# ALARA AT TYCO HEALTHCARE-MALLINCKRODT

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**How to approach the ALARA requirement?** That was one of the question in the beginning of the 1990's at the Mallinckrodt site for the preparation of radiopharmaceuticals. This question was raised after the ICRP published their guidelines in the ICRP60 publication, with the average effective dose limit that was changed from 50 to 20 mSv per year. In the early 1990's the individual effective dose at Mallinckrodt was up to 20 mSv/year and some of the people over this number.

As a first result of the discussion Mallinckrodt adopted the 20 mSv/year as being the legal limit, although it finally took over a decade to incorporate this ICRP limit into legislation. A second action was to introduce a site internal limit: if a person would exceed 75 % of the legal limit, the person would be restrained from radiation work. This restriction forced everybody to look for solutions to decrease dose and area dose rate. This was the beginning and resulted in nobody exceeding 15 mSv/year after a couple of years and a lower average dose than before, with no extra employees.

The second stage in the process of ALARA was a systematic approach of the decrease in personal dose. This systematic approach consists of three phases. The first phase is dose assessment followed by routine measurements. The third phase is the ALARA step.
First phase, dose assessment. Normally this could be done in a meeting or even behind the desk: assess the dose per department or per group or per activity. Make a decision on which party will get high priority, medium priority and low priority. Normally this means that the department with the highest dose will get the highest priority.

Second phase, routine measurements. This means that within the chosen department or group a series of measurments takes place in order to establish which part of the process results in personal high doses. This part of the process will receive the highest attention in the third step.
Third step, ALARA. In the third step the process will be looked at from a radiation protection point of view: distance, time, shielding. Analysing the whole process step and look for opportunities to lower the dose. After establishing possible actions these have to be incorporated, which is in effect the fourth step.

The examples given in the presentation are related to the production of radiopharmaceuticals at Mallinckrodt in the Netherlands. Some numbers: approximately 200 radiation workers producing about 1000 Mo99/Tc99m-generators per week and about 220.000 radioactive shipments per year.

The first example is the extremities dose within the hotlab production area. Before 1998 there was no regular registration of extremities dose. In 1997 Mallinckrodt started the ALARA process with establishing the extremities dose per department; 6 to 8 weeks per department. This resulted in routine measurements of the extremities dose at the hotlab production area. Soon it was found that two processess where contributing 80 % of the total extremities dose: the production of I-131 capsules and the cleaning of production equipment for Mo99/Tc99m-generators.

In 1995 Mallinckrodt already started a project for building a separate I131-production facility from a business point of view; the results from the extremities study made it even more necessary. After finishing this I131-project in 1999 the collective extremities dose decreased with about 40%.
In 1998 it was clear from the study that the only solution for further reducing the extremities dose was changing the process and in a different set-up. At the end of 1998 a project was defined to change the glove box set-up to a manipulator type hotcell. This project ended in late 2001. The latest results from routine measurements are that no employee will exceed 60 mSv in 2002 and probably this will further decrease in 2003.

The second example is the effective dose at the preparation of radioactive shipments ready for shipment. As there was registration of the effective dose for many years the first assessment existed of task analysis and dose breakdown per task. For this analysis the employees were required to wear electronic personal dosimeters and read out per week, as the routine tasks lasted one week. From this data three major tasks were prioritized: packing Mo99/Tc99m-generators into boxes, packing I131-capsules into boxes and with highest priority the parcel collecting and truck loading task.

Through the above mentioned I131-production facility also a robotized storage was created from which automated order picking was possible. Next to this a automated packing of Mo99/Tc99m-generators was realised. Both installation required no more manual handling and made extra shielding between operator and packaging possible.

For the highest priority task several solution were created: shielded and automated transport belts and manipulators and shielded intermediate storage. All this resulted in no persons exceeding 10 mSv per year with an average of approximately 5,5 mSv/year. Still the parcel collecting and truck loading task is one of the hot items in this department. But for this particular task the average weekly effective dose was reduced with 50 %.

The most important lesson is to have the departments involved throughout the whole ALARA process and keep the distance, time and shielding in mind while involving the employees themself for possible solutions.