source, subject revealed that his two-week vacation in Israel afforded him an opportunity to catch up on some overdue rest. Subject explained to [redacted] that he had no close calls while in Israel with Arab guerrillas with whom the people of Israel must contend with on a daily basis. According to third source, subject went on to explain that [redacted]

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On December 17, 1968, [redacted] supra, advised that her records disclose that [redacted] have resided at [redacted] Pittsburgh, Pa., since 1959. The records show that he was born in [redacted] and has been employed since [redacted] as [redacted]. The records show that he has maintained a satisfactory credit standing with that bureau. (S)(C)u

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DR. ZALMAN MORDECAI SHAPIRO

(U)

[On December 21, 1968,] third source advised that on that date subject's wife, [redacted] requested Reva Swartz, wife of Joseph Swartz, previously mentioned, to carry a package on her forthcoming visit to Israel and to deliver same to a person by the name of [redacted] whom she explained was connected with the Israel atomic energy.

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[redacted] advised Reva, according to source, that she would write this individual's name and telephone number on the package. Third source advised that [redacted] described [redacted] to Reva as being a very nice and dedicated person.

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[On December 24, 1968,] first source advised that subject and his family planned to spend the Christmas vacation in San Juan, Puerto Rico. Source advised that subject will depart Pittsburgh, Pa., via Eastern Airlines (EAL), Flight 303, at 9:05 a.m., December 25, 1968, for Miami, Florida, and will leave Miami via EAL Flight 590, arriving San Juan, 4:05 p.m., same date. Source revealed that subject will stay at the Condado Beach Hotel, San Juan, until December 31, 1968, when he and his family plan to return to Pittsburgh, Pa., via EAL Flight 950, departing San Juan 9:05 a.m., December 31, 1968.

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[On January 8, 1969,] third source advised that on

[redacted]

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[On November 25, 1968, a fourth source, who has furnished reliable information in the past,] revealed that during September, 1968, NUMEC commenced publishing a four-page newspaper temporarily called "NUMEC News." NUMEC is currently running a contest among their employees to obtain a more suitable name.

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DR. ZALMAN MORDECAI SHAPIRO

Concerning this publication, source advised that subject recently informed employees at NUMEC that because of the growth of NUMEC there exists a need to establish an effective way for getting information to employees at NUMEC concerning their plans, problems, and activities, and that the publication of this newspaper is intended to serve that purpose.

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(u) ~~(S)~~ ~~(X)~~ [It is recalled that on October 30, 1968, fourth source advised] that

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[redacted] he learned that NUMEC had sustained unaccountable losses of nuclear material, and since, that this material might possibly have been diverted by subject to Israel. [Fourth source revealed] that about the same period of time that NUMEC sustained the unaccountable losses of U-235, subject was involved in the development and manufacture of food irradiators for Israel. Source advised that at least one large irradiator was manufactured, and a number of smaller units called "Howitzers" were manufactured and sent to Israel. Source was of the opinion that had U-235 or any other nuclear material been available for shipment to Israel, it would have been a simple matter of placing large quantities of the material in these food irradiator units and shipping to Israel with no questions asked.

(u)
~~(S)~~ ~~(X)~~

(u) ~~(S)~~ ~~(X)~~ [On November 25, 1968, fourth source] made available a copy of attached four-page document entitled, "NUMEC" and bearing the subtitle, "Neutron-Pac: irradiator-Howitzer NAC-64," which describes the irradiator-Howitzer of the type manufactured and sent to Israel by subject, according to source.

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NUMEC

Nuclear Materials and Equipment Corporation, internationally recognized as a leading manufacturer of nuclear materials, equipment and radioisotopes, offers another new commercial product—the NUMEC Neutron-Pac®. Through its inherent versatility, this unique neutron irradiator-howitzer enables a diversity of experiments in the areas of chemistry, physics, biology and metallurgy.

Functional capabilities of the Neutron-Pac® include:

- Demonstration and investigation of neutron phenomena
- Irradiation of biological specimens including small animals, plants and seeds
- Generation of appreciable quantities of radioisotopes
- Activation analysis of gaseous, liquid and solid materials

Description

The Neutron-Pac® is a cylindrical tank containing five fixed thermal radiation positions, an irradiation well with removable plugs of solid moderating material and a liquid irradiation tank. Neutron sources or material for bombardment may be inserted in irradiation positions in the plugs, or the plugs may be entirely removed to permit introduction of an animal cage or a twelve liter solution container for irradiation by sources within or below the liquid. From one to three fast or thermal neutron beam ports are also available as optional features.

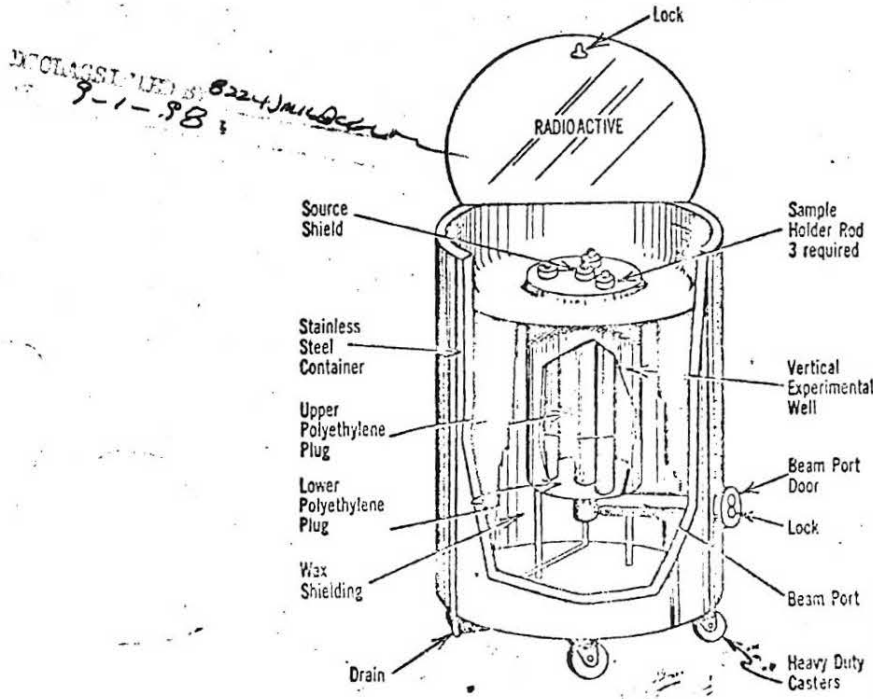
An activation potential (thermal neutron flux) of 7.5 to 8.0×10^4 thermal neutrons per square centimeter per second is produced from three 2 curie NUMEC Pu-Be or Am-Be neutron sources. While neutron interaction can be demonstrated with only a single 1 or 2 curie source, up to 30 curies can be used safely.

The stainless steel irradiator tank is carefully filled with a special paraffin preparation which provides efficient neutron moderation and fast neutron shielding. Irradiation with fast neutrons is accomplished through the use of cadmium or boron liners which filter out the thermal neutrons.

Operational Features

The NUMEC Neutron-Pac® readily provides various types of irradiation facilities; the more important operational features include:

- A single position high-efficiency thermal neutron facility with reproducible geometry
- Simultaneous irradiation in three reproducible geometry thermal neutron positions
- Thermal or fast neutron small animal irradiation facility
- Production of up to millicurie quantities of radioisotopes
- Infinitely variable geometry for thermal neutrons in a liquid filled facility
- Fast and thermal neutron beams for irradiation and attenuation experiments



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Description

The design of the NUMEC Neutron-Pac® offers unique operating versatility. A brief description of the various operational arrangements is presented below.

1. Central Source Position with Annular Experiments

Arrangement 1 shows upper and lower polyethylene plugs in the vertical experimental well and a source or sources in the central irradiation position. Sample containers are in the three annular irradiation positions which are located 120° apart in the region of maximum thermal flux. This arrangement enables three different or similar experiments to be conducted simultaneously.

2. Annular Source Position with Central Experiment

Thermal neutron flux rises to a maximum and then decreases as a function of distance from a fast neutron source due to the combined effects of geometry and moderation. The Neutron-Pac® takes advantage of this phenomenon achieving higher flux when three sources are placed in the annular positions and a single experiment is performed in the central irradiation position as shown in Arrangement 2.

3. Beam Experiments in Vertical Position

Any of the three vertical irradiation positions may be used as a vertical beam port for absorptimetry experiments and analysis or for neutron radiography as shown in Arrangement 3. A fast neutron beam can be obtained by lining any irradiation position with a cadmium sleeve.

4. Small Animal Irradiators

For radiation exposure of small animals, a cage may be placed on the lower polyethylene plug.

The upper plug provides shielding while the source handling rod holes provide ventilation, as shown in Arrangement 4.

5. Experiment Tank

a. Liquid with Dry Source

By replacing the upper polyethylene plug with the liquid irradiation tank as shown in Arrangement 5, the entire 8" diameter by 14" high cylindrical volume is available for either fast or slow neutron experimentation depending on whether an unlined or cadmium-lined tank is used. For these experiments, the sources are placed at the top of the lower polyethylene plug. The irradiation in this tank may be performed in air or under any liquid, in a system with infinite incremental geometric variables, or the tank may be used to produce radioisotopes in large volumes of solutions.

b. Liquid with Wet Sources

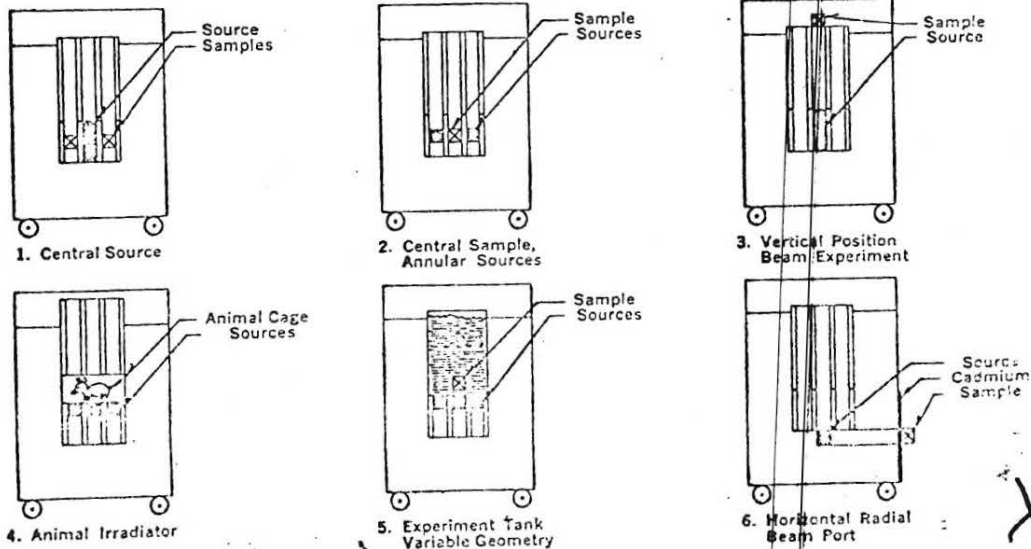
Simple fixtures can be used to suspend multiple NUMEC neutron sources in the liquid experiment tank, thereby allowing maximum interaction of the emitted neutrons with the tank contents. The liquid experiment tank may also be filled with water into which experiment capsules are immersed, thereby providing a completely flexible facility with unlimited sources and samples arrangement possibilities.

6. Horizontal Radial Beam Port

Where horizontal rather than vertical beam irradiation is desirable, up to three optional horizontal radial beam ports are available to provide either slow or fast neutron beams, which can be used for absorptimetry or for radiographic purposes as shown in Arrangement 6.

If a fast neutron beam is desired, a cadmium radial beam shield is inserted in the beam port to absorb most of the thermal neutrons in the beam.

Typical Operating and Experimental Tank Arrangements



Specifications

Container: The basic structure of the Neutron-Pac® is a 22" diameter by 35" high stainless steel container with a coved experiment tray, a vertical experimental well, a hinged cover with lock and key and optional beam ports with lock and key. The container is mounted on ball bearing casters for easy mobility. Design considerations enable sources and port shields to be secured so that the Neutron-Pac® can be safely left unattended during irradiation periods.

Shielding: A special microcrystalline wax, having a melting point of 157°F and a flash point of 550°F, is carefully cast between the vertical experiment well and the outer container to provide an integral uniform shield for the operator. With the source in the central position, a surface dose rate of less than 1 mrem. per hour per curie of Pu-Be and Am-Be source occurs.

Vertical Irradiation Well: An 8" diameter by 21" high vertical irradiation well holds the 5" lower and 16" upper polyethylene irradiation plugs which provide four fixed irradiation positions of 1 3/8" diameter.

Placing a 12.5 liter stainless steel irradiation tank in the vertical irradiation well provides containment for solutions to be irradiated or allows infinitely variable geometry. An optional cadmium-lined liquid irradiation tank is available when fast neutron interaction is desired.

When the animal cage is placed on the lower polyethylene irradiation plug, the upper plug provides shielding for the operator and ventilation for animals. A stainless steel drain and valve are provided in the bottom of the well to facilitate cleaning or draining.

Sample Shield and Removal Tool: Each of three 17 1/2" long sample shield and removal tools locks onto one of the three sample containers by means of a "J" slot. These containers are then usable to position foils, liquid irradiation bottles or materials for irradiation in any of the four fixed vertical irradiation positions. These tools shield the source when the annular array is used.

Source Lifting Tool: A 30" source lifting tool with a permanent magnet is provided for convenient and safe moving of sources and magnetic polyethylene plugs. The dose 30" from an Am-Be or Pu-Be neutron source is 3.5 mr/hr/ curie; thus an exposure of 30 curie-hours per week at 30" may be tolerated before reaching the U. S. A.E.C. maximum permissible dose of 100 mr/week.

Foils: A set of activation foils is provided which consists of 10 indium foils, 20 cadmium foils, one 10k gold foil and one 18k gold foil. Calibrated foils are also available.

Beam Port: Up to four aluminum-clad beam ports can be provided. Each beam port has a 2" diameter by 11" long semi-cylindrical sample holder (with lock and key) which can be used with moderator spacers and foils to obtain flux profiles.

Source Magnetic Caps: Three source magnetic caps of 430 stainless steel are attached to the standard NUMEC Pu-Be neutron source or the Type A NUMEC Am-Be neutron source.

Spacers: Five magnetic and twelve 3/8" diameter plexiglass spacers are included. Others are available as an extra.

Experimental Applications

The operational features of the Neutron-Pac® enable numerous experiments to be performed; typical experiments are described in step-by-step procedural fashion in the Neutron-Pac® Experiment Manual. A partial listing of experiment categories follows:

General

Radiation Survey
Absolute Foil Counting

Physics

Half-life and Saturated Activity
Total Cross-Section 1/v Absorbers
Most Probable Neutron Energy
Temperature Coefficient of Nuclear Cross-section
Fission Product Activity
Neutron Reactor Control
1) Poison
2) Reflection
Neutron Radiography

Chemistry

Activation Analysis, Quantitative and Qualitative
Isotopic Analysis by Absorptimetry
Production of Short Lived Isotopes
(I¹³¹, Mn⁵⁴, P³², Ag¹⁰⁸, V⁵¹, In¹¹⁴, Ir¹⁹², Re¹⁸⁷, several rare earths, and others)
Isotope Dilution Technique
Physical Chemistry Studies (solubilities, electrode reactions, etc.)
Slurry Settling
Diffusion
Szilard-Chalmers Reaction

Metallurgy

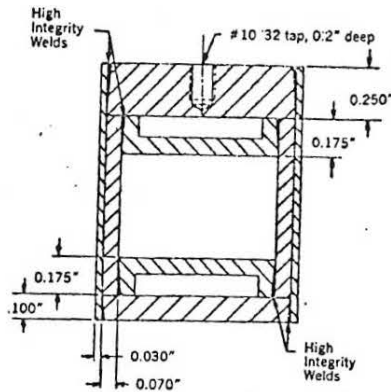
Diffusion
Activation of Gold and Platinum-Iridium Alloys
Radiography
Trace Analysis

Biology

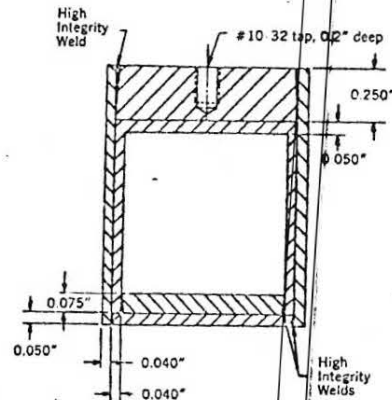
Translocation of I¹³¹ and Mn⁵⁴ in Animals and Plants

Neutron sources of Pu-Be and Am-Be are available from NUMEC for neutron irradiator-howitzer and other applications. These sources are attractive from an experimental viewpoint since their

high specific activity combined with long half-life permits a high constant neutron output. Specification data for NUMEC Pu-Be and Am-Be neutron sources is presented below.



Standard NUMEC Americium Neutron Source Capsule
Inner Capsule: 304L Stainless Steel
Outer Capsule: 304L Stainless Steel



Standard NUMEC Plutonium Neutron Source Capsule
Inner Capsule: Tantalum
Outer Capsule: 304L Stainless Steel

Standard NUMEC Pu239-Be Neutron Sources

Catalog Designation	Plutonium Content Curies	Plutonium Content Grams	Diameter Cylinder (In.) (1)	Length Cylinder (In.) (1)	Approximate Strength (NPS)	Price (2) (U.S. Dollars)
NUMEC-AA	1	16	1.310	1.105	1.8×10^6	\$ 665
NUMEC-C	2	32	1.310	1.510	3.6×10^6	765
NUMEC-D	3	48	1.310	1.915	5.4×10^6	865
NUMEC-F	4	64	1.310	2.320	7.2×10^6	965
NUMEC-H	5	80	1.310	2.720	9.0×10^6	1,065

Standard NUMEC Am-Be Neutron Sources

Catalog Designation	Americium Content Curies	Americium Content Grams	Diameter Cylinder (In.) (1)	Length Cylinder (In.) (1)	Approximate Strength (NPS)	Price (3) (U.S. Dollars)
NUMEC-AM-31-3A	1	0.309	1.310	0.575	2.1×10^6	\$1,150
NUMEC-AM-62-3A	2	0.618	1.310	0.720	4.2×10^6	1,710
NUMEC-AM-93-3A	3	0.926	1.310	0.870	6.3×10^6	2,225
NUMEC-AM-123-3A	4	1.23	1.310	1.020	8.4×10^6	2,735
NUMEC-AM-154-3A	5	1.54	1.310	1.170	1.0×10^7	3,240
NUMEC-AM-185-3A	6	1.85	1.310	1.320	1.3×10^7	3,740

- (1) All dimensions are ± 0.002 inches.
- (2) Pu-Be prices include source fabrication, all USAEC use and loss charges during fabrication, calibration of source against standard NUMEC source, and "all risk" marine insurance during transit within continental United States; a \$90 handling charge is added to each non-domestic order. Prices do not include the contained plutonium which must be leased from the USAEC by domestic customers and purchased from the USAEC by non-domestic customers.
- (3) Am-Be prices include source fabrication, contained americium, packing and shipping per I.C.C. and other applicable regulations and "all risk" marine insurance from NUMEC to any point within the continental United States. A \$50 handling charge is added to each non-domestic order.

Shipping containers can be purchased for customer storage use or returned to NUMEC for deposit refund.
Prices are subject to change without notice.