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PROPOSED REVISIONS TO THE ALLOCATION AND DISTRIBUTION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES

C. P. Keim

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PROPOSED REVISIONS TO THE ALLOCATION AND DISTRIBUTION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES

C. P. Keim

November 22, 1954

DEC 3 1954

STABLE ISOTOPE RESEARCH AND PRODUCTION DIVISION
C. P. Keim, Director

OAK RIDGE NATIONAL LABORATORY
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PROPOSED REVISIONS TO THE ALLOCATION AND DISTRIBUTION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES

C. P. Keim

OBJECTIVES OF THE PROGRAM OF PROVIDING ELECTROMAGNETICALLY ENRICHED ISOTOPES

The electromagnetic separation and distribution of naturally occurring isotopes were started in 1946. The principal objective of this program is to provide enriched isotopes for research and other applications at Atomic Energy Commission facilities, at other Government laboratories, at hospitals, and at university and industrial laboratories. The major unclassified uses to date have been in the measurement of neutron cross sections, in research related to hyperfine spectroscopy, in the discovery and mass identification of new radioactive isotopes produced in nuclear reactors and in particle accelerators, in the regular production of certain radioactive isotopes, in stable isotope dilution analysis, and in other areas where nuclear differences contribute to different properties. By providing these enriched isotopes better agreement has been achieved between nuclear theory and experiment as, for example, in studies related to nuclear spins and magnetic moments, in cross section studies, in investigations of beta decay, in theories of superconductivity, and in the determination of reactor fuel consumption.

PAST HISTORY AND CURRENT STATUS OF THE PROGRAM

Over 2,225 shipments of electromagnetically enriched isotopes have been made from January 1946 to October 1954. Sixty per cent of all stable isotope shipments have gone to Commission laboratories and 40% to other Government, university, and industrial laboratories. It is not known how many of the off-project shipments are used in research supported by the Commission; however, a conservative estimate is that at least two-thirds of all research done with electromagnetically enriched isotopes are done with Commission funds. This is not unexpected since the Commission has a major interest in nuclear properties. Over five hundred technical papers have appeared in the open journals reporting on research made possible by these isotopes.

Electromagnetically enriched isotopes are distributed domestically only on a loan basis as allocated by the Isotopes Division, Atomic Energy Commission. The loan agreement stipulates the return of the isotope within six months unless an extension of time has been granted by the Commission. Only 30% of all isotopes shipped have been returned in accord with the loan agreement. Off-project users have returned 52% of their shipments; on-project users have returned 17% of theirs. Among the national laboratories, one laboratory has returned 35% of all isotopes they had received, another has returned 6% of theirs, and a third laboratory has not returned any isotopes loaned to them.

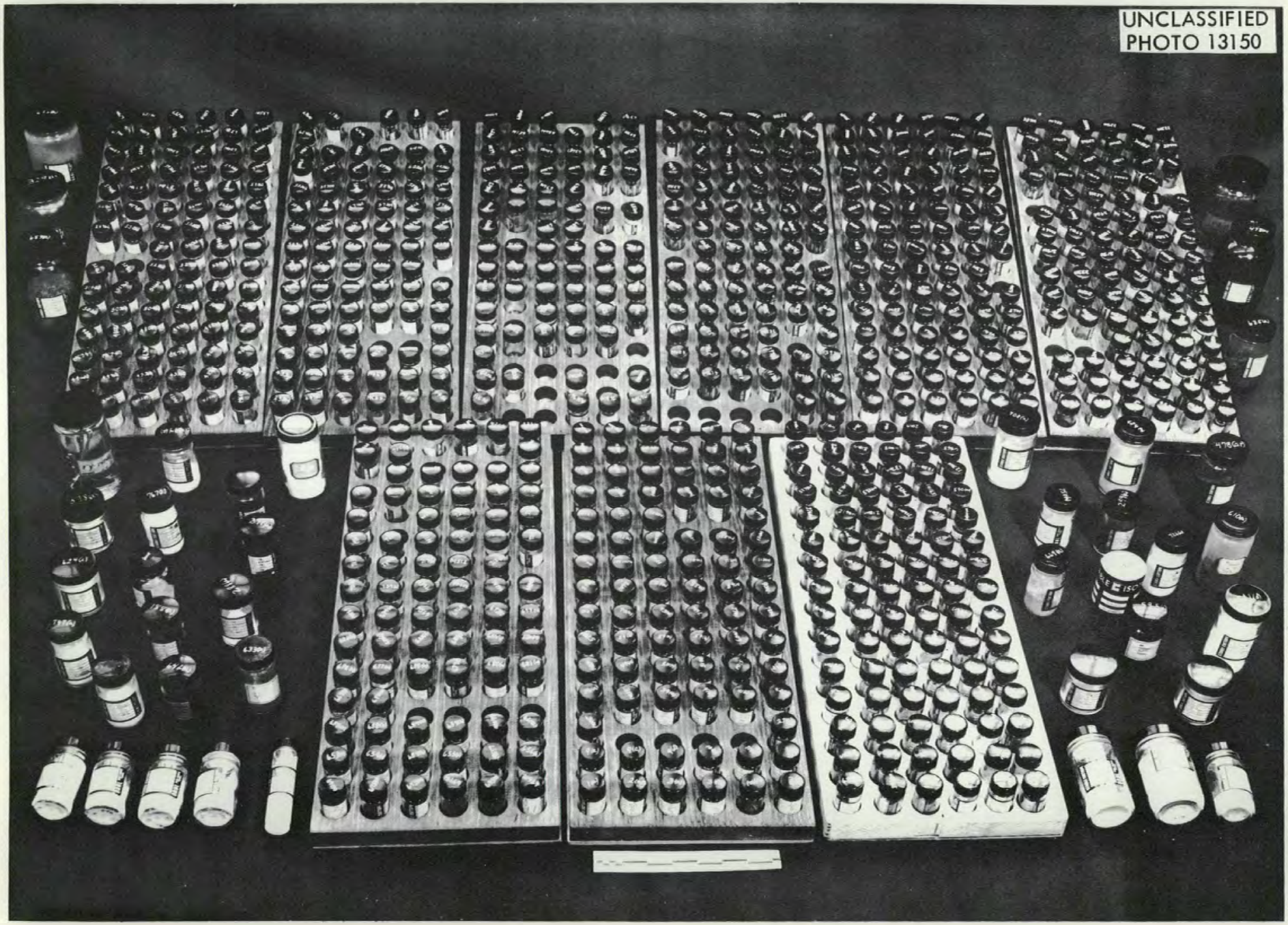
Very few of the returned isotopes can be placed in stock so as to be available to other users. The return of a used isotope is not in itself

of value. There is nothing to be gained by the return of isotopes that cannot be reused without reprocessing. Many isotopes are badly contaminated during use. Only 5% of all shipments have been returned to stock either in part or in whole, because the quantity of isotope to be recovered is so minute and the effort to recover it is so great that it is uneconomical and wasteful of technical manpower to attempt recovery. Most returned isotopic products are in such condition that the recovery of the original isotope approaches despair. Specific chemistry would have to be developed and applied to every returned lot. It is usually more economical to enrich new lots of needed isotopes since the calutron unit cost is much less than the chemistry cost would be if this returned material were reworked.

When the loan procedure for the distribution of electromagnetically enriched isotopes was inaugurated it was believed by the Commission that the stock of isotopes would serve as a bank from which users could borrow isotopes, then return them for other users to borrow. When the original loan policies were set up it was not anticipated that in most applications in which stable isotopes are used they would undergo alteration, dilution, or contamination which makes their return to the bank extremely difficult and impractical.

Since July 1954 electromagnetically enriched isotopes are sold to certain foreign users. Currently there is only the loan possibility to domestic users, only the sales policy to foreign users.

Photograph 1 shows the current inventory of enriched stable isotopes. Photograph 2 shows the miscellaneous assortment of returned isotopes in



THE INVENTORY OF ELECTROMAGNETICALLY ENRICHED STABLE ISOTOPES

various forms, shapes, sizes, and levels of radioactivity, each lot representing a formidable chemical recovery project.

CURRENT ALLOCATION, DISTRIBUTION, AND PRICING POLICIES FOR ELECTROMAGNETICALLY ENRICHED ISOTOPES

In the distribution of electromagnetically enriched isotopes to domestic users on a loan basis, the requester first makes application for an allocation to the Isotopes Division, Atomic Energy Commission, using Form AEC-100. If the allocation is approved the Commission returns the approved form to the requester, instructing him to mail his order with the original of the approved allocation to the Stable Isotope Research and Production Division, Oak Ridge National Laboratory. The loan is made for a period of six months and the charge is $50.00 per isotope shipped. Extensions of the loan period are considered by the Atomic Energy Commission on request from the user.

Shipments of electromagnetically enriched isotopes are made only as allocated by the Commission. So far as the Laboratory is concerned each order is processed as it is received and no user or use is granted a priority unless a priority has been established by the Commission.

Electromagnetically enriched isotopes are sold to foreign recipients on allocation by the Commission. A pricing formula was devised by the Commission and the Laboratory and unit sales prices were computed for all completed lots of isotopes listed in the inventory.

The price list of electromagnetically enriched isotopes is attached to this report as an appendix.

PRESENT ADVANTAGES FOREIGN USERS HAVE OVER DOMESTIC USERS IN OBTAINING ELECTROMAGNETICALLY ENRICHED ISOTOPES

Under the present domestic loan policy and the foreign sale policy the foreign user has some advantages over the domestic user although he also has some disadvantages. The foreign user should have no advantages over domestic users.

Stable isotopes are used in a wide variety of ways, in some cases multigram quantities are needed, in other cases only a few milligrams are necessary. Some uses of stable isotopes involve only nuclear property determinations where the isotopic material undergoes no change, other uses actually result in a change in the isotopic material and it undergoes dilution, contamination, or transmutation. As a result, some stable isotopes can be readily reused and should be returned to the inventory, whereas other isotopes are not suitable for reuse.

If large amounts of enriched stable isotopes are needed (e.g. for cross section measurements) where the isotopic nature will not be altered, the foreign user may be at a disadvantage. He may not be able to purchase an expensive lot of material. The domestic user, however, can borrow this same material at the loan fee.

On the other hand, if the foreign user requires milligram amounts of an enriched isotope (e.g. in stable isotope dilution analysis) or larger amounts (e.g. as cyclotron or reactor targets for radioisotope production), he can purchase these materials and expend them. Often it will be economically and technically advantageous for him to purchase these isotopes. Milligram amounts will often cost him less than the loan fee

which the domestic user must pay and, in addition, the foreign user can use his isotopes without restriction and without obligation to return them.

The domestic user is not privileged to purchase stable isotopes and expend them without restriction if he conscientiously abides by his loan agreement. Although some users apparently make no attempt to return loaned isotopes there are others who do not request loans because they know they will not be able to return them due to the nature of their research. There are many applications of importance to the Commission, to industry, and to medicine awaiting the availability of electromagnetically enriched isotopes on an unconditional sales basis.

RECOMMENDED POLICIES ON THE LOAN AND SALE OF ELECTROMAGNETICALLY ENRICHED ISOTOPES

Oak Ridge National Laboratory recommends the following procedures on the loan and sale of electromagnetically enriched isotopes to domestic users.

I. That each requester for electromagnetically enriched isotopes indicate on Form AEC-100 if he is requesting an allocation on

   A. A six months loan basis, or

   B. An outright sales basis.

II. Loans.

   A. That, in general, a six months loan transaction be deemed preferable:

1. If the requester states that the isotope can be returned within six months to the supplier, and
2. If the returned isotope will not have been unduly diluted or contaminated isotopically, and
3. If the returned isotope can be replaced in stock with no chemical reworking, or
4. If a loan transaction is in the best interest of Commission research or in research in which the Commission has a special interest.

(Note: Past experience indicates that loans would constitute less than 20% of all requests if these criteria were followed.)

B. That each isotope loaned be returned within six months, or

1. If it cannot be returned due to unfinished research that arrangements be made with the producer for extended use under conditions listed under Section D below, or
2. If it cannot be returned due to its loss, expenditure, or its unsuitability for reuse, that the user request a release from returning the isotope to the producer, the user certifying its loss, expenditure, or unsuitability for reuse.

C. That each individual isotope loaned require a payment of an amount equal to 10% of the sales price, as a rental and handling fee for the initial six months loan period, but

that in no case shall this fee be less than $50.00. This stipulated fee does not include special chemical services which may be ordered by the user from the supplier.

D. That an additional charge, equal in amount to the initial loan fee, be made for each six months period the isotope is retained by the user beyond the initial six months loan period, if the user has not received a release from returning the isotope.

E. That Oak Ridge National Laboratory collect all loan fees in advance for the Commission.

F. That the user be notified when his six months loan period expires and an additional loan period begins.

G. That if a user retains a loaned isotope for repeated loan periods of six months each, the loan fees be collected only until the original production costs of the isotope have been recovered from loan fees received. (Note: Where 10% of the sales value is paid every six months, full production costs will have been received by the end of the fifth year following date of shipment.)

H. That no isotope obtained on loan be re-loaned or sold by the borrower without approval by the loaner since isotopes on loan remain government property.

III. Sales.

A. That, in general, a sale transaction of electromagnetically enriched isotopes be considered preferable:

1. If it is reasonably certain that the isotope will be expended by the user, or

2. If the isotope will be diluted isotopically or altered chemically to such an extent that it cannot be reused, or

3. If the user wishes to retain the isotope for an indefinite period or purchase it outright for other reasons acceptable to the loaner.

(Note: Past experience indicates that sales under these criteria would constitute over 80% of all requests.)

B. That on all sales of electromagnetically enriched isotopes a handling charge of $10.00 per shipment be made in addition to the selling price of the isotopes.

C. That credit on future purchases of electromagnetically enriched isotopes be granted for all isotopic material originally sold by and returned to Oak Ridge National Laboratory Stable Isotope Research and Production Division in its original isotopic and chemical form; however, in no case will the credit so given reduce the charges to the user for that particular isotope transaction to less than what would have been the loan fees if this had been a loan transaction.

IV. It is proposed by Oak Ridge National Laboratory that all the above procedures go into effect without advance notice upon announcement to users.

V. It is proposed that each borrower be requested to return, prior to a designated date, all isotopes obtained by him under the now-existing loan policy and which he has had longer than six months, unless he requests and receives an extension of the initial six months loan period or unless the supplier indicates they need not be returned. If the user cannot return these isotopes because they are in no condition to be reused, he must request that the loan transactions be terminated, certifying that the isotopes have been contaminated, expended, or lost. At the afore-mentioned date, the revised loan policies will go into effect and additional loan fees will then be due for those isotopes retained by the borrower on a loan basis, these loan fees being computed according to the revised loan pricing policies.

It is recommended that there be no change in the sales policy as applied to foreign recipients.

It is recommended that the user have the option of indicating on which basis (loan or sales) he prefers to receive the allocation of the isotope, since some research will be stimulated by a domestic sales procedure while other research of importance to the Commission may thrive better under the current loan procedure. Final authority as to whether

the allocation is to be a loan or a sale will rest in the allocation office since Commission needs must be protected.

It might be thought that all isotopes should be sold and credit given if they are returned. An exclusive sales policy is not desirable for several reasons. Payments by the user for purchases would impound his research funds for an indefinite period of time and create a serious accounting problem, particularly at the end of a fiscal year. The Laboratory believes this accounting expense would be excessive. On the other hand, an optional loan policy facilitates the return of reuseable isotopes to the inventory; this is the least expensive method to replenish the isotope inventory.

A survey indicates that the revenues during the first three months of FY-55 from ninety loans and six foreign sales of electromagnetically enriched isotopes reached $5,500. However, an optional loan or sales procedure would have resulted in estimated revenues of $27,000 for these same three months. This is believed to be a realistic estimate since allocations for this period have been examined to determine if they would have been loans or sales under the revised policies. If these ninety-six transactions had all been outright sales the estimated income would have been approximately $93,000. However, if only sales had been available to domestic users revenues would not have reached $93,000 because some users would not have been able to buy them outright and, even if they had, an estimated $66,000 would be refunded when the isotopes were returned for credit.

It would be detrimental to Atomic Energy Commission research, to other research of national importance, and to the stable isotope production program itself if there were no optional loan policy. It is detrimental to many types of research and to important applications that there is no alternate sales policy.

RECOMMENDED ADMINISTRATION OF ALLOCATION FOR ELECTROMAGNETICALLY ENRICHED ISOTOPES

The Laboratory recommends that all requests from domestic users for the allocation of electromagnetically enriched isotopes either on a loan or sales basis be directed to the Oak Ridge National Laboratory Stable Isotope Research and Production Division, which will act on the request for an allocation. The Laboratory's direct handling of requests for allocations is recommended because of the importance of establishing direct communication between the users and the producer, because such direct handling is more expedient, and "since no radiological health hazard is associated with the use of concentrated stable isotopes, approval of a request is based only on availability of the materials and the feasibility of the proposed use".[1]

Anticipating that the adoption of a policy permitting outright sale of separated isotopes will contribute to a greatly increased demand which will, at least for some isotopes, be in excess of the production capabilities, the Laboratory recommends that the Atomic Energy Commission appoint an Advisory Committee on Stable Isotopes Distribution, similar

(1) Quotation from "Stable Isotope Distribution Policies," Isotopes Division, U. S. Atomic Energy Commission, February 1953.

to the Advisory Committee on Isotope Distribution that now establishes new policies on distributing radioactive materials. The Advisory Committee on Stable Isotopes Distribution would establish priorities and general principles on the basis of which requests for allocations could be handled equitably by the Laboratory.

Within the framework of policies and guiding principles established by the Advisory Committee, the Laboratory will be able to handle requests for allocation in an efficient manner, assuring that production and demand are kept as nearly in balance as possible and that the most urgent needs are met. Increased exchange of information and greater cooperation between the user and producer will assure that the Laboratory is in a good position at all times to evaluate and act upon requests for allocations according to the principles and policies established by the Advisory Committee.

It is not intended that the Advisory Committee review each request for allocation or that they be concerned with the details of such decisions as whether a loan or a sale is indicated in a particular instance, but rather that at annual, or perhaps semi-annual meetings, they consider the general problems that have arisen and establish the general principles by which these problems will be resolved in the future. The detailed steps of determining whether a request for allocation is to be approved and whether it should be a sale or a loan and of carrying out the operations of shipping, billing, etc., will be the function of the Oak Ridge National Laboratory and will be handled in such a way as to recover, so far as possible, all costs of production and distribution of separated stable isotopes.

SCIENTIFIC BENEFITS ANTICIPATED BY THE REVISION OF ALLOCATION AND DISTRIBUTION PROCEDURES

The revision of the domestic loan policy, the establishment of an optional sales policy for domestic users and the transfer of the allocation function nearer the source of stable isotopes will increase the benefits from stable isotope research to the Commission and to the nation in general. Some of these advantages have been discussed earlier in this report, others are discussed below. It is impossible to forecast what all the scientific benefits will be, but the increase in interest among scientists in stable isotopes and the expansion in the variety of applications in which these isotopes are being used makes it evident that the optimum benefits are not yet being realized.

Under the revised loan procedures a greater mobility will be gained among the isotopes now being loaned. The borrower will have incentives to return borrowed isotopes promptly if they can be re-loaned to others. However, the borrower will not be censured if his research consumed the isotope and he cannot return it. Furthermore, under the revised loan procedures, users of electromagnetically enriched isotopes who keep them on loan for a long time will pay a more equitable share of the production cost of those isotopes. It is extremely important that reuseable isotopes be returned to the Commission's inventory of stable isotopes for re-loan because existing production facilities cannot meet current needs and furthermore, the returning of reuseable isotopes is the most economical way to replenish the inventory.

A policy of outright sale of enriched stable isotopes has many very

important potentialities. The expenditure of these isotopes as cyclotron targets makes it possible to produce a wide variety of radioisotopes especially needed in medical research. The complete cost of calutron production, cyclotron bombardment, and radio-chemistry can be recovered and the unit cost per millicurie of radioisotope will be attractive to the user. For example, the reaction Te^{130} (p,n) I^{130} is of interest because 12.6 hour I^{130} has advantages over 8 day I^{131} in some applications. Other possibilities now under development wherein enriched stable isotopes have promise are: Cr^{54} (p,n) Mn^{54}, Ca^{46} (n,γ) Ca^{47}, and Ca^{48} (p,pn) Ca^{47}. At the present time the latter reaction producing 4.8 day Ca^{47} could be most important in research related to bone cancer.

The reactions Fe^{58} (n,γ) Fe^{59}, Fe^{54} (n,γ) Fe^{55}, and others have been used regularly in radioisotope production, it being obvious at allocation that the stable isotopes would be transmuted, but the transfer of enriched stable isotopes for these expendable purposes should be clarified. Some radioisotopes can be produced more economically in the nuclear reactor by using enriched stable isotopes as starting material; other radioisotopes cannot be produced in any other way than by using enriched stable isotopes as target material in a cyclotron such as the Laboratory 86-inch high current machine.

The outright sale of enriched stable isotopes will result in important benefits where isotope dilution analysis techniques can accurately measure parts per million and even parts per billion by using enriched stable isotopes as "spikes", then measuring mass abundances in

the mass spectrometer. The petroleum industry has shown considerable interest in the use of stable isotopes to determine accurately low concentrations of metallic contaminants in crude oil. These analyses must be done prior to refining and the concentration of certain metals lowered so as to avoid damage to expensive catalysts. The transistor industry has used stable isotopes on a recurrent loan basis to determine accurately trace amounts of contaminants in germanium which may affect its transistor properties greatly. Soil chemists and agricultural chemists have inquired regarding enriched stable isotopes although they still have much research which can be done with radioisotopes; however, certain experimental results with radioactive isotopes must be checked with non-radioactive isotopes. Several manufacturers of optical and spectroscopic equipment have borrowed enriched isotopes for use in electrodeless discharge tubes, the wave length of the emitted light being used as a standard of measurement. In most of these applications very small amounts of enriched isotopes suffice so the cost per application will be relatively inexpensive. However, the number of applications and total sales volume could conceivably reach a very high figure.

The Atomic Energy Commission in its stable isotope program at Oak Ridge National Laboratory is making an appreciable investment each year in the production and distribution of electromagnetically enriched isotopes. Controls and policies which were necessary during the formative years of the program are no longer needed and are now actually restraining broader uses of enriched isotopes. Experience gained over nine years now indicates that the allocation phase of the stable isotope activity warrants revision,

that the loan procedures need modification, and that a domestic sales policy should be established. As production, allocation, and distribution functions of electromagnetically enriched isotopes keep pace with their ever-widening applications, the scientific returns to the Commission will increasingly justify the continued expenditure of research funds for electromagnetically enriched isotopes and, in addition, the cost of production will be more equitably shared by income through loans and sales.

A p p e n d i x

Established Prices of Most Electromagnetically
Enriched Isotopes
In the Current Inventory

(All prices subject to change without notice.)

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Antimony			
121	99.4	AE 93(ar)	$6.50
121	97.7	BT 274(a)	6.00
123	96.7	AE 94(ar)	5.00
123	95.6	BT 275(a)	5.00
Barium			
130	27.5	FT 720(a)	80.00
130	23.3	FU 727(a)	60.00
132	6.7	FT 721(a)	10.00
132	12.0	FU 728(a)	25.00
134	15.4	FT 722(a)	0.50
134	50.8	FU 729(a)	5.00
135	67.3	DG 432(a)	2.00
135	58.2	FU 730(a)	1.50
136	50.0	DG 433(a)	1.25
136	39.2	FT 724(a)	1.00
136	48.7	FU 731(a)	1.25
137	39.0	DG 434(a)	1.00
137	43.6	FU 732(a)	1.00
138	98.0	DG 435(a)	0.25
138	96.7	FT 726(a)	0.25
138	97.4	FU 733(a)	0.25
Boron			
10	86.8	DP 481(a)	17.50
10		FV 734(a)	
10	88.3	GF 768(a)	20.00
11	93.5	BM 250(a)	10.00
11	96.3	DP 482(a)	15.00
11	97.8	FV 735(a)	15.00
11	96.4	GF 769(a)	15.00
Bromine			
79	87.0	EJ 552(a)	25.00
81	91.4	AO 130(a)	15.00
81	96.8	EJ 553(a)	20.00

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Cadmium			
106	19.9	AC 88(a)	$2.75
106	32.9	CE 314(a)	7.50
108	14.2	AX 170(a)	2.50
110	55.8	AX 171(a)	0.75
110	70.0	CE 316(a)	1.00
111	53.3	AC 89(a)	0.75
111	64.5	CE 317(a)	1.00
112	79.3	AX 172(a)	0.50
112	83.5	CE 318(a)	0.50
113	25.5	AB 86(a)	0.25
113	54.1	CE 319(a)	0.75
114	79.5	AC 90(a)	0.75
114	94.2	CE 320(a)	0.75
114	94.2	CE 320(ar)	0.75
116	71.2	CE 321(a)	2.25
116	71.2	CE 321(ar)	2.25
Calcium			
40	98.6	V 61(b)	0.35
40	99.9	X 70(a)	0.35
40	98.9	BN 251(a)	0.35
40	99.8	DI 441(d)	0.35
40	99.9	EV 613(a)	0.35
40	99.9	FF 648(a)	0.35
40		FO 689(a)	
42	28.3	DI 442(b)	5.00
42	82.5	EV 614(a)	50.00
42	64.2	FF 649(a)	25.00
42		FO 690(a)	
43	37.6	DI 443(b)	25.00
43	68.0	FO 691(a)	75.00
44	85.4	BN 254(a)	6.50
44	98.0	FF 651(a)	8.50
44		FO 692(a)	
48	7.5	FF 653(a)	2.00
Carbon			
12	99.9	FD 638(aj)	5.00
Cerium			
136	4.7	CU 387-388(a)	5.00
136	30.0	FR 706(a)	60.00
138	4.4	DW 502(a)	2.50
138	10.2	FK 676(a)	15.00
138	13.1	FR 707(a)	20.00

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Cerium (cont'd)			
140	98.5	CW 389(a)	$0.50
140	98.7	DD 417(a)	0.50
140	98.7	DD 417(ar)	0.50
140	99.3	DW 503(ar)	0.50
140	99.6	FK 677(a)	0.50
140	99.7	FR 708(a)	0.50
142	87.4	DD 418(b)	3.00
142	87.4	DD 418(br)	3.00
142	83.4	DW 504(a)	2.75
142	88.8	FK 678(a)	3.00
142	90.1	FR 709(a)	3.00
Chlorine			
35	95.7	FW 736(a)	0.75
35	89.7	FW 736(b)	0.50
37	65.6	DH 438(a)	1.50
37	66.3	FW 737(a)	1.50
37	60.5	FW 737(b)	1.25
Chromium			
50	88.3	EU 609(a)	10.00
50		GR 836(a)	
50		GS 840(a)	
52	98.8	D 11(a)	0.25
52	98.8	D 11(ar)	0.25
52	99.1	CD 310(a)	0.25
52	97.1	EU 610(a)	0.25
52		GR 837(a)	
52		GS 841(a)	
53	90.1	EU 611(a)	2.50
53		GR 838(a)	
53		GS 842(a)	
54	83.1	CD 312(a)	10.00
Copper			
63	97.0	A 1(a)	0.70
63	97.0	A 1(ar)	0.70
63	99.4	J-K 31-37(a)	0.70
63	98.2	AW 161(cu)	0.70
63	99.1	DF 426(a)	0.70
63	96.1	DL 455(a)	0.70
63	99.4	DU 497(a)	0.70
63	99.9	FJ 673(a)	0.70
63		GT 849(a)	0.70 (tentative)
65	93.1	A 2(ar)	0.85
65	90.6	AV 162(cu)	0.85
65	98.2	DU 498(a)	0.85
65		GT 850(a)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Gadolinium			
152	15.0	GK 798(a)	$20.00
154	33.2	GK 799(a)	5.00
155	72.3	GK 800(a)	1.00
156	80.2	GK 801(a)	1.00
157	69.7	GK 802(a)	1.00
158	92.9	GK 803(a)	1.50
160	95.4	GK 804(a)	1.25
Gallium			
69	98.4	EI 554(a)	0.75
71	98.1	EI 555(a)	1.25
Germanium			
70	88.1	BD-BE 205-210(a)	0.75
70	91.4	FZ 747(a)	0.75
72	89.2	BD-BE 206-211(a)	0.40
72	94.9	FZ 748(a)	0.50
73	68.9	BD-BE 207-212(ar)	1.50
73	78.0	FZ 749(a)	2.00
74	95.2	BD-BE 208-213(a)	0.50
74	95.8	FZ 750(a)	0.50
76	79.3	BD-BE 209-214(a)	1.50
76	81.0	FZ 751(a)	1.50
Hafnium			
174		GP 825(a)	
174		GP 825(b)	
174		GP 825(c)	
176	59.5	GP 826(a)	6.00
176		GP 826(b)	
177	59.1	GP 827(a)	3.00
177		GP 827(b)	
178	84.8	GP 828(a)	2.00
178		GP 828(b)	
179	47.6	GP 829(a)	2.50
179	53.3	GP 829(b)	2.75
179		GP 829(c)	
180	93.3	GP 830(a)	1.50
180	91.2	GP 830(b)	1.50
180	49.6	GP 827(z)	0.50

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Indium			
113	22.8	BH 225(a)	$2.50
113	16.8	CO 354(a)	1.50
113	65.4	CQ 358(a)	25.00
113	14.2	DE 419(a)	1.00
113	59.6	ER 594(a)	25.00
115	99.6	AD 92(a)	0.75
115	99.6	BH 226(a)	0.75
115	99.6	BH 226(ar)	0.75
115	99.9	CO 355(a)	0.75
115	99.9	ER 595(a)	0.75
115	99.9	ER 595(ar)	0.75
Iridium			
191	85.9	GL 810(a)	25.00
193	89.1	GL 811(a)	20.00
Iron			
54	39.0	B 3(f)	0.75
54	81.1	E 14(a)	5.00
54	83.0	F 18(a)	5.00
54	49.2	AM 122(a)	2.00
54	60.9	AZ 183(a)	2.50
54	87.9	BA 187(a)	5.00
54	87.9	BA 187(ar)	5.00
54	87.4	BB 194(a)	5.00
54	84.3	CI 328(a)	5.00
54	34.5	DO 477(a)	0.75
54	93.1	FC 634(a)	6.00
54	94.7	FN 685(a)	6.00
54	96.7	FN 685(b)	6.00
56	98.4	B 4(a)	0.15
56	98.5	B 4(e)	0.15
56	98.6	E 15(a)	0.15
56	97.4	F 19(a)	0.15
56	98.9	AM 123(a)	0.15
56	99.0	AZ 184(a)	0.15
56	98.5	BA 188(a)	0.15
56	98.3	BB 192(a)	0.15
56	96.5	CI 329(a)	0.15
56	99.8	CZ 404(f)	0.20
56	99.7	DO 478(a)	0.20
56	99.7	DO 478(ar)	0.20
56	99.7	DO 478(as)	0.20
56		FC 635(a)	0.15
56		FN 686(a)	0.15
56	98.8	FN 686(b)	0.15

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Iron (cont'd)			
57	21.1	B 5(a)	$1.00
57	30.5	B 5(f)	1.25
57	69.6	F 20(a)	5.00
57	33.2	AM 124(a)	1.25
57	75.8	BA 189(a)	7.00
57	77.6	BB 193(a)	7.00
57	51.9	CZ 405(f)	4.00
57	79.4	DK 449(a)	7.00
57	62.4	DL 453(a)	5.00
57	59.3	DL 453(d)	4.00
57	31.9	DL 453(e)	1.25
57	59.3	DL 453(f)	4.00
57	43.5	DL 453(j)	2.25
57	40.6	DL 463(a)	2.25
57	45.4	DL 463(b)	2.25
57	67.3	DL 463(e)	5.00
57	53.5	DL 463(j)	4.00
57	54.2	DL 463(k)	4.00
57	63.1	DL 467(c)	5.00
57	83.4	FC 636(a)	9.00
57		FN 687(a)	
57		FN 687(b)	
58	22.0	C 8(b)	3.50
58	10.3	AM 125(a)	0.75
58	23.4	DL 454(f)	3.50
58	71.7	DL 454(m)	45.00
58	75.7	DO 480(a)	45.00
58	42.0	DO 480(b)	14.00
58	34.8	DO 480(c)	8.00
58	74.2	FN 688(b)	45.00
58	59.7	FN 688(c)	30.00
58	55.7	FN 688(d)	25.00
58	57.3	FN 688(f)	25.00
58	65.9	FN 688(g)	30.00
58	78.7	FN 688(i)	45.00
58	78.0	FN 688(j)	45.00
Lanthanum			
138	0.6	EF 544(a)	5.00
138	1.7	GO 823(a)	40.00
139	99.9	EF 545(a)	1.00
139		GO 824(a)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Lead			
204	7.8	O 43(a)	$1.00
204	16.7	AQ 135(ar)	2.00
204	23.4	BO 257(a)	5.00
204	25.7	EO 581(a)	5.00
204	5.3	FQ 702(a)	1.00
206	75.7	O 44(a)	1.50
206	77.9	AQ 136(a)	1.50
206	71.3	BO 258(a)	1.50
206	71.3	BO 258(ar)	1.50
206	64.9	EO 582(a)	1.00
206	35.0	FQ 703(a)	0.50
207	61.6	O 45(a)	1.50
207	48.2	AQ 137(a)	0.75
207	48.2	AQ 137(ar)	0.75
207	66.8	BO 259(a)	1.75
207	66.8	BO 259(ar)	1.75
207	61.1	EO 583(a)	1.50
207	26.8	FQ 704(a)	0.75
208	92.1	O 46(a)	0.75
208	92.1	O 46(ar)	0.75
208	82.1	AQ 138(a)	0.50
208	96.6	BO 260(a)	1.00
208	95.8	CN 352(ar)	1.00
208	88.0	EO 584(a)	0.75
208	75.4	FQ 705(a)	0.50
Lithium			
6	95.7	FY 745(bd)	2.75
6	97.0	FY 745(c)	2.85
6	99.8	GD 764(e)	3.00
7	98.4	CU 379(a)	0.20
7	99.8	FI 668(j)	0.25
7	99.9	GE 767(l)	0.25

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Magnesium			
24	99.5	P 47(a)	$0.85
24	98.4	Q 50(a)	0.75
24	99.5	BZ 288(a)	0.85
24	99.2	BZ 288(b)	0.85
24	99.5	BZ 288(c)	0.85
24	99.4	BZ 288(d)	0.85
24	99.6	DZ 519(a)	0.85
25	62.6	Q 51(a)	1.75
25	32.8	Q 51(b)	1.25
25	86.8	BZ 289(a)	3.00
25	92.3	DZ 520(a)	3.50
26	96.2	P 49(a)	4.00
26	95.9	BZ 290(a)	4.00
Mercury			
196	8.4	DR 485(a)	450.00
196	1.9	DR 485(b)	25.00
196	1.5	DR 485(c)	25.00
198	79.1	DR 486(a)	10.00
198	66.1	DR 486(b)	5.00
198	53.4	DR 486(c)	5.00
198	54.4	DR 486(d)	5.00
199	73.1	DR 487(as)	17.50
199	72.1	DR 487(b)	17.50
199	65.5	DR 487(d)	15.00
199	65.5	DR 487(ds)	15.00
200	91.4	DR 488(a)	6.00
200	86.5	DR 488(b)	5.00
200	86.5	DR 488(bs)	5.00
200	80.9	DR 488(c)	5.00
200	74.9	DR 488(d)	4.00
200	64.7	DR 488(e)	3.00
200	76.3	DR 488(f)	3.50
201	71.8	DR 489(a)	30.00
201	62.5	DR 489(b)	20.00
201	62.5	DR 489(bs)	20.00
202	98.3	DR 490(a)	5.00
202	98.1	DR 490(b)	5.00
202	97.3	DR 490(c)	5.00
202	96.5	DR 490(d)	5.00
202	95.1	DR 490(e)	5.00
202	91.5	DR 490(f)	4.00
202	91.5	DR 490(fs)	4.00
202	87.9	DR 490(g)	3.00
202	80.3	DR 490(h)	3.00
202	75.8	DR 490(i)	2.00

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Mercury (cont'd)			
204	89.2	DR 491(as)	$20.00
204	77.6	DR 491(b)	15.00
204	69.8	DR 491(c)	12.50
204	69.8	DR 491(cs)	12.50
204	62.8	DR 491(d)	9.00
204	49.7	DR 491(e)	6.00
204	49.7	DR 491(es)	6.00
204	42.9	DR 491(f)	5.00
204	30.1	DR 491(g)	2.00
204	72.3	DR 491(h)	12.50
204	72.3	DR 491(hs)	12.50
Molybdenum			
92	92.1	R-T 53(a)	1.25
92	92.1	R-T 53(ar)	1.25
92	95.5	AW 163(a)	1.25
92	95.5	AW 163(ar)	1.25
92	87.6	FP 695(a)	1.00
94	74.7	R-T 54(a)	2.00
94	79.1	AW 164(a)	2.00
94	84.9	FP 696(a)	2.25
95	80.8	R-T 55(a)	1.00
95	88.0	AW 165(a)	1.25
95	86.7	FP 697(a)	1.25
95	91.3	FP 697(b)	1.25
96	85.9	R-T 56(a)	0.75
96	90.6	AW 166(a)	1.00
96	92.0	FP 698(a)	1.00
97	78.0	R-T 57(a)	1.25
97	78.0	R-T 57(ar)	1.25
97	75.4	AW 167(a)	1.25
97	73.5	FP 699(a)	1.25
97	89.6	FP 699(b)	1.75
98	95.0	R-T 58(a)	1.00
98	89.9	R-T 58(b)	1.00
98	96.3	AW 168(a)	1.00
98	95.2	FP 700(a)	1.00
100	90.2	R-T 59(a)	1.75
100	90.2	R-T 59(b)	1.75
100	86.7	FP 701(a)	1.50

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Neodymium			
142	93.0	EQ 587(a)	$0.75
142	93.0	EA 587(ar)	0.75
142	93.9	FX 738(a)	0.75
142	56.6	FX 738(b)	0.50
142		GI 783(a)	
143	83.9	EQ 588(a)	1.50
143	82.8	FX 739(a)	1.50
143	49.7	FX 739(b)	0.75
143	53.5	GI 784(a)	0.75
144	93.5	EQ 589(a)	1.00
144	93.5	EQ 589(ar)	1.00
144	95.7	FX 740(a)	1.00
144	62.6	FX 740(b)	0.50
144	87.0	GI 785(a)	0.75
145	78.6	EQ 590(ar)	2.00
145	70.0	FX 741(a)	1.75
145	76.2	GI 786(a)	2.00
146	95.6	EQ 591(a)	1.50
146	95.6	EQ 591(ar)	1.50
146	86.9	FX 742(a)	1.25
146		GI 787(a)	
148	89.9	EQ 592(a)	6.00
148	84.6	FX 743(a)	5.00
148		FX 743(b)	
148		GI 788(a)	
150	94.8	EQ 593(ar)	4.00
150		FX 744(a)	
150	88.2	GI 789(a)	4.00
Nickel			
58	98.5	K 33(a)	0.25
58	99.3	AS-AT 141-147(a)	0.25
58	98.4	DF 422(a)	0.25
58	99.9	FJ 669(a)	0.25
58		GT 844(a)	
60	94.4	J 28(a)	0.45
60	94.4	J 28(ar)	0.45
60	87.1	K 34(a)	0.35
60	98.5	FJ 670(a)	0.50
60		GT 845(a)	
61	34.4	K 35(a)	3.50
61	80.4	AS-AT 143-149(a)	20.00
61	79.5	FJ 671(a)	20.00
61		GT 846(a)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Nickel (cont'd)			
62	68.0	K 36(a)	$2.00
62		DF 425(br)	
62	96.8	FJ 672(a)	5.00
62		GT 847(a)	
64	85.1	J 32(a)	35.00
64	80.6	DF 427(a)	35.00
64		GT 848(a)	
Palladium			
102	35.2	GG 770(a)	20.00
104	63.2	GG 771(a)	4.00
105	78.2	GG 772(a)	6.00
106	82.3	GG 773(a)	2.50
108	94.2	GG 774(a)	2.00
110	91.4	GG 775(a)	4.00
Platinum			
190	0.8	GH 776(a)	40.00
192	13.9	GH 777(a)	25.00
192	7.6	GH 777(b)	10.00
194	65.1	GH 778(a)	1.25
195	60.1	GH 779(a)	4.00
196	65.9	GH 780(a)	2.00
198	61.0	GH 781(a)	20.00
198	58.3	GH 781(b)	20.00
Potassium			
39	99.5	BJ 237(a)	1.00
39	99.9	CM 346(a)	1.00
39	99.9	CM 346(ar)	1.00
39	99.9	DA 407(a)	1.00
39	99.7	DB 410(a)	1.00
39	99.9	DT 494(a)	1.00
39	99.9	EX 621(g)	1.00
39	99.9	EY 624(i)	1.00
39	99.8	FA 629(a)	1.00
39		GN 820(a)	
40	6.2	GN 821(a)	400.00

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Potassium (cont'd)			
41	92.9	BJ 239(a)	$12.50
41	98.9	DT 496(a)	15.00
41	98.9	DT 496(ar)	15.00
41	99.2	EY 626(e)	15.00
41	99.2	EY 626(er)	15.00
41	87.8	FA 631(a)	10.00
Rhenium			
185	85.4	CP 356(a)	1.50
187	98.2	CP 357(a)	1.75
Rubidium			
85	96.0	EW 619(a)	5.00
87	89.6	EW 620(a)	6.00
Ruthenium			
96	95.5	GJ 790(a)	20.00
96		GJ 790(b)	
98		GJ 791(a)	
98		GJ 791(b)	
99		GJ 792(a)	
99		GJ 792(b)	
100		GJ 793(a)	
100		GJ 793(b)	
101		GJ 794(a)	
101		GJ 794(b)	
102		GJ 795(a)	
102	94.2	GJ 795(b)	10.00
104		GJ 796(a)	
104		GJ 796(b)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Samarium			
144	58.9	FH 660(a)	$5.00
144		GM 813(a)	
144		GM 813(b)	
147	78.4	FH 661(a)	1.50
147	81.6	EM 569(a)	1.50
147	85.1	GM 814(a)	1.50
148	76.0	EM 570(a)	1.50
148	62.4	FH 662(a)	1.00
148	72.7	GM 815(a)	1.50
149	71.5	EM 571(a)	1.00
149	73.0	FH 663(a)	1.00
149	81.5	GM 816(a)	1.50
150	74.1	EM 572(a)	3.00
150	68.0	FH 664(a)	2.50
150	64.8	GM 817(a)	2.25
152	89.9	EM 573(a)	0.75
152	93.9	FH 665(a)	0.75
152	93.9	FH 665(ar)	0.75
152	91.4	GM 818(a)	0.75
154	92.1	EM 574(a)	1.25
154	96.1	FH 666(a)	1.25
154	96.1	FH 666(ar)	1.25
154	99.1	GM 819(a)	1.25
154		GM 819(b)	
Selenium			
74	6.5	AK 109(a)	2.50
74	14.1	DS 268(a)	12.50
74	12.3	CY 397(a)	12.50
74	12.3	CY 397(ar)	12.50
74	12.1	DY 513(a)	12.50
74	18.0	FG 654(a)	25.00
76	43.5	AN 126(a)	1.75
76	41.5	BS 269(a)	1.75
76	54.8	CY 398(a)	3.50
76	54.8	CY 398(ar)	3.50
76	57.4	DY 514(a)	3.50
76	74.2	FG 655(a)	6.00
76	88.5	FG 655(b)	9.00

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Selenium (cont'd)			
77	50.1	AK 110(a)	$4.00
77	53.6	BS 270(a)	4.00
77	53.6	BS 270(ar)	4.00
77	49.4	CY 399(a)	4.00
77	58.4	DY 515(a)	4.00
77	74.2	FG 656(c)	7.50
77	83.2	FG 656(d)	8.50
77	86.6	FG 656(e)	10.00
78	79.3	AN 127(a)	1.75
78	79.3	AN 127(ar)	1.75
78	72.7	BS 271(a)	1.75
78	81.7	CY 400(a)	1.75
78	81.7	CY 400(ar)	1.75
78	82.6	DY 516(a)	1.75
78	90.2	FG 657(b)	2.50
78	96.6	FG 657(d)	3.00
80	86.7	AK 111(a)	1.00
80	94.6	BS 272(a)	1.25
80	94.6	BS 272(ar)	1.25
80	91.7	CY 401(a)	1.25
80	93.8	DY 517(a)	1.25
80	96.9	FG 658(a)	1.50
80	98.4	FG 658(b)	1.50
82	49.6	AN 128(a)	3.50
82	44.4	BS 273(ar)	3.00
82	51.6	CY 402(a)	3.50
82	51.6	CY 402(ar)	3.50
82	52.4	DY 518(a)	3.50
82	75.7	FG 659(a)	7.50
82	89.9	FG 659(b)	11.00
Silicon			
28	99.4	AI-AJ 103-106(a)	0.85
28	98.1	BW 280(a)	0.85
28	99.2	EB 524(a)	0.85
28		GC 761(a)	
29	70.8	EB 525(a)	12.00
29	80.8	GC 762(a)	17.50
30	63.9	AI-AJ 105-108(a)	25.00
30	49.6	BW 282(a)	15.00
30	64.0	EB 526(a)	25.00
30		GC 763(a)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Silver			
107	89.0	N 41(a)	$3.50
107	90.3	S-U 41(b)	3.50
107	90.3	S-U 41(br)	3.50
109	95.9	N 42(a)	1.25
109	92.2	S-U 42(b)	1.00
109	92.2	S-U 42(br)	1.00
109	99.5	EA 523(a)	1.50
Strontium			
84	46.0	FL 679(a)	20.00
86	69.9	Z 78(a)	2.50
86	69.9	Z 78(ar)	2.50
86	89.0	EH 549(a)	4.25
86	83.4	FL 680(a)	4.00
87	42.8	FL 681(a)	1.50
88	98.9	Z 79(a)	0.75
88	99.5	BL 248(a)	0.75
88	99.7	EH 551(a)	0.75
88	99.6	FL 682(a)	0.75
Sulfur			
32	97.9	CX 391(a)	1.50
32	98.5	ES 596(a)	1.50
32		GB 757(a)	
33	5.5	CX 392(a)	10.00
33	5.5	CX 392(b)	10.00
33		GB 758(a)	
34	5.4	CX 393(b)	0.10
34	14.9	ES 598(a)	12.00
34		GB 759(a)	
36	0.9	ES 599(a)	200.00
36		GB 760(a)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Tellurium			
120	22.3	DX 505(a)	$125.00
122	77.8	AU 154(a)	10.00
122	86.3	DX 506(a)	12.50
122	81.7	FE 641(a)	11.00
123	34.9	AU 155(a)	10.00
123	60.9	DX 507(a)	25.00
123	48.6	FE 642(a)	15.00
124	72.5	AU 156(a)	5.00
124	83.9	CA 295(a)	7.00
124	21.8	CA 295(b)	1.00
124	76.5	DX 508(a)	6.00
124	81.3	FE 643(a)	7.00
125	81.1	AU 157(a)	2.75
125	87.9	CA 296(a)	3.00
125	87.9	CA 296(ar)	3.00
125	40.5	CA 296(b)	1.00
125	81.7	DX 509(a)	2.75
125	80.5	FE 644(a)	2.75
126	93.2	AU 158(a)	1.00
126	95.4	CA 297(a)	1.00
126	95.4	CA 297(ar)	1.00
126	79.0	CA 297(b)	0.75
126	89.7	DX 510(a)	1.00
126	93.5	FE 645(a)	1.00
128	93.5	AU 159(a)	0.75
128	94.4	CA 298(a)	0.75
128	94.4	CA 298(ar)	0.75
128	91.8	CA 298(b)	0.75
128	94.0	CA 298(c)	0.75
128	82.3	DX 511(a)	0.50
128	96.5	FE 646(a)	0.75
130	93.0	AU 160(a)	0.75
130	97.4	CA 299(a)	0.75
130	93.5	CA 299(br)	0.75
130	78.2	DX 512(a)	0.50
130	97.8	FE 647(a)	0.75

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Thallium			
203	75.6	BV 278(a)	$12.50
203	58.8	CC 307(a)	15.00
203	86.0	CF 322(a)	20.00
203	34.1	CG 324(a)	10.00
203	61.0	CH 326(br)	15.00
205	89.5	BR 267(a)	4.00
205	92.8	BU 277(a)	4.00
205	95.2	BV 279(a)	5.00
205	98.7	BX 285(a)	5.00
205	92.8	BY 287(a)	4.00
205	86.1	CC 308(a)	3.00
205	95.6	CF 323(a)	5.00
205	91.8	CH 327(a)	4.00
205	90.5	CJ 333(a)	4.00
Tin			
112	30.8	BI 227(a)	4.00
112	58.9	FS 710(a)	15.00
114	50.0	EC 528(a)	35.00
114	45.1	FS 711(a)	30.00
115	4.5	BI 229(a)	1.00
115	14.0	EC 529(a)	10.00
115		FS 712(b)	
116	74.5	AY 176(a)	0.50
116	74.5	AY 176(as)	0.50
116	58.4	BC 198(a)	0.35
116	43.2	BI 230(a)	0.25
116	89.6	CR 363(a)	0.75
116	92.6	EC 530(a)	0.75
116	90.9	FS 713(a)	0.75
116		FS 713(b)	
117	75.3	BI 231(b)	1.00
117	75.3	BI 231(bs)	1.00
117	73.9	CR 364(a)	1.00
117	77.1	EC 531(a)	1.00
117	61.8	FS 714(a)	1.00
117		FS 714(b)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Tin (cont'd)			
118	69.3	AL 117(a)	$0.25
118	90.1	AY 178(a)	0.50
118	90.1	AY 178(as)	0.50
118	91.8	BC 200(a)	0.50
118	84.6	BI 232(a)	0.50
118	93.3	CR 365(a)	0.50
118	94.9	EC 532(a)	0.50
118	95.9	FS 715(a)	0.50
118		FS 715(b)	
119	77.1	AY 179(a)	0.75
119	77.1	AY 179(as)	0.75
119	64.4	BC 201(a)	0.50
119	78.5	BI 233(a)	0.75
119	78.3	CR 366(a)	0.75
119	79.8	EC 533(a)	0.75
119		FS 716(a)	
119		FS 716(b)	
120	93.5	AL 119(a)	0.25
120	95.4	AY 180(a)	0.25
120	95.4	AY 180(as)	0.25
120	72.6	BC 202(a)	0.15
120	53.6	BI 234(a)	0.10
120	97.0	CR 367(a)	0.25
120	98.1	EC 534(a)	0.25
120	98.2	FS 717(a)	0.25
120		FS 717(b)	
122	45.8	BI 235(a)	0.50
122	83.7	CR 368(a)	1.75
122	88.9	EC 535(a)	1.75
122	88.9	EC 535(au)	1.75
122	84.6	FS 718(a)	1.50
122		FS 718(b)	
122	71.0	BI 236(a)	1.00
124	71.0	BI 236(ar)	1.00
124	83.1	CR 369(au)	1.25
124	95.0	EC 536(a)	1.75
124	95.0	EC 536(as)	1.75
124	90.3	FS 719(a)	1.75
124		FS 719(b)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Titanium			
46	84.3	BF 215(a)	$2.50
46	84.3	BF 215(ar)	2.50
46	82.7	EN 576(a)	2.50
46	82.7	EN 576(ar)	2.50
46	84.4	GA 752(a)	2.50
47	82.1	BF 216(a)	1.25
47	63.1	EN 577(a)	1.00
47	82.8	GA 753(a)	1.25
47	70.0	GA 753(b)	1.15
48	99.2	BF 217(a)	0.35
48	98.9	EN 578(a)	0.35
48	98.9	EN 578(ar)	0.35
48	97.6	GA 754(a)	0.35
48	96.8	GA 754(b)	0.35
49	77.6	BF 218(a)	3.25
49	77.6	BF 218(ar)	3.25
49	79.4	GA 755(a)	3.25
49	27.5	GA 755(b)	0.30
50	81.4	EN 580(a)	3.50
50	80.3	GA 756(a)	3.50
50	71.4	GA 756(b)	2.00
Tungsten			
180	5.0	CL 340(a)	50.00
180	5.0	CL 340(ar)	50.00
180	7.0	EL 561(a)	100.00
182	94.3	BG 221(a)	1.25
182	91.6	CL 341(a)	1.25
182	92.3	EL 562(a)	1.25
183	86.2	BG 222(a)	1.50
183	82.0	CL 342(a)	1.50
183	82.6	EL 563(a)	1.50
184	95.7	BG 223(a)	1.00
184	91.1	CL 343(a)	1.00
184	91.1	CL 343(ar)	1.00
184	95.1	EL 564(a)	1.00
186	97.9	BG 224(a)	1.00
186	97.2	CL 344(a)	1.00
186	97.2	CL 344(ar)	1.00
186	97.5	EL 565(a)	1.00

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Vanadium			
50	22.8	FM 683(b)	$60.00
50	22.8	FM 683(br)	60.00
51	99.9	FB 633(a)	0.75
51	99.9	FM 684(a)	0.75
Zinc			
64	83.8	AG 97(a)	0.35
64	93.1	EK 556(a)	0.60
66	78.4	AH 100(a)	0.50
66	93.8	EK 557(a)	0.85
67	56.0	BK 242(a)	2.50
67	60.5	EK 558(a)	2.75
68	93.9	BN 243(a)	0.80
68	95.5	EK 559(a)	0.80
70	32.9	AG-AH 99-102(a)	4.50
70	32.9	AH 102(a)	4.50
70	32.0	BK 244(a)	4.50
70	32.0	BK 244(ar)	4.50
Zirconium			
90	91.7	AA 80(a)	0.50
90	91.7	AA 80(ar)	0.50
90	98.0	CK 334(a)	0.75
90	98.0	CK 334(ar)	0.75
90	95.6	CV 381(a)	0.75
90	98.7	EE 539(a)	0.75
90		GQ 831(a)	
91	54.4	AA 81(a)	1.00
91	54.4	AA 81(ar)	1.00
91	86.6	CK 335(a)	2.75
91	86.6	CK 335(ar)	2.75
91	75.1	CV 382(a)	2.00
91		GQ 832(a)	
92	92.7	CK 336(a)	1.75
92	92.7	CK 336(ar)	1.75
92	89.8	CV 383(a)	1.50
92	95.4	EE 541(a)	1.75
92		GQ 833(a)	

ELECTROMAGNETICALLY CONCENTRATED ISOTOPES

Mass	Isotopic Abundance Enriched (at.%)	Production Lot	Selling Price Per mg
Zirconium (cont'd)			
94	82.1	AA 83(a)	$1.25
94	82.1	AA 83(ar)	1.25
94	92.8	CK 337(a)	1.50
94	92.8	CK 337(ar)	1.50
94	80.9	CV 384(a)	1.25
94	80.9	CV 384(ar)	1.25
94	97.9	EE 542(a)	1.75
94		GQ 834(a)	
96	40.6	AA 84(a)	6.50
96	74.6	CK 338(a)	10.00
96	74.6	CK 338(ar)	10.00
96	89.5	EE 543(a)	15.00
96		GQ 835(a)	