Module 4: Occupational exposure from fluoroscopically guided procedures

**General information**
CODE occupational exposure from fluoroscopically guided (FG) interventional procedures module provides prospective or retrospective estimates of absorbed dose to the embryo of a pregnant employee involved in such procedures.

A C-arm unit and an anthropomorphic phantom simulating an average patient were used to determine scatter exposure rates at specific locations over a 50 cm x 50 cm grid around the table of the angiography suite. Data were collected for all commonly used fluoroscopic projections centered on three different anatomical regions i.e. chest, abdomen or pelvis. These projections are shown in Table 3. For each projection, exposure data were obtained for various combinations of tube voltage and total filtration. Exposures in $\mu$Sv/h were measured at operator’s waist i.e. 110 cm from the floor. Projection-specific spatial 2-d maps of normalized to dose-area product (DAP) scatter exposure rate were derived.

Scatter exposure data were obtained for various fluoroscopy beam field sizes. Monte Carlo simulation was employed to determine the exposure reduction factor achieved by using radioprotective apron for different values of operating tube voltage and protective apron lead equivalence.

Scatter exposure at the specific position of the pregnant employee in the operating room is converted to embryo dose using gestation stage-specific air kerma to embryo dose conversion factors previously published (Damilakis et al, JCE 2005).

Embryo dose (ED) from a specific FG procedure for which n different projections are involved is calculated from:

$$ED = \sum_{i}^{n}(NE_i(p, kV, filtration) \times DAP_i \times f_{field size} \times f_{gest.stage} \times f_{pb apron})$$

where $NE_i$ is the normalized scatter exposure at the waist level for the fluoroscopic projection $i$ determined for the same tube voltage and total beam filtration, $DAP_i$ is the cumulative DAP recorded for the specific projection $i$, $f_{field size}$ is the correction factor for the specific beam field size at entrance skin surface, $f_{gest.stage}$ is the correction factor for the selected
gestational stage of the pregnant employee, and $f_{\text{Pb\ apron}}$ is the correction factor for the specific lead apron worn by the pregnant employee.

### TABLE 3. The fluoroscopic projections investigated

<table>
<thead>
<tr>
<th>Projection*</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior-Anterior</td>
<td>PA</td>
</tr>
<tr>
<td>Posterior-Anterior/Caudal 30°</td>
<td>PA/CAU30</td>
</tr>
<tr>
<td>Posterior-Anterior/ Cranial 30°</td>
<td>PA/CRA30</td>
</tr>
<tr>
<td>Right Anterior Oblique 30°</td>
<td>RAO30</td>
</tr>
<tr>
<td>Left Anterior Oblique 30°</td>
<td>LAO30</td>
</tr>
<tr>
<td>Left Anterior Oblique 45°</td>
<td>LAO45</td>
</tr>
<tr>
<td>Right Anterior Oblique 45°</td>
<td>RAO45</td>
</tr>
<tr>
<td>Left Lateral</td>
<td>LLAT</td>
</tr>
<tr>
<td>Right Lateral</td>
<td>RLAT</td>
</tr>
</tbody>
</table>
* All projection angulations refer to the position of image intensifier with respect to the vertical axis.
How to use the occupational exposure module?

The user has to select the occupational exposure module.

The user has to define/provide the following data regarding the occupational exposure of the pregnant employee:

1. **Anatomical region of interest:** A pull down menu guides the user to define the exposed patient anatomical region. Three options are available: chest, pelvis and abdomen.
2. **Orientation of the projection:** A pull down menu, guides the user to select one of 17 different fluoroscopic beam projections illustrated in Table 3.

3. **Exposure parameters of the examination:** The user has to define tube potential (kV), and tube inherent/added filtration (mm Al/mm Cu) used for the specific projection selected.
4. **Field size**: The user has to select the field size of the fluoroscopic beam for the selected projection (acceptable values 25 cm\(^2\) to 625 cm\(^2\)).

5. **DAP**: The user should define the DAP value of the specific selected projection in Gy cm\(^2\).
6. **Gestational stage:** A pull down menu guides the user to select the gestational stage of the exposed pregnant employee i.e. 1<sup>st</sup>, 2<sup>nd</sup> or 3<sup>rd</sup> trimester.

7. **Lead apron:** When the pregnant employee uses a radioprotective lead apron, the user has to define Pb-equivalent thickness of the apron in mm (acceptable values 0.0 to 0.5 mm Pb)
8. Position of pregnant operator: The user has to define the position of the pregnant operator in the operating room by selecting the corresponding bullet on the operating room grid show.
When all the necessary data has been supplied, the dose absorbed by the embryo of the pregnant employee is calculated and presented in the corresponding field. The scatter exposure map corresponding to the selected fluoroscopic projection is presented if the user presses the button <Exposure chart>.

Using the <Save Results> button, the registered user can also save a calculation, including all exposure data and date and time of submission for later revision.
The user can clear the form and start over a new calculation using the <Clear> button.

Additionally, the user has the opportunity to calculate the cumulative embryo dose from several fluoroscopic exposures for which calculation of embryo dose has been performed and saved. The user has to press <Previous Calculations> button and select the specific exposures. The cumulative embryo dose from the selected exposures is then calculated and presented.
References


