

## Experience of French organisations in environmental impact assessment for remediation of contaminated sites

Christian DEREGEL

Nuclear Defense Expertise Division

Branch in charge of naval reactors

[www/irsn.org](http://www/irsn.org)

[christian.deregel@irsn.fr](mailto:christian.deregel@irsn.fr)

### Expertise and Research

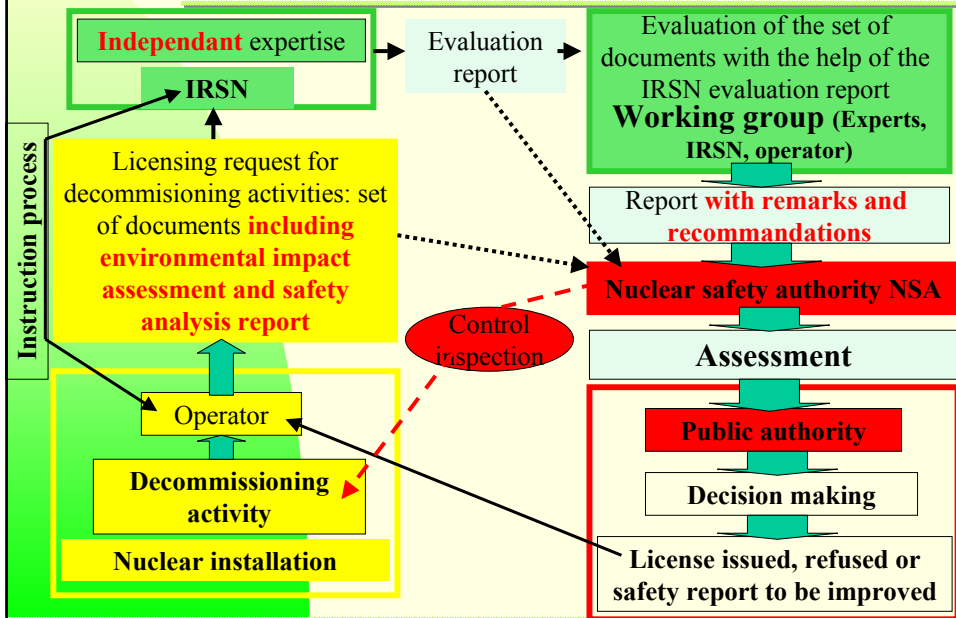
Research, analysis and work within the fields of nuclear safety, protection against ionising rays, control and protection of nuclear materials and protection against acts of malevolence.

Creation of the IRSN is similar to that of agencies for health and safety. Like them, the IRSN will play an active role in providing information to the public within its fields of expertise : nuclear and radiological risks.

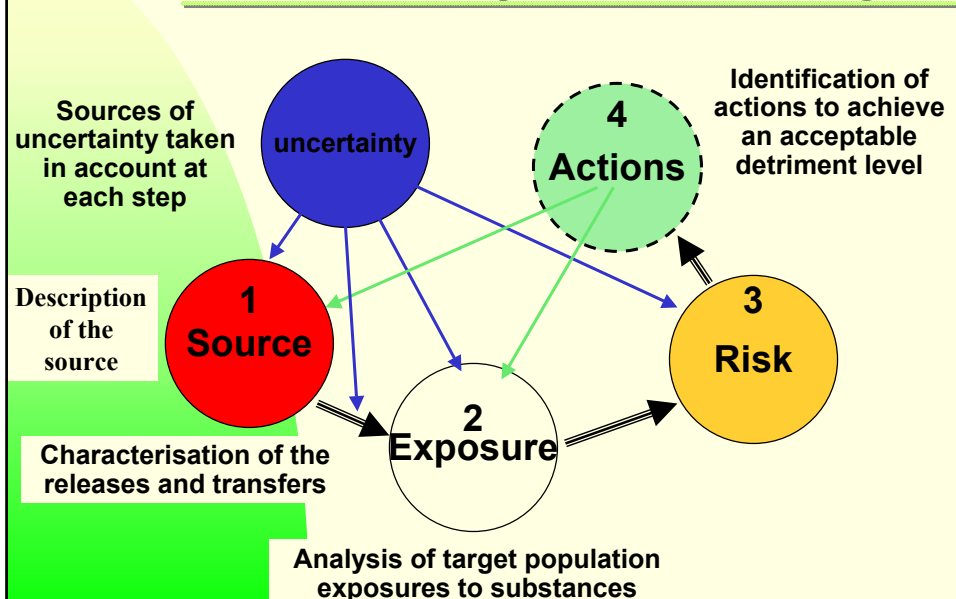
### Separate Control and Analysis

The IRSN will not exert any authority of control. For greater transparency, the government has decided to separate the technical analysis from the function of authority of control (authorisations and decisions of a regulatory nature).

## IRSN Position of IRSN in the decision-making chain for licensing

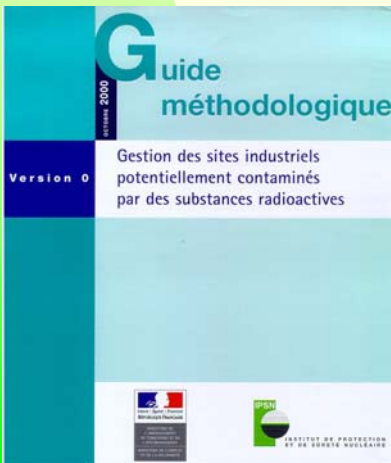


## IRSN Scheme of environmental impact assessment and management



## **IRSN** Guidelines for the remediation of a contaminated site

A methodological document for the help of stakeholders in the decision making concerning the rehabilitation of sites polluted by radioactive substances



- Established by IRSN on the request of French ministers for health and environment
- on the model of existing guidelines for chemical contamination
- for non nuclear areas polluted by radioactive substances

*Prepared with the help of the « Environment and Emergency Operations » division (DEI) of the French institute for radioprotection and nuclear safety (IRSN)*

## **IRSN** Guidelines for the remediation of a contaminated area

**Structure:** operational-oriented guide lines

**Purpose:** To assist parties concerned by the management of sites contaminated by radioactive substances by providing them with a standardised methodology known by all parties (stakeholders) involved and allowing to keep in mind assumptions made

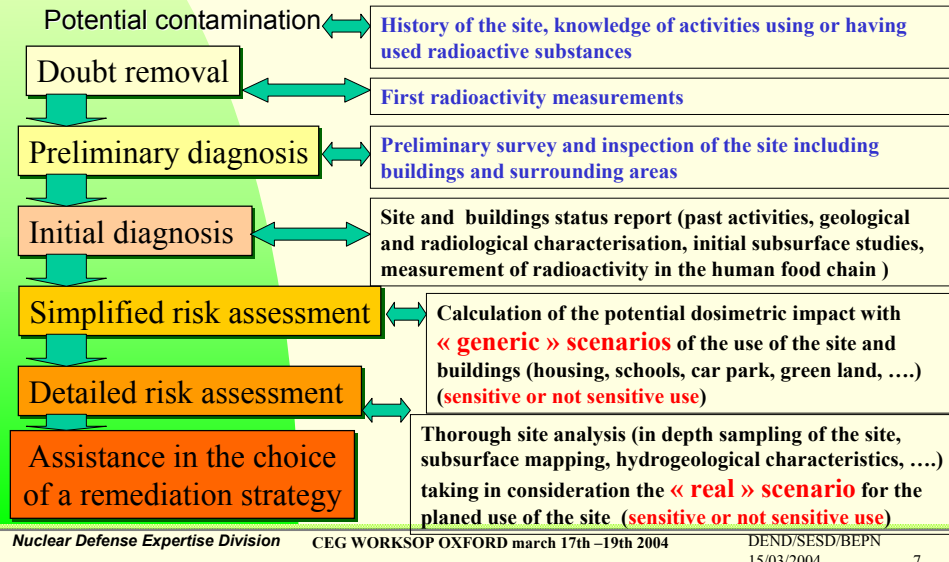
**Sites concerned:** sites where industrial activities take place today or took place in the past with potential radioactive pollution

**What kind of radioactive pollution ?**

- + soil and/or buildings contaminated (loose or fixed contamination)
- + radioactive sources (sealed or not)
- + radioactive elements as  $^3\text{H}$ ,  $^{14}\text{C}$ ,  $^{90}\text{Sr}$ ,  $^{137}\text{Cs}$ ,  $^{232}\text{Th}$  (+descendants),  $^{238}\text{U}$  (+descendants),  $^{241}\text{Am}$ ,  $^{234}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{210}\text{Pb}$ , and so on

## IRSN Guidelines for the remediation of a contaminated area

**Principles:** 6 steps ranging from the characterisation of the site up to the definition of rehabilitation strategies depending on the future use of the site



## IRSN Guidelines for the remediation of a contaminated area

### Outcome of the different steps of the methodology

Step 1 »Doubt removal » : if radioactive elements detected, first immediate measures to clean the site. If site cleaned or not contaminated: **END**

Step 2 « Prediagnosis » : short term actions as restricting access to some zones, marking or removing of « hot spots », removing all sources of contamination and/or irradiation. If site cleaned : **END**

Step 3 « Initial diagnosis » : determination of the **vulnerability of the environment** (ground and surface waters, air), of risk for **human food chain**.

If localised contamination and/or sources, sources removed and patches of contamination cleaned: **END**

## **IRSN** Guidelines for the remediation of a contaminated area

Step 4 « Simplified risk assessment » : according to the results of the initial diagnosis:

**Evaluation of the dosimetric impact  $D_j$**  induced by the site taking in account « generic scenarios » covering the future use of the site and comparison to a selected limit **SL** fixed by public authorities. (Selected limit = **individual equivalent dose of less than one mSv/year**)



If  $DJ < SJ$  for the planned use of the site AND rehabilitation work performed in parts with sensitive use : **END**

Step 5 « Detailed risk assessment » : Evaluation of the dosimetric impact  **$D_j$**  induced by the site taking in account the real scenarios planned and comparison to the selected limit **SL** fixed by public authorities.



If  $DJ < SL$  for the specifics scenarios chosen : **END**



If  $DJ < SL$  **BUT** sensitive use or if  $DJ > SL$ , assistance to decision-making concerning the choice of a remediation strategy

## **IRSN** Guidelines for the remediation of a contaminated area

Step 6 « Assistance in selecting a remediation strategy » : **choice of a remediation strategy and decision concerning the methods to be used.**

The IRSN document suggests to establish tables that indicate, for each potential remediation strategy:

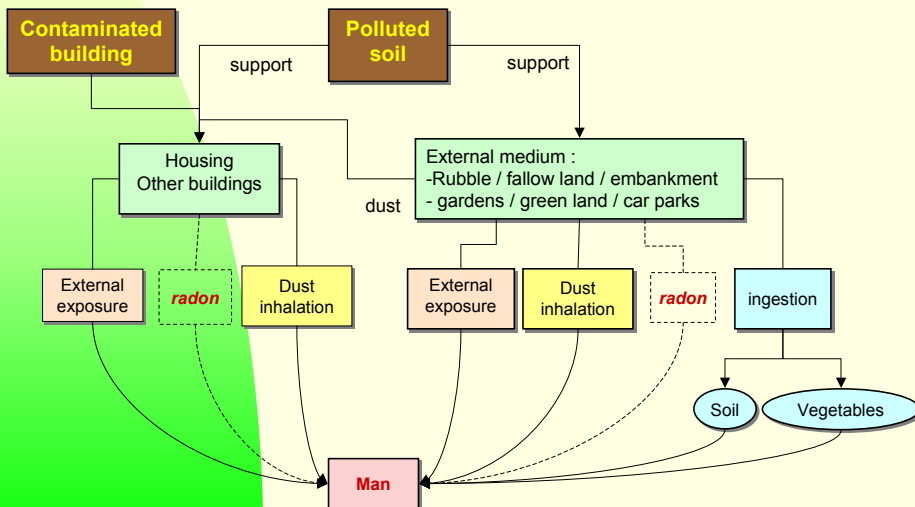
- the radiological impact,
- the cost,
- the effect on workers exposure,
- the nuisances associated with implementing the strategy,
- the characteristics of the strategy in terms of service life of remediation measures, reversibility, institutional monitoring.

**These tables should be accompanied by a description of the assumptions needed for calculations, the sensitivity of the results to the assumptions made and the uncertainties affecting the results.**

**Methods and tools usable**

- 1 –Ways of aggression of human beings by radioactivity
- 2- Calculation code: CERISE (contaminated site)
- 3- Generic scenarios
- 4- CIBLEX programme
- 5- Calculation code: ASTRAL (accident consequences)

**Ways of aggression studied**



CERISE

Code d'Evaluations Radiologiques Individuelles pour des Scénarios en Entreprises et dans l'Environnement  
Code for individual radiological evaluations for activities in firms and in open air

• Exposure calculations made for preplanned scenarios

⇒ External exposure ( $\beta, \gamma$ )

Exposure to simple geometric forms

point sources, cube, sphere, infinite flat surface,

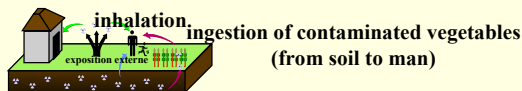
⇒ Mixed exposures

« housing" (all ways of aggression)

Atmospheric emission (External exposure and inhalation)

• Results in sievert/year or by activity

CERISE



Sélection of radionuclides



Characterisation of the Contaminated material



Scenario representative of the aggression's way to study



Individual radiological impact (Sv/year)

Mathematical model

$$H = A_{in} D_{in} (H_{inh} + H_{ext} + H_{ing}) \cdot (S \cdot D)$$

$$H_{inh} = \sum C_{air} \cdot \eta_{inh} \cdot \tau_{inh} \cdot \eta_{inh}$$

$$H_{ext} = \sum D_{ext} \cdot \eta_{ext} \cdot (V_{ext} + V_{inh})$$

$$H_{ing} = D_{ing} \cdot \eta_{ing} \cdot D_{ing}$$

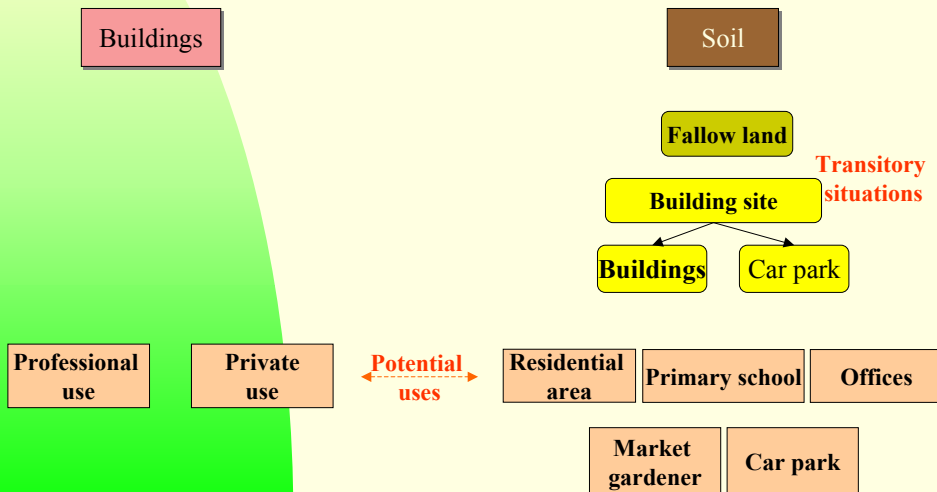
Parameters describing the studied situation



Generic scenarios

- **What is a generic scenario?**
  - ↳ A simplified description adapted to a problematic and representative of a whole of situations of same kind
    - ↳ Generic parameters (ICRP, ....)
      - \* human behaviour
      - \* environment description
- **Scenarios utilized for the simplified risk evaluation**
  - ↳ Generic scenarios of use of soil, of buildings

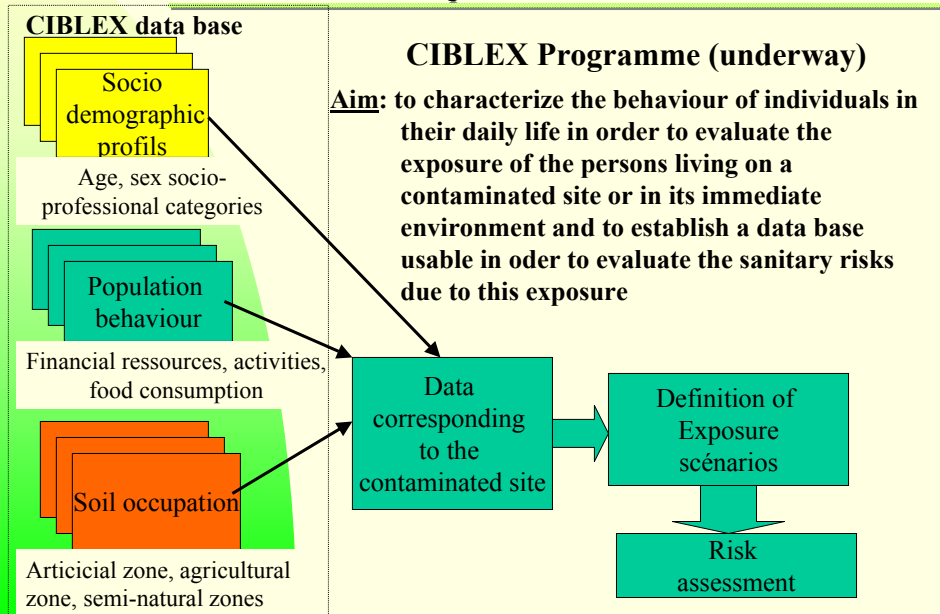
Generic scenarios studied



Some numeric values given by the guide for decision making taking in account the potential use of the site (generic scenarios)

Annual effective dose ( $\mu\text{Sv}/\text{yr}$ ) for 1 Bq/g of each RN or decay chain							
	Residential area	Agricultural land	Primary school	Office	Parking area	Waste-land	Building site
$^{232}\text{Th}+$	640	1160	230	64	16	220	240
$^{238}\text{U}+$	490	805	170	45	11	175	170

Activity (Bq/g) for a dose of 1 mSv/yr of each RN or decay chain							
	Residential area	Agricultural land	Primary school	Office	Parking area	Waste-land	Building site
$^{232}\text{Th}+$	1.6	0.9	4.4	16	62	4.5	4.2
$^{238}\text{U}+$	2.0	1.2	5.9	22.4	89	5.7	5.9



**ASTRAL CODE** (1997, improvement in 2001)

**Assistance Technique en Radioprotection post-Accidentelle**  
 (Technical assistance in radioprotection after an accident)

**Aim:** to quantify the transfer of radioactive elements in agricultural areas and in forests after a nuclear accident

Evaluates in time and space the contamination levels in the food chain and the radiological impact on human beings

Takes in account the transfers for soil to plant, from plant to animal and man, from animal to human beings,

Evaluates the radiological consequences for human beings due to:

- the external exposure,
- the internal exposure by inhalation (radioactive particles in suspension in the air) and by ingestion.

More informations: [jean-marc.peres@irsn.fr](mailto:jean-marc.peres@irsn.fr)

Environment and Emergency Division, Environmental  
 Radioactivity Study and Monitoring Department

IRSN/DEI

IRSN web sites: [www.irsn.org](http://www.irsn.org), [www.irsn.org/net-science/](http://www.irsn.org/net-science/)