SURVEY OF INDUSTRIAL RADIOISOTOPE SAVINGS

Only three decades after the discovery of artificial radioactivity and two after radioisotopes became available in quantity, methods employing these as sources or tracers have found widespread use, not only in scientific research, but also in industrial process and product control. The sums spent by industry on these new techniques amount to millions of dollars a year. Realizing the overall attitude of industry to scientific progress - to accept only methods that pay relatively quickly - one can assume that the economic benefits must be of a still larger order of magnitude.

In order to determine the extent to which radioisotopes are in "daily" use and to evaluate the economic benefits derived from such use, IAEA decided to make an "International Survey on the Use of Radioisotopes in Industry". In 1962, the Agency invited a number of its highly industrialized Member States to participate in this Survey. Similar surveys had been performed in various countries in the 1950's. However, the approaches and also the definition of the economic benefits differed greatly from one survey to another. Hence, the Agency's approach was to try to persuade all countries to conduct surveys at the same time, concerning the same categories of industries and using the same terms of costs, savings, etc.

In total, 24 Member States of the Agency agreed to participate in the survey and in due course they submitted contributions. The quality of these differed considerably. In some cases, the national bodies responsible for the local surveys took their task seriously and submitted lengthy reports providing full details on how their industries made use of radioisotopes and what they thought were the benefits in monetary terms. In other cases only rather general statements were made or reports were written on the use, as indicated by the records of the licensing authorities.

Although USA and the USSR did not participate in this study, the USA submitted the results of an earlier survey (1958), together with information to bring the old results more up to date. In the case of the USSR, useful information could be extracted from the Russian literature and conference proceedings.

The national reports were discussed at a "Study Group Meeting on Radioisotope Economics", convened in Vienna in March 1964 (See Bulletin, August 1964, p.26). Based upon these discussions, the national reports have been edited and summarized. A publication showing the administration of the Survey and providing all details is now published by the Agency.

From the publication it is evident that in general the return of technical information was quite high, of the order of 90 %, but, unfortunately the economic response was much lower. However, most of the reports had some bearing on the economic aspects also, and in several cases it was possible to compare the economics of individual applications in quite a few countries. This was true of certain gauging applications and the applications of gamma radiography to the control of welds and castings.

MANY MILLIONS SAVED

Hence, 20 countries reported on the number of radioisotope gauges installed in various categories of industry. Tables I - III show the number of the three main types of gauges that were distinguished in the survey.

As regards economy, considerable differences were recorded from one type of application to another, but the order of magnitude differed not very much from one country to another – savings in raw material and scrap and increased production with 0.1 to 5%, depending on the purpose of installation.

The average cost-benefit ratios were, for example, in paper thickness gauging 1 to 6. Extremely high figures were reported, e.g. from Australia and Finland. In other industries, such as the textile and the plastics and rubber industry, the cost-benefit ratios from gauging varied between 1 - 2 and 1 - 50. Some of the highest values were reported from France, Spain and the Netherlands.

In the case of radiography, Table IV gives the number of gamma sources applied in various countries.

Considerable savings were also reported from the use of gamma radiography. Although the most important benefits, such as increased safety, are intangible and fell beyond the scope of the survey, many examples of savings in labour or testing time were quoted. The benefits were calculated in comparison with other methods of destructive or non-destructive testing. The cost-benefit ratios reported by industry ranged from 1 - 3 to 1 - 13.

Table V shows a comparison made in the report of the number of gauging and radiography devices in the various countries, and put it also in relation to the output of their industry.

The national reports covered also tracing, ionization applications and the industrial applications of massive irradiation. Although the two latter techniques are of great potential importance, not least in developing countries, their economic relevance in the survey period was still very limited. Tracing, however, was rather wide-spread. No less than 1 200 industrial applications could be accounted for.

Also the application of tracers created savings of many kinds, e.g. in industrial research, but here reliable cost-benefit ratios were extremely difficult to establish. In industrial processing and product control, however, ratios from 1 - 10 to 1 - 50 were frequent. Most important were here the decrease of time required for analysis and wear tests, as well as improvements of chemical processes.

The global results of the savings estimates are shown in Table VI. Here figures for the 24 countries are presented together with assumptions made by authoritative bodies in USA and the USSR. It is seen from the table that the direct net savings are considerable. In fact, both in the 24 participating countries and in the United States, they approach one per thousand of the

(continued after the tables)

TABLE I

THICKNESS GAUGES
In Various Industries — Broad Product Group

COUNTRY:	Food	Tobacco	Textile	Wood & Paper	Rubber	Chem. & Plastics	Cement	Petrol & Coal	Basic Metals	Machinery	Services	Not Identified	Total
ARGENTINA	-	-	2	3	-	1	-	-	4	-	1	-	11
AUSTRALIA	-	-	3	12	-	20	-	-	2	-	2	-	39
AUSTRIA	-	-	-	16	5	7	-	-	2	-	-	-	30
BELGIUM	-	-	2	42	1	9	-	1	9	-	-	-	64
CANADA	1	-	1	165	8	17	1	9	17	43	11	-	284
CSSR	-	-	2	5	3	8	-	-	58	-	5	-	81
DENMARK	3	-	-	56	2	5	-	-	1	-	-	-	67
FINLAND	-	-	2	31	1	3	-	-	-	-	1	-	38
FRANCE	-	-	81	166	35	38	2	-	16	20	-	16	374
GERMANY *	1	-	18	382	69	427	86	16	198	20	11	3	1231
JAPAN	-	-	6	20	11	13	8	1	46	14	5	12	127
NETHERLANDS	-	-	-	63	10	11	-	-	5	-	-	-	89
NORWAY	-	-	5	48	4	6	-	-	2	-	-	-	65
POLAND	-	-	-	5	4	-	-	-	8	-	-	-	17
PORTUGAL	-	-	-	3	-	-	-	-	-	-	-	-	3
SOUTH AFRICA	-	-	-	10	11	-	-	-	-	-	-	-	21
SPAIN	-	-	-	4	6	12	-	-	12	-	-	-	34
SWEDEN	-	-	20	140	10	75	10	-	-	15	-	-	270
U.K.	1	-	72	357	41	71	17	4	93	51	11	-	718
YUGOSLAVIA	-	-	1	3	-	-	1	-	8	1	-	-	14
TOTAL	6	-	215	1531	221	723	125	31	481	164	58	22	3577

* *Based upon national report and other additional sources of information. The total is probably still too low.*

TABLE II

DENSITY GAUGES

In Various Industries — Broad Product Group

COUNTRY	Food	Tobacco	Textile	Wood & Paper	Rubber	Chem. & Plastics	Cement	Petrol & Coal	Basic Metals	Machinery	Services	Not Identified	Total
ARGENTINA	-	-	-	-	-	-	-	-	-	-	-	-	-
AUSTRALIA	1	32	-	-	-	1	1	-	-	-	-	-	35
AUSTRIA	-	-	-	-	-	-	-	-	-	-	-	-	-
BELGIUM	-	4	-	-	-	-	-	1	-	-	-	-	5
CANADA⊕	13	464	-	16	-	16	11	4	135⊕	9	35	-	703
CSSR	1	-	-	-	-	6	-	2	-	-	-	-	9
DENMARK	-	72	6	-	-	-	2	1	-	-	-	-	81
FINLAND	-	-	-	-	-	1	-	-	2	-	-	-	3
FRANCE	-	-	-	-	-	15	-	8	2	7	-	16	48
GERMANY*	1	-	-	5	1	5	-	2	1	1	1	-	17
JAPAN	-	-	-	-	-	2	1	2	7	4	9	6	31
NETHERLANDS	-	59	-	-	-	-	-	-	-	-	7	-	66
NORWAY	-	3	-	-	-	-	-	-	1	1	-	-	5
POLAND	-	-	-	-	-	1	-	3	-	-	-	-	4
PORTUGAL	-	-	-	-	-	-	-	-	-	-	-	-	-
SOUTH AFRICA	-	59	-	-	-	1	-	-	12	-	-	-	72
SPAIN	-	2	-	-	-	-	-	-	-	-	-	-	2
SWEDEN	-	20	-	1	-	-	-	4	-	-	-	-	25
U.K.	2	897	-	3	-	25	2	8	-	11	9	-	957
YUGOSLAVIA	1	-	-	2	2	1	-	-	-	-	-	-	6
TOTAL	19	1612	6	27	3	74	17	35	160	33	61	22	2069

** Figures are low, due to low response rate.*

⊕ Classification in probably sometimes inappropriate.

TABLE III

LEVEL GAUGES

In Various Industries — Broad Product Group

COUNTRY	Food	Tobacco	Textile	Wood & Paper	Rubber	Chem. & Plastics	Cement	Petrol & Coal	Basic Metals	Machinery	Services	Not Identified	Total
ARGENTINA	-	-	-	-	-	-	1	-	1	-	-	-	2
AUSTRALIA	-	-	-	-	-	9	-	30	4	2	-	-	45
AUSTRIA	-	-	-	-	-	1	-	-	-	-	-	-	1
BELGIUM	4	-	-	5	-	10	6	26	20	-	3	-	74
CANADA	10	-	-	12	-	85	9	6	12	30	4	-	168
CSSR	1	-	-	-	-	15	5	-	2	2	-	-	25
DENMARK	-	-	-	-	-	6	-	6	6	2	5	-	25
FINLAND	-	-	-	17	-	5	-	4	2	-	-	-	28
FRANCE	7	-	6	11	-	102	40	125	164	119	279	5	858
GERMANY *	2	-	-	5	-	22	16	7	20	20	7	-	99
JAPAN	-	-	42	26	-	56	1	7	9	10	2	1	154
NETHERLANDS	-	-	-	-	-	3	9	128	1	-	8	-	149
NORWAY	-	-	-	9	-	-	-	-	3	2	-	-	14
POLAND	-	-	-	-	-	44	10	33	3	-	98	-	188
PORTUGAL	-	-	-	-	-	-	-	1	-	-	-	-	1
SOUTH AFRICA	-	-	-	-	-	-	2	-	2	-	-	-	4
SPAIN	-	-	-	-	-	2	-	-	-	-	-	-	2
SWEDEN	10	-	-	110	-	30	-	5	10	20	-	-	185
U.K	16	-	-	2	-	161	34	20	45	27	12	-	317
YUGOSLAVIA	4	-	-	3	-	7	-	-	-	-	-	-	14
TOTAL	54	-	48	200	-	558	133	398	304	234	418	6	2353

* *Figures are low, due to the low response rate.*

TABLE IV

GAMMA RADIOGRAPHY SOURCES

In the Various Industries – Broad Product Group

COUNTRY	Food	Tobacco	Textile	Wood & Paper	Rubber	Chem. & Plastics	Cement	Petrol & Coal	Basic Metals	Machinery	Services	Not Identified	Total
ARGENTINA	-	-	-	-	-	1	-	5	2	1	18	-	27
AUSTRALIA	-	-	-	-	-	-	-	1	12	7	30	-	50
AUSTRIA	-	-	-	-	-	-	-	-	30	-	-	-	30
BELGIUM	-	-	-	-	-	-	-	1	17	13	20	-	51
CANADA	-	-	-	-	-	-	-	5	60	45	35	-	145
CSSR	-	-	-	-	-	-	8	-	12	138	10	-	168
DENMARK	-	-	-	-	-	-	-	-	1	-	20	-	21
FINLAND	-	-	-	-	-	-	-	-	4	1	3	-	8
FRANCE*	-	-	-	-	1	11	1	19	80	300	50	38	500
GERMANY*	-	-	-	1	-	10	15	6	40	200	28	-	300
JAPAN	-	-	1	-	-	8	-	-	39	112	2	8	170
NETHERLANDS	-	-	-	-	-	-	-	8	-	127	-	-	135
NORWAY	-	-	-	-	-	-	-	1	1	13	1	-	16
POLAND*	-	-	-	-	-	-	-	-	-	60	20	-	80
PORTUGAL*	-	-	-	-	-	-	-	-	-	10	-	-	10
SOUTH AFRICA	-	-	-	-	-	1	-	-	2	14	31	-	48
SPAIN	-	-	-	-	-	-	-	-	1	16	-	-	17
SWEDEN	-	-	-	-	-	-	-	-	10	20	50	-	80
U.K.	-	-	-	-	-	14	4	10	147	364	167	-	706
YUGOSLAVIA	-	-	-	-	-	-	-	1	3	93	25	2	124
TOTAL	-	-	1	1	1	45	28	57	461	1534	510	48	2686

* *Approximate figures.*

TABLE V

COMPARISON OF THE USE OF GAUGING AND RADIOGRAPHY IN VARIOUS COUNTRIES

Country	Industrial production million US$	Gauging		Radiography	
		Number of devices	Number per thousand million US$	Number of sources	Number per thousand million US$
ARGENTINA	1 760	33	19	27	15
AUSTRALIA	6 000	125	21	50	8
AUSTRIA	3 100	34	11	30	10
BELGIUM	4 600	144	30	51	11
CANADA	12 400	1 394	112	145	11
CSSR	n.a.	115	-	168	-
DENMARK	2 600	174	67	21	8
FINLAND	1 800	69	38	8	4
FRANCE	30 800	1 465	47	500	16
GERMANY, Fed. Rep. of	36 400	2 000	55	300	8
JAPAN	18 600	341	16	170	9
NETHERLANDS	4 700	304	64	135	28
NORWAY	1 700	84	48	16	9
POLAND	9 800	219	22	80	8
PORTUGAL	950	8	8	10	10
SOUTH AFRICA	2 700	113	42	48	18
SPAIN	3 100	41	13	17	5
SWEDEN	5 400	480	89	80	15
U.K.	32 000	2 037	64	706	22
U.S.A.	157 000	8 000	51	n.a.	-
YUGOSLAVIA	2 200	41	19	124	56

TABLE VI

GLOBAL ANNUAL SAVINGS FROM RADIOISOTOPE USE

$ million

	24 countries (1961-63)	U S A (1963)	U S S R (1961)	T o t a l
Gauging	26.7 - 43.4	35.2 - 50.4	100+	162 - 194
Radiography	12.1 - 28.9	4.0 - 7.6	22	38 - 58
Ionization	1 - 2	-*	-*	1 - 2
Tracing	10 - 40	27 - 48⊕	58+	95 - 146
Massive irradiation	-	-	-	-
T o t a l	49 - 104	66 - 106	180	296 - 400

* *included in other groups.*

⊕ *includes also certain gauging and ionization applications.*

\+ *the exact distribution of savings in gauging and tracing is not known.*

total industrial output (which is around $180 and $160 thousand million respectively). In the Soviet Union the economic importance is still higher, and of the order of two to three per thousand.

These results are even more striking when one takes into account the limited number of firms that have so far found applications for radioisotope methods. There are no doubt great domains of industry that still await the introduction of these helpers. One should also bear in mind that these early harvests of atomic energy derive from rather marginal and frequently overlooked parts of nuclear research. One result of the survey is to show that much may still be expected from industrial radioisotope methods; it is particularly important that the developing countries give them due consideration when starting their industrialization.