



WP1 Deliverables

The present report gives some explanation with the first two deliverables of the ORAMED (Optimization of Radiation Protection of Medical Staff) project WP1 (Extremity dosimetry and eye lens dosimetry in interventional radiology/cardiology). The first WP1 deliverables are: the protocol for measurements and the protocol for simulations.

D1.1 Measurement protocol: Annex-1

Within WP1 an extensive measurement program will be done in various hospitals in Europe using the same measurement protocol (Annex 1). Special attention will be given to eye lens and feet doses as there is lack of data at the present time. By using the same protocol the measurements will be homogenized and all data can be compared and evaluated. Other parameters such as the DAP values, the radioprotective equipment used by the staff, the staff position etc will be noted down in order to correlate them with the extremity and eye lens doses. All the data will be analyzed in order to define the optimal radiation protection measures. The measurement protocol has been developed by the different partners involved in WP1, and has been optimised by test measurements.

The measurement protocol is a two page form with 7 tables to be filled in. The data that need to be recorded are:

- General information for the hospital and the system used in the procedure
- The protective equipment used by the medical staff (lead apron, thyroid collar, eyeglasses etc) as well as the protective equipment that is found in the room (table 1)
- The position of the staff relatively to the patient's body and the X-ray tube (table 2)
- General parameters for the irradiation field and the procedure (table 3)
- Data for the fluoroscopy and acquisition (cine) with the corresponding DAP values (tables 4A, B, 5)
- Some other remarks such as the physician's experience, height, the complexity of the procedure etc (table 6) and finally
- The measuring points: the two ring fingers, the wrists, the legs and the eyes. There are also some description details at the end of the second page about the way that the TLDs should be positioned. The TLDs should be stuck on the person's skin. It should be stressed that for the leg measurements the TLDs should be positioned on the part of the leg not covered by the protective lead apron. The measuring points for the eyes are on the side of the left/right eyebrow, when the X-ray tube is positioned on the left/right part of the monitored person respectively and in the middle of the distance between the eyes. Attention should be drawn in such a way that both the measuring points for the eyes are behind the lead glasses if used. The wrist and ring dosimeters should be positioned inside when the X-ray tube is below the table, and outside when the tube is above.

D1.2 Simulation protocol: Annex-2

In order to perform the numerical simulations for a set of combinations of the main parameters that influence the extremity and eye lens doses, a simulation protocol has been established (Annex 2) between the WP1 simulation partners. The simulation of workplaces/procedures in interventional radiology and cardiology will be performed to determine the effectiveness of different radiation protection measures.

The input file that will be used contains the ORNL anthropomorphic phantom as a patient and the same one at the medical doctor's position. Eyes, hands, a thyroid collar and a lead apron of 0.5 mm thickness will be added to the medical doctor phantom in order to simulate better the real procedure. The combinations of the different parameters (tube voltage, filtration, protective equipment, position of doctor, etc) that will be examined have already been discussed and will be divided to the WP1 simulation partners.



The simulation protocol is an EXCEL file to be filled in by the partners with the results of the various tallies that will be used in accordance with the measuring points. The various columns will be used for the different parameters that will be studied.

The EXCEL simulation protocol has various lines referring to:

- The Monte Carlo Code
- The description of the source (tube voltage, filtration etc), filed size and beam projections. It should be noted that the collimators are considered as ideal and the filters are included in the spectrum
- The protective equipment used by the staff as well as the room's shielding equipment
- The part of the patient's body that is irradiated. For reasons of simplicity we considered only four regions: the head and neck, the thorax, the abdomen and the lower limbs.
- The doctor's position relatively to the patient body and the X-ray tube.
- The statistics. The results of the tallies are considered good when the relative error is better than 5%. Possible variance reduction techniques as well as the libraries used for the calculations should be mentioned
- Finally there are 14 scoring tallies most of which are close to the measuring points of the measurement protocol. The tallies are:
 - the DAP tally. An F2 (surface flux) tally should be used using the conversion coefficients from fluence to Kerma from ICRU 57. The proposed distance of the DAP tally from the source is 20 cm and the defined surface equal to the field surface at the measuring point. An image intensifier will be added at the input file.
 - the left and right ring tallies simulating the ring finger dose of the measurement protocol. An F6 (Track length estimate of energy deposition within a cell) tally should be used positioned at 0.07 mm depth, with a thickness of $5 \cdot 10^{-4}$ cm. The other dimensions should be 7.8×7.8 cm². This is not exactly the "ring region". The tally covers the whole hand at the ring level.
 - The left and right wrist tallies simulating the wrist dose. An F6 tally is also used in this case. The tally should be positioned at 0.07 mm depth, with a thickness of $5 \cdot 10^{-4}$ cm. The other dimensions should be 5×5 cm².
 - The left and right hand tallies simulating the whole hand dose. The absorbed dose to the whole hand should be calculated using an F6 tally.
 - The left and right leg tallies simulating the leg doses of the measurement protocol. The F6 tally should also be used in this case. It is positioned at 0.07 mm depth, with a thickness of $5 \cdot 10^{-4}$ cm. It will cover the half front part of the leg and the height should be 5 cm. It should be positioned 5 cm below the point that the lead apron ends.
 - The eye dose using an F6 tally should be calculated. 5 tallies should be used. The two tallies will be placed at the position of the eyes and simulate the eye dose (H_T). The other three tallies will simulate the $H_p(3)$. They will be positioned at 3 mm depth, with a thickness of $5 \cdot 10^{-4}$ cm. The cell diameter should be 1 cm. The three tallies should be positioned in the middle of the distance between the eyes and the other two above the left and right eye.