TOWARDS THE IMPLEMENTATION OF ALARA IN TRANSPORT

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INTRODUCTION

Radiation exposures are required to be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account. The optimisation of protection is one of the principles of the system of radiological protection recommended by the International Commission on Radiological Protection (ICRP 1990). The ALARA principle is frequently appealed to in transport but its implementation is rarely documented: a structured approach is required to assist management, workers and regulators in applying it.

For transport workers it is possible to obtain data on the level of individual doses likely to be incurred in well-managed operations. This information can then be used as an example of good practice for other comparable situations. It will also enable trends in exposures to be identified and examined. Guidance on the optimisation of radiation protection in the transport of radioactive material has been published by the International Atomic Energy Agency (IAEA 1986): this guidance is being updated.

DOSE CONSTRAINTS

ICRP, in its summary of recommendations (ICRP 1990), states that for many types of occupation, it is possible to reach conclusions about the level of individual doses likely to be incurred in well-managed operations. This information can then be used to establish a dose constraint for that type of occupation. The identification of a well-managed practice would require data, over a number of years, on exposures and operational arrangements.

IMPLEMENTATION IN TRANSPORT

Implementing ALARA requires a structured approach with commitment at all staff levels. Management must provide adequate facilities and establish a suitable exposure database. Records of operational procedures and any changes implemented should be kept. Adequate documentation is important. The CEC has published a practical book (CEC 1991) on ALARA-From theory towards practice: it contains much useful guidance. IAEA has published guidance on optimisation in transport (IAEA 1986). An ALARA procedure may require the use of decision-aiding techniques but these are independent of the procedure itself and are not always necessary. The ALARA procedure is an aid to decision making.

Companies transporting radioactive materials are recommended to achieve a strong commitment to ALARA and to establish an adequate database. Modelling techniques and measurements can be used for assessing worker exposure and, the former for assessing public exposure. In many cases exposures can be optimised, for little cost, by changes in operational procedures.

RADIATION EXPOSURES

There are a large number of persons employed in transport although not all will come into contact with packages containing radioactive materials. The large numbers of packages carried primarily by road but also by rail, sea and air, give rise to exposure of members of the public. Packages, even when not carried under exclusive use, are allowed surface dose rates of up to 2 mSv per hour (IAEA 1990): such packages may be manually handled by workers and be transported in some passenger conveyances.

A recent review of the radiation exposure from the normal transport of radioactive materials within the UK by road and rail (Gelder 1992), showed that radiation doses were reduced during the nineteen-eighties. The collective dose to all transport workers was apparently halved between 1982 and 1989, however, much of this was due to improved data, although real reductions were affected for the most exposed workers. This

demonstrates the importance of realistic estimates and adequate personal monitoring data. The highest exposures are to driver/handlers involved with transport of radionuclides for medical and industrial use: some 100 such workers receive doses in excess of a few mSv per year. These driver/handlers are employed by several companies, one of which has provided detailed data for 1989-1991. The individual doses for this company's driver/handlers are shown in Figure 1. The higher individual doses have ben reduced and the collective dose has also declined during this period. Some of the driver/handler duties were transferred to other staff (packers) whose exposures are shown in Figure 2: individual and collective doses for these workers were also reduced in this period. Table 1 lists the collective doses for 1989-1991.

Table 1 Collective doses to drivers and packers

	Collective dose (man Sv)	
Year	Drivers	Packers
1989	0.119	0.323
1990	0.105	0.291
1991	0.071	0.196

Changes in work practices enabled exposures to be reduced. Workers were encouraged to keep unnecessary time in radiation areas to a minimum. Environmental dose rates in loading areas were reduced by keeping technetium generators in a distant holding bay and, by replacing manual handling with distant handling.

DOSE PER UNIT TRANSPORT INDEX (TI)

The TI of a package is generally a measure of its external radiation field. In such cases there may be a relationship between worker exposure and transport index. The total TIs handled or moved by various groups or workers have been compared with their collective doses: the results are given in Table 2.

Table 2 Dose per unit transport index for various groups

Group	No. of workers	Collective dose (10^{-3} man Sv)	Total TI	Dose/unit TI (μSv/TI)
1	12	122	$7.0\ 10^4$	1.7
2	71	36	$1.5\ 10^4$	2.4
3	5	30	$3.6\ 10^4$	0.8
4	6	30	$1.5\ 10^4$	2.0
5	4	20	$0.6\ 10^4$	3.3
TOTALS	98	238	$14.2\ 10^4$	AVERAGE 1.7

The major contribution to all these workers' exposures came from the handling and movement of technetium generators.

REFERENCE DOSES

Current data, as shown in Figs 1 and 2, indicate that a dose constraint of 10 mSv per year for the most exposed transport workers and, a reference dose range of 1-3 μSv per unit TI, are achievable for the transport of technetium generators. Other types of transport operations have been examined but the radiation exposures are much lower and further work is required. A Canadian study (Lawrence and van der Vooren 1988) concluded that it was possible to estimate doses to some transport workers by determining the number of packages carried. Correlations were obtained for handlers of medical radionuclides, and drivers carrying uranium hexafluoride cylinders and some waste containers. Although this study concentrated on numbers of packages some limited TI data were given: doses per unit TI appear to be in the range 1-3 μSv.

CONCLUSIONS

From these data a dose constraint of 10 mSv per year is suggested as possible for exposed transport workers. Reference dose ranges for particular operations can be identified and made generally available. A reference dose range of 1-3 μSv per unit TI has been determined for technetium generator work.

Operators are recommended to establish an ALARA procedure starting with a commitment at all levels. Adequate databases and documentation are required covering worker and public exposures.

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Figure 1

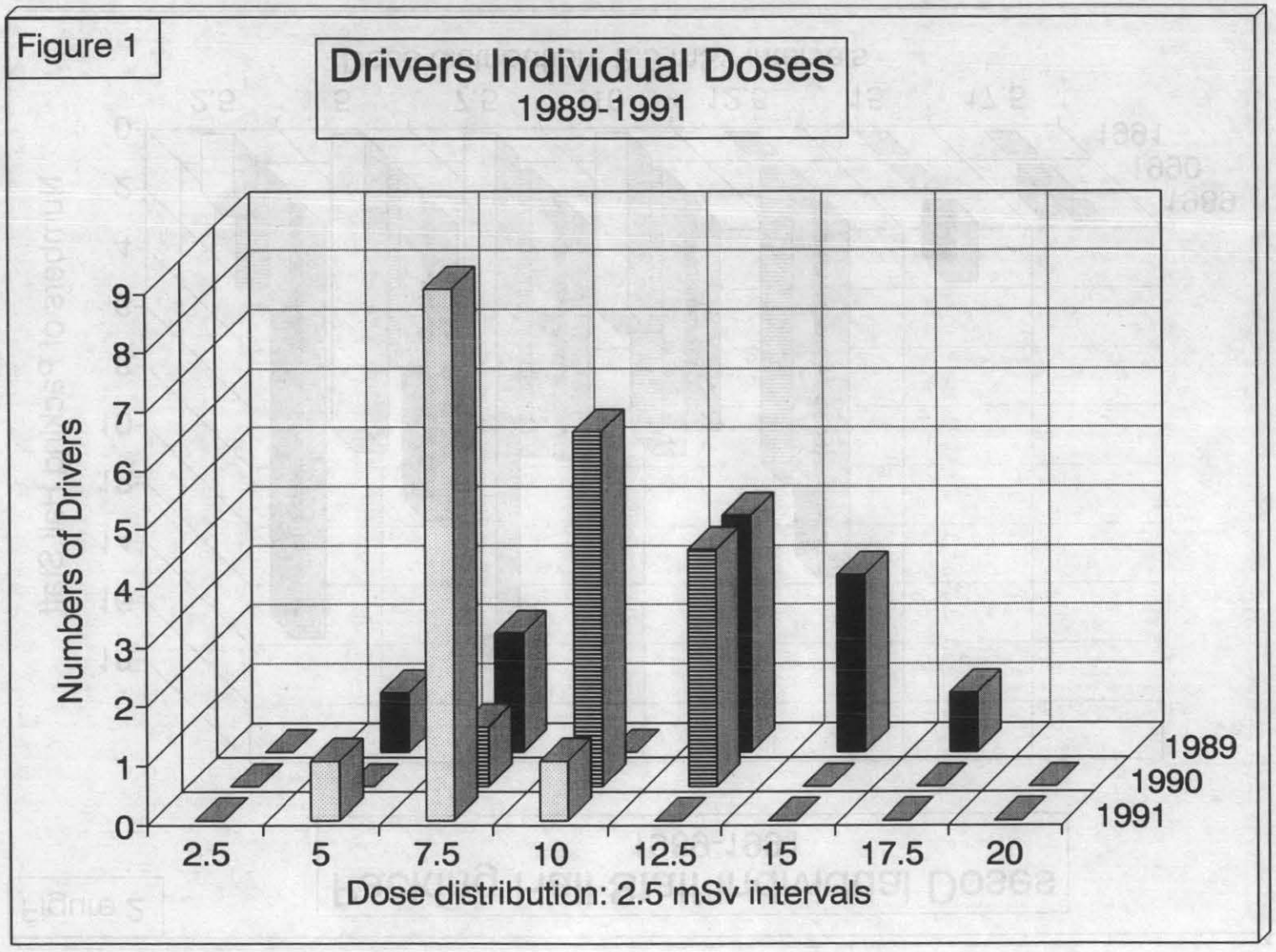
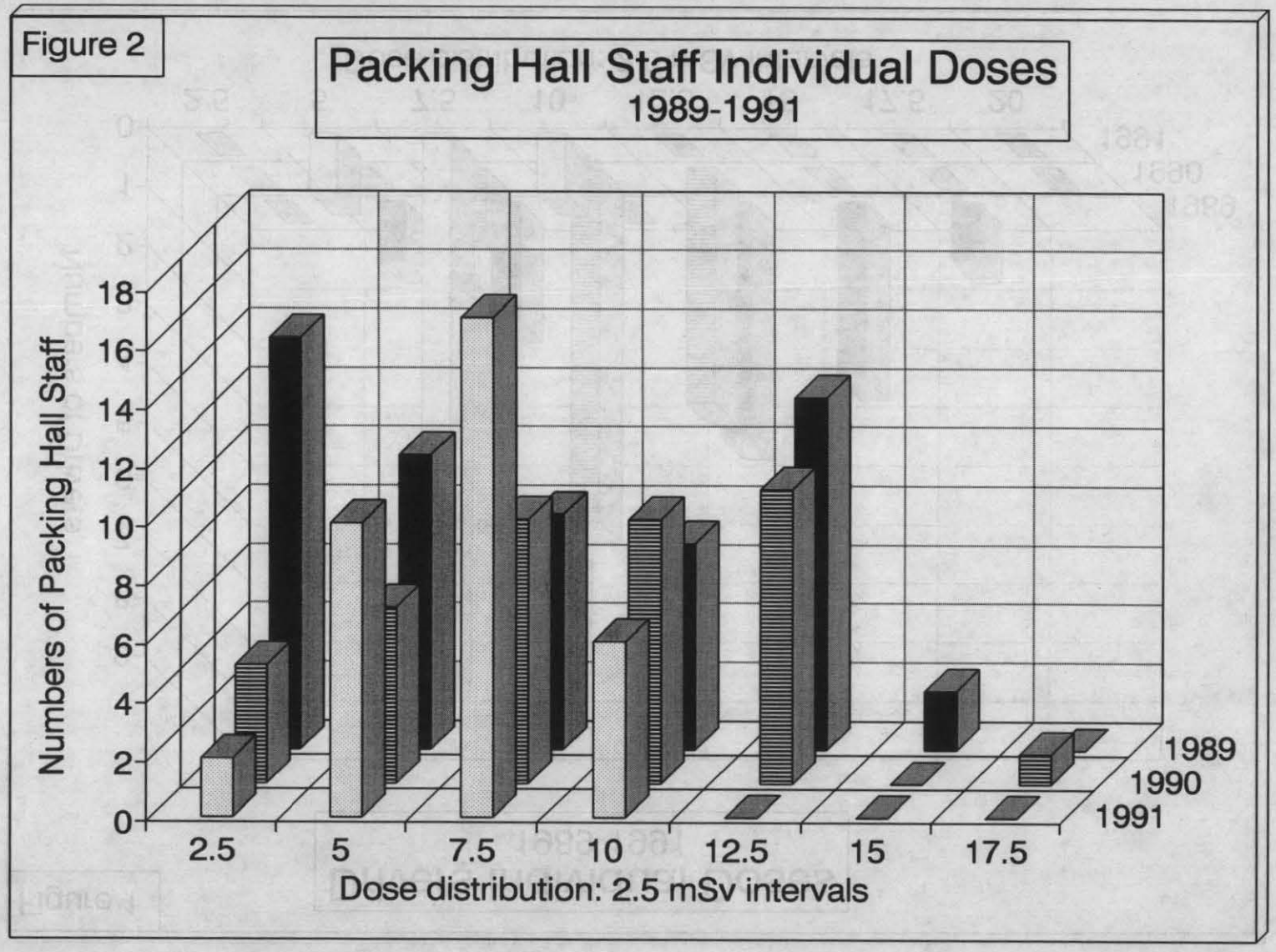

Drivers Individual Doses
1989-1991
Numbers of Drivers
0
1
2
3
4
5
6
7
8
9
2.5
5
7.5
10
12.5
15
17.5
20
Dose distribution: 2.5 mSv intervals
1989
1990
1991

Figure 2


Packing Hall Staff Individual Doses
1989-1991
Numbers of Packing Hall Staff
0
2
4
6
8
10
12
14
16
18
2.5
5
7.5
10
12.5
15
17.5
Dose distribution: 2.5 mSv intervals
1989
1990
1991