A MODEL TO MEASURE THE DOSIMETRIC RISKS OF GAMMAGRAPHIC INSPECTIONS

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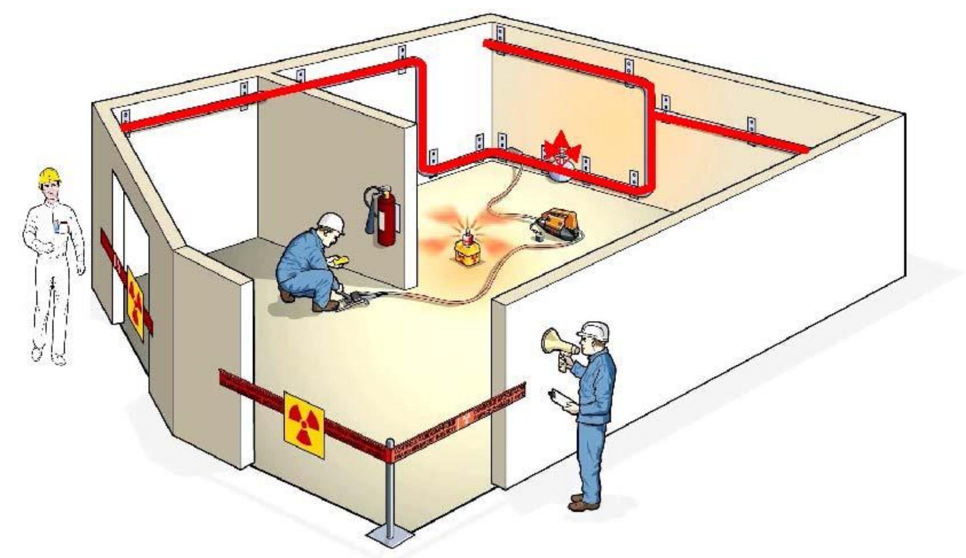
Entering restricted area / operator incident / hand dose / orphan source

Distance ↓ Time →

Source Ir 192 4.4 tBq (120 Ci)	15 s	2 mn 30 s	30 mn	4 h	1 week
1 cm 5 000 000 mSv/h	20Sv only hands. necrosis Saintes 81	200 Sv			
10 cm 5000 mSv/h	200 mSv not yet bio.effects.	2 Sv severe lesions Chili 05, iran 96	20 Sv whole body dead Perou 99	200 sv	
1 m 500 mSv/h	2 mSv incident criterion	20 mSv annual limit Blayais 01 Flamanv. 03,09	200 mSv cas enveloppe pendant le tir	2 Sv severe lesions Dakar 06	20 Sv dead Mexico 62 Setif 78 Casablanca 84 Le Caire 00
10 m 5 mSv/h	0.02 mSv OK	0.2 mSv OK	2 mSv Criterion incident reporting	20 mSv annual limit	200 mSv

STEP 1 : Table indicating typical dose magnitudes :
- red : orphan source,
- orange : hand dose,
- green : entering the restricted area,
- yellow : operator incident.

Each case is characterized by a dose corresponding to a distance and a duration of exposure by a conventional Ir-192 source of 4.4 TBq.



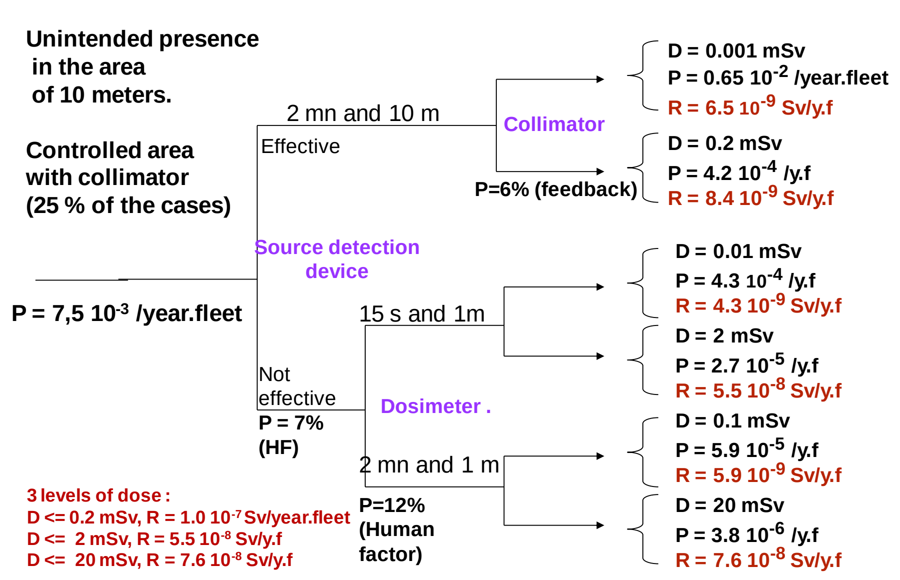
The scene of a gammagraphic inspection area.
The operator works within a zone which is marked off-limits.

Very favorable transition / favorable / unfavorable / very unfavorable

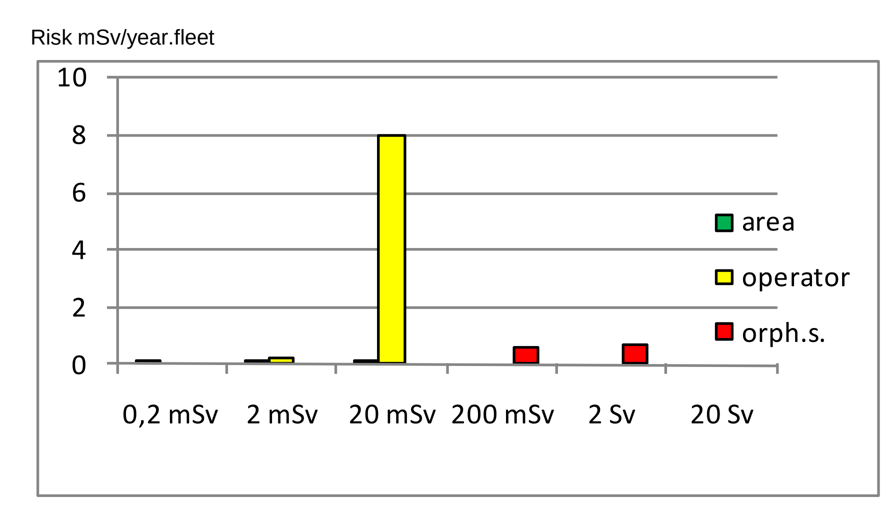
Distance ↓ Time →

Source Ir 192 4.4 tBq (120 Ci)	15 s	2 mn 30 s	30 mn	4 h	1 week
1 cm 5 000 000 mSv/h	20Sv	200 Sv			
10 cm 5000 mSv/h	200 mSv (initiator hand dose)	2 Sv	20 Sv	200 Sv	
1 m 500 mSv/h	2 mSv (initiator operating incident)	20 mSv	200 mSv (initiator orphan source)	2 Sv	20 Sv
10 m 5 mSv/h	0.02 mSv	0.2 mSv (initiateur entering area)	2 mSv	20 mSv	200 mSv

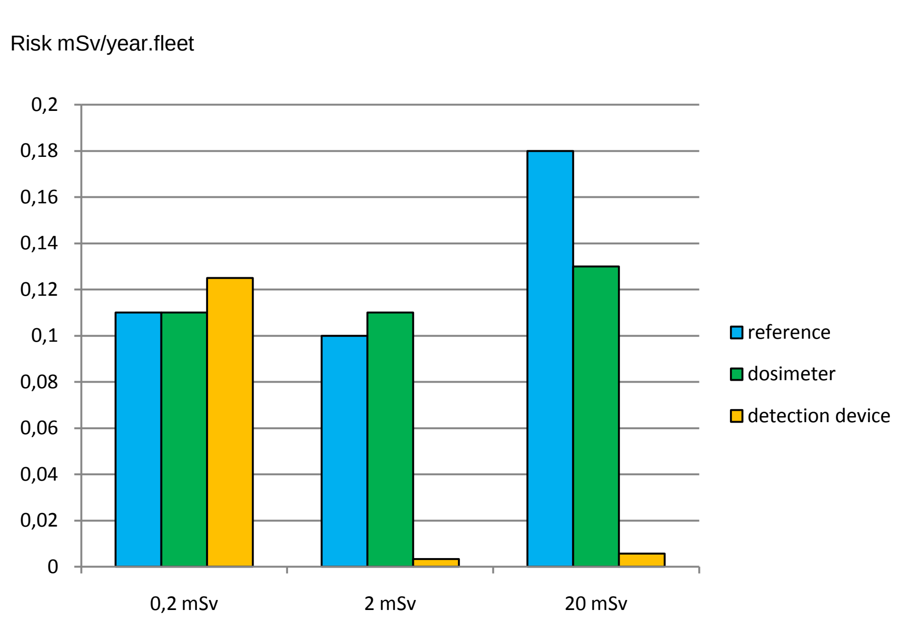
STEP 2 : Representation of the main possible transitions between different cases in the table of risks (from green : very favorable, to red : very unfavorable).



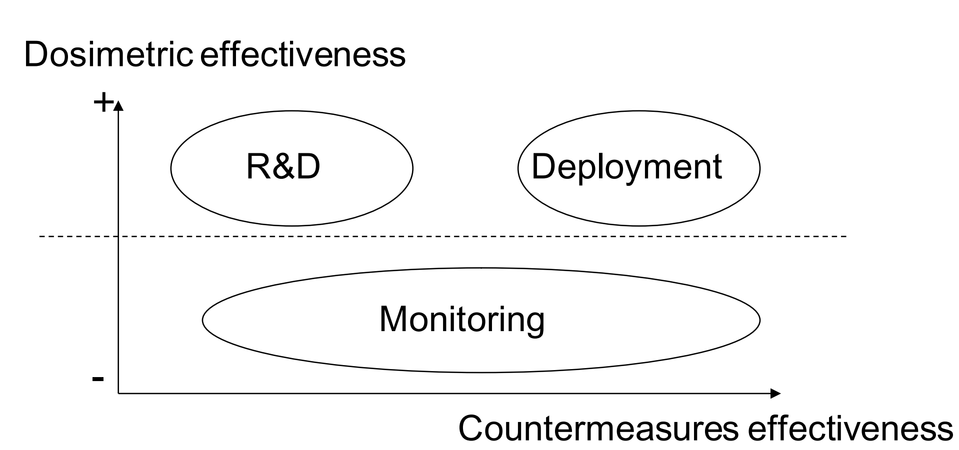
STEP 3 : Building an « event tree » model showing the different possible aggravation scenarios. Each scenario is characterized by a dose, a probability and a risk (which is the product of the dose by the probability).



STEP 4 : Comparison of the risks related to different situations. In this case, the main risk is related to the activity of the operator (yellow). It is more important than entering the restricted area (green) or orphan sources (red). The risk is expressed as a group of values in six dimensions from 0.2 mSv to 20 Sv.



STEP 5 : Many possible applications : indicators, ranking of incidents based on the risk, anticipation of severe accidents, evaluation of protection devices, safety organization, etc. In this case, the generalization of dosimeters is compared with an automatic detection device that informs the team of the operator of an intrusion into the restricted area. The detection device for intrusions (orange) is the most effective protection compared to the option of equipping all staff with an alarm dosimeter (green). These two options are compared with the situation of reference currently in use on sites (blue).



Looking beyond the gammagraphic controls : we can generalize the method to all dosimetric activities in order to achieve a global vision and structuring of all radiological hazards present in Nuclear Power Plants. Each activity is placed in a chart (dosimetric effectiveness versus countermeasures). Three regions are defined (R & D needed, deployment of industrial solutions or simple monitoring).
Thus, we can define the most effective strategy to reduce dosimetric risks.

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