

## Historical Evaluation of the Transport of Radioactive Materials in Italy

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### INTRODUCTION

Relevant duty of a Competent Authority is to verify that the transport of radioactive material is carried out in compliance with national laws, both based on IAEA and international Regulation. Safety assessment and risk analysis and survey actions are necessary to carry out this duty; therefore it is essential to have data regarding domestic shipments of radioactive materials.

In Italy the transport of radioactive material is carried out by authorised carriers. The authorisation is issued by the Minister of Industry together with the Minister of Transport. An item, in the authorisation decree, obliges the carrier to send to the Competent Authority, on three months bases, data of the shipments carried out according to a specific format.

The above mentioned rules, together with "ad hoc surveys campaign" carried out in the most important traffic places (railway stations and airports), allow the Competent Authority to have a large number of data that permitted to realise a TRANSPORT DATA-BANK.

## TRANSPORT DATA-BANK CHARACTERISTICS

Data are collected from the authorised carriers by a specific format issued by the Minister of Industry. Every year the "records" of shipments sent to the Competent Authority amount to about 300.000 ( in each format there are more than one record ). A relevant percentage (about 70%) of these data are reported on magnetic tape; the other data are reported on paper sheets.

The DATA-BANK is structured according to four principal lines regarding respectively:

- administrative data;
- package characteristics;
- radioactive material characteristics;
- data of the shipment.

The table below shows the information enclosed into the DATA-BANK.

Administrative data	Package characteristics	Radioactive material characteristics	Shipment information
carrier	type	chemical symbol	mode of transport
previous carrier	transport index	activity	date of departure
subsequent carrier	size	physical state	date of arrival
consignor	mass	mass	
consignor province	identification certificate		
consignee			
consignee province			

The software used for the management of DATA-BANK is the Digital Rdb/VAX, that allows to make a merge between the SQL (Structured Query Language) and the FORTRAN language. The SQL allows the access to the data in a simple and interactive manner while FORTRAN allows to realise specific procedures for data introduction and data elaboration.

The most important problem for a data-bank management is to verify the confidence of data. In fact the risk assessment and radiation protection evaluation (for example the dose to the workers), made by the use of DATA-BANK, must have an high level of confidence. Therefore it is important to point out that a lot of time has been spent and will be spent to validate information contained into the DATA-BANK. This phase consists of a number of checks to identify either "systematic " or "random" errors. In particular specific procedures have been written to identify:

- values not included in the range of numeric variables (transport index);
- values that can have an influence for some evaluations (average transport index).

Procedures have been written to allow a good quality of data elaboration and to permit to other people to verify the confidence of data.

Another evolution phase for the DATA-BANK will be to process information about transport of large sources of radioactive materials and fissile materials and transport of isotopes with a long half-life. That will be useful in emergency situations and also to make evaluation on the storage facilities for radioactive materials.

DATA EVALUATION OF SHIPMENTS IN THE PERIOD 1987-1990.

A summary of data of the transport of radioactive materials carried out in Italy during the period 1987 - 1990 is reported in the following tables. In the tables are not included the shipments of pharmaceutical radioactive materials.

Year 1987

Mode of transport	Road		Air		Sea		Rail	
	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)
Radiotherapy	63	6312	8	954.6	-	-	2	87.32
Industrial Irradiation Facility	3	12025	-	-	1	6660	-	-
Industrial Radiography	6500	3500	-	-	-	-	2600	1400
Irradiated Fuel	31	402836	-	-	12	271686	-	-
Nuclear Fuel	2695	18.858	3	3.601	-	-	-	-

Year 1988

Mode of transport	Road		Air		Sea		Rail	
	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)
Radiotherapy	98	8873	6	593	-	-	10	757
Industrial Irradiation Facility	5	16035	-	-	2	9435	-	-
Industrial Radiography	7000	3700	-	-	-	-	2800	1500
Irradiated Fuel	11	85635	-	-	11	85635	-	-
Nuclear Fuel	62	0.164	7	0.029	-	-	-	-

Year 1989

Mode of transport	Road		Air		Sea		Rail	
	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)
Radiotherapy	49	4450	10	1180	-	-	10	610
Industrial Irradiation Facility	1	4070	-	-	1	4070	-	-
Industrial Radiography	7000	3770	-	-	630	339	2450	1320
Irradiated Fuel	26	157470	-	-	26	157470	-	-
Nuclear Fuel	473	7.77	16	0.155	-	-	-	-

Year 1990

Mode of transport	Road		Air		Sea		Rail	
	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)	N° Movements	Activity (TBq)
Radiotherapy	75	8495	16	2006	-	-	11	1947
Industrial Irradiation Facility	7	20720	2	7215	-	-	2	2405
Industrial Radiography	6850	3680	-	-	645	347	2520	1358
Irradiated Fuel	43	167549	-	-	43	167549	-	-
Nuclear Fuel	321	2.111	135	0.285	-	-	-	-

## SURVEYS AD HOC

Another way to verify if the transport of radioactive materials would be carried out in compliance with national and international regulations is to carry out surveys ad hoc in the most relevant traffic places. The Italian Competent Authority (Enea-Disp) carried out in the last years several measurement campaigns in the most important national railway station and airport. In following are reported the results of a survey campaign carried out during one week in the railway station and the airport of the same city.

Table I shows the data concerning a one week checks carried out in the city of Turin. It must be noted that the 31% of the railway station packages were represented by the same packages coming from the airport. During the week through the airport passed the 75% of the total of packages.

**TABLE I**

	Airport	Railway Station	Total (1)
N° packages	437	214	584
Total activity (GBq)	1265	188	1400
Average activity (GBq) (2)	3,2	1,5	3,1
Average Transport Index measured (3)	0,3	0,3	0,3
Average Transport Index reported on the label	0,4	0,4	0,4
Average Radiation level on the surface of the packages (mSv/h) (3)	0,075	0,06	0,075
Max. radiation level on the surface of the packages (mSv/h)	1,5	0,8	1,5

(1) The total number of packages takes into consideration of the 67 packages transported from the airport to the railway station and therefore measured one time only.

(2) The value is calculated taking into account of the values grater than 0.

(3) The value is calculated taking into account of the values grater than the background radiation (0.08  $\mu$ Sv/h).

### *Type of packages and labelling*

The types of package are shown in detail in TABLE II. It must be noted that there was a large number of Type A packages, also used as excepted packages. Moreover in the row of Industrial packages are included excepted package too. In TABLE III are reported the labels distribution of the packages.

In TABLE IV and fig.2 are reported some data concerning the isotopes transported.

**TABLE II**

Package	Airport	Railway Station	Total(1)
N° packages 'Type INDUSTRIAL'	68	90	154
N° packages 'Type A'	367	122	426
N° packages 'Type B'	2	2	4

(1) The total number of packages takes into consideration of the 67 packages transported from the airport to the railway station and therefore measured one time only.

**TABLE III**

Label	Airport	Railway Station	Total(1)
EXCEPTED	119 (27%)	93 (44%)	198
WHITE	156 (36%)	44 (21%)	173
II-YELLOW	136 (31%)	59 (28%)	168
III-YELLOW	26 (6%)	14 (7%)	37
NONE LABEL	-	4	4

(1) The total number of packages takes into consideration of the 67 packages transported from the airport to the railway station and therefore measured one time only.

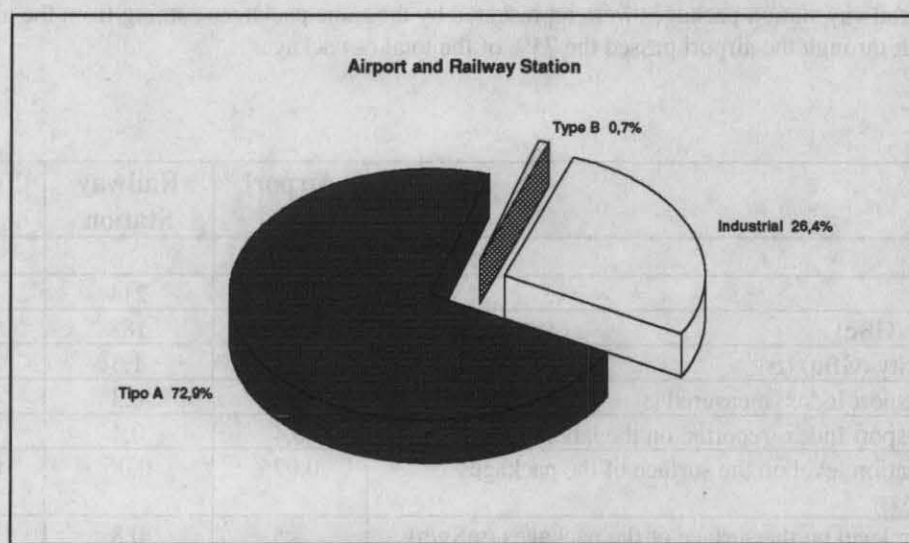


Fig.1 Percentage distribution of packages

**TABLE IV**

Isotope	Average Activity (Bq)	maximum Activity (Bq)	TI measured average	TI measured max.
C-14	2,6E6	3,7E6	-	-
CO-57	2,2E5	2,2E5	-	-
CO-60	3,7E6	3,7E6	0,03	0,03
CR-51	3,7E7	3,7E7	0,01	0,01
CS-137	3,7E5	3,7E5	0,01	0,01
ER-169	3,7E8	3,7E8	-	-
GA-67	2,8E8	1,1E9	0,11	0,45
H-3	5,0E8	1,0E9	-	-
I-125	8,5E5	1,1E7	0,04	0,1
I-131	2,8E8	1,8E9	0,22	0,7
IN-111	1,1E8	1,1E8	0,04	0,1
IR-192	6,7E10	4,7E11	0,86	1,5
P-32	1,8E8	1,8E8	-	-
SR-90	3,7E4	3,7E4	-	-
TC-99	6,6E9	2,2E10	0,66	2,0
TL-201	2,2E8	7,4E8	0,04	0,15
XE-133	2,5E9	5,5E9	0,07	0,1

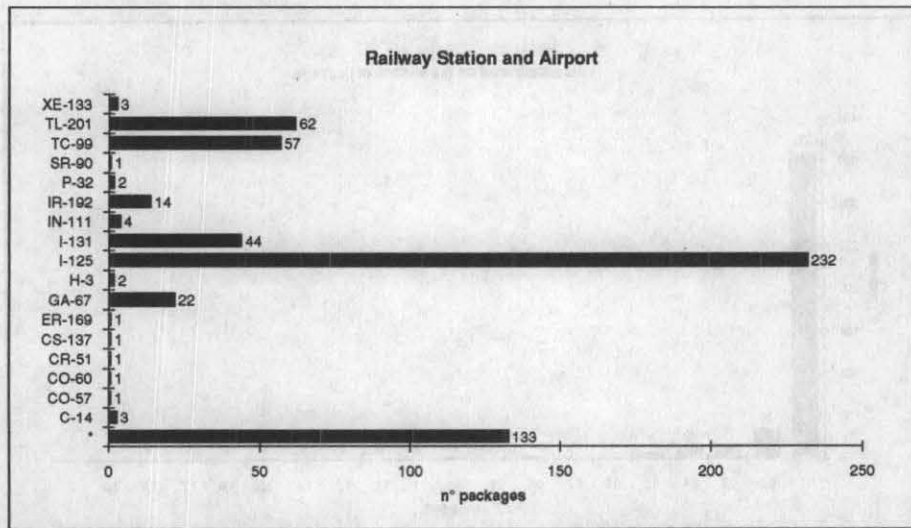


Fig.2 Distribution of packages per isotopes (with the symbol (\*) are represented the excepted packages)

### Transport index and radiation level

Data regarding measurements of the transport index (TI) and the radiation level on the surface of the packages are interesting about the radiation protection. Figure 3 shows the transport index distribution measured compared with the distribution of transport index reported on the labels. Figure 4 shows the radiation level measured on the surface of packages.

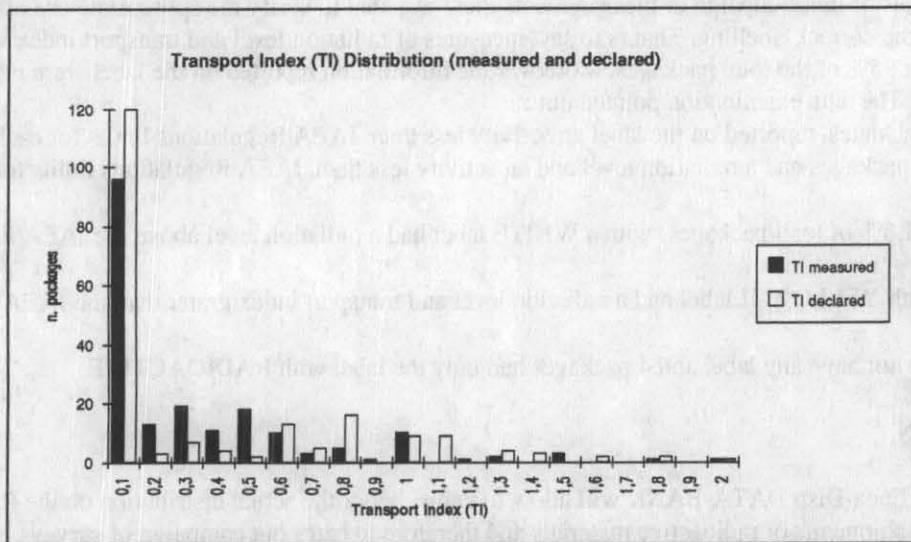


Fig.3

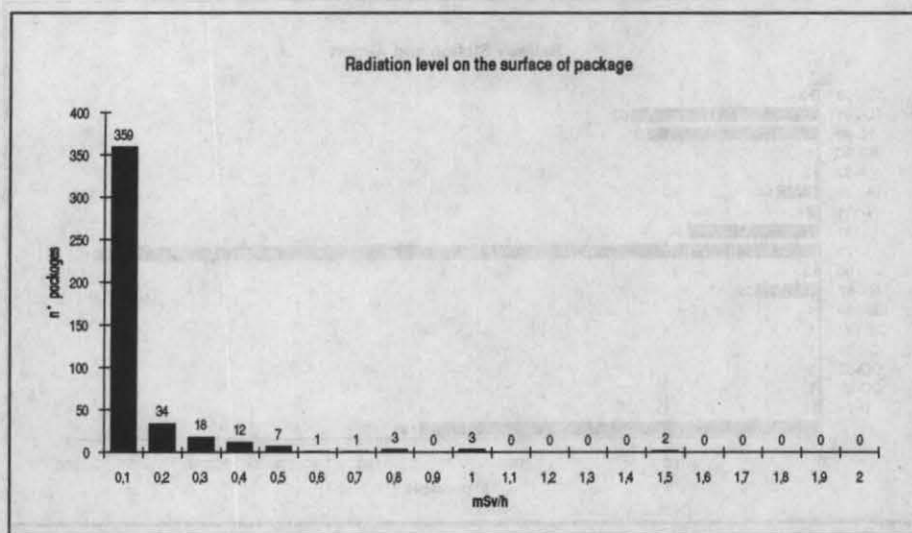


Fig.4

#### Contamination controls

A non-fixed contamination controls were carried out on 23 packages, equal to 4% of the total packages. The smear-tests were measured in the Enea-Disp laboratory. The results of the measurements pointed out the absence of non-fixed contamination on those packages.

#### Results of the survey

Among the goals of this campaign of measurements there was that to verify the appropriate use of the packages and the correct labelling. That is to say, measures of radiation level and transport index were carried out over about 95% of the total packages. Moreover the information reported on the label were recorded for other controls. The data examination pointed out :

- all Type A packages reported on the label an activity less than IAEA Regulations limits for each isotope;
- all Excepted packages had a radiation level and an activity less than IAEA Regulations limits for each isotope;
- 9 packages (1.5% of total packages) with a WHITE label had a radiation level above the IAEA limits for this category;
- 1 package with YELLOW-II label had a radiation level and transport index greater than the IAEA limits for this category;
- 1 package did not have any label and 4 packages had only the label with RADIOACTIVE.

#### CONCLUSION

The use of the Enea-Disp DATA-BANK will allow to know better the actual distribution on the Italian territory of the shipments of radioactive materials and therefore to carry out campaign of surveys in consistent manner.

Moreover it will be able to help the Competent Authority to makes evaluation of dose to workers deriving from the transport of radioactive materials. This will be possible only if the data collected into the Data-Bank will have the right level of confidence. In this prospective we are moving to establish specific procedures to verify the confidence of data coming from the authorised carriers.



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