Hypothetical scenario for acute atmospheric release of tritium

The objective of the study is to analyse the consequences of an acute atmospheric release of tritium, by considering various pathways in terms of activity in biosphere compartments and products, as well as the contribution of the various forms of tritium (HT, HTO, and subsequent OBT) to total exposure. This study aims to give practical guidance to decision-makers in the case of a severe release, taking account of the prevailing conditions during the release. The purpose of the study is to produce a set of results/guidelines that could be used by authorities to reduce the consequences of the release, if required. This may require a harmonisation of crisis management on a technical/scientific basis within an international framework.

An integrated approach will be followed, i.e. the study will encompass immediate atmospheric impact, further impact on the food chain and subsequent consequences for aquifers. The intent is to:

- establish at least a classification of different pathways;
- define the importance of different parameters;
- assist in the definition of a post-release monitoring plan; and
- give an evaluation of what is required to return to a normal (pre-accident) situation.

The scenarios will be generic (i.e. not site specific), taking due account of previous work, and limited to the minimum number necessary for a good understanding.

The final document will distinguish between features and processes that are well established and those with uncertainties in terms of crisis management. Lack of scientific information would also be identified.

Scenarios

Condition	**Value**
Release amount (HTO, HT)	10 g (3.7 E15 Bq)
Release period	1 hour (constant rate)
Effective Release height	20 m point source (no plume rise)
Latitude	45° N
Date	End of June
Day length, from sunrise to sunset	19h30
Potential evapotranspiration	3.2 mm/day
Soil water content	30% of volume
Soil density	1.2 kg/l
Soil depth : garden / wheat	20cm / 40 cm
Average rainfall during summer	60 mm/month
Irrigation of garden vegetables Irrigation of wheat	Yes No
Surface roughness length	0.4 m

Three types of meteorological conditions are considered at the end of June: (± means 1 sigma)

	Case 1	Case 2	Case 3
	day	day	midnight
Wind speed ($m.s^{-1}$)	2	5	2
Direction (°N)	45±25 (to make the standard deviation more consistent with the stability class)	45±10	45±3
Diffusion conditions	unstable	neutral	stable
Weather	fine	cloudy	clear
Classe pasquill	A	D	F
Solar radiation (W/m^2)	700	300	0
Temperature (°C)	20	20	10
Rain	no	15mm before the end of release (continuous throughout the release or in the last 15 minutes?)	no
Relative humidity %	70	90	95

The meteorological conditions are assumed to remain constant for 6 hours. Subsequent conditions are assumed not to have a large influence on the results.

What species (HTO or HT) are released in each case?

Human food consumption rates

		Adult	**Infant (1-2 yr)**	Harvest and duration of consumption of stored products
		g/day		
Green vegetables	Salad and leafy veg.	**130**	**80**	In Harvest period *
Root vegetables	Radish, turnip	30	15	In Harvest period
	Potatoes	200	100	Harvest in late August, 8 months (to make consistent with the following table)
	Carrots	50	25	Harvest starts mid-July
	Total	**280**	**140**	
Fruit vegetables	String beans	50	25	In Harvest period
	Peas	50	25	In Harvest period
	Tomatoes	100	50	Harvest starts in late July
	Total	**200**	**100**	
Cereals	Wheat	**430**	**40**	Harvest starts in early August, 1 year
Milk	Milk (including butter and cheese)	**500**	**440**	
Meat	Beef	140	60	
	Chicken & eggs	100	50	
	Total	**240**	**110**	

Details on crop yields and times between accident and harvest are given in the following table.

Crop yield and time between accident and harvest of direct contaminated crop

Product	Yield (kg f.w./m^2) per crop and % dry matter	Minimum time between accident and beginning of harvest	Maximum time between accident and end of harvest	Number of crops/year after accident
Salads	3 8%	0*	1 month	4
Radish and turnip	1 20%	0	3 weeks	3
Potatoes	3 21%	2 months	3 months	1
Carrots	2.5 16%	2 weeks	2 months	2
Peas	1 25%	0	1 month	2
Beans	0.4 25%	0	1 month	3
Tomatoes	3 6%	4 weeks	3 months	1
Cereals (grains)	0.8 86%	4 weeks	7 weeks	1
Grass	0.7 15%	0	2 months	4

NB. : Release occurs immediately before flowering period for tomatoes

* It is assumed that these crops are ready for harvest when the release occurs. The crop lasts for one month, i.e. the leaves from crops consumed during this period would have been exposed to atmospheric tritium. One month after exposure, a new crop is planted, for which only soil contamination/root uptake has to be considered.
In a garden, new crops are sown after each harvest.
It is considered that the end of contamination of the surface environment is in November: no crops anymore and migration of tritium down to the water table. Cows are supposed to eat Hay harvested before the accident during the winter. But it is true that they also may eat contaminated maize (whole plant) from November to March (35kg/day 35%Dry Matter). Test may be done on this particular point if judged necessary.

Animal parameter values

Animal	Fodder consumption		Breathing rate	Water intake
	Grass	Wheat		
Cow	70 kg f.w./d	2 kg fw/d	5.4 m^3/h	50 l/d
Chicken		0.1 kg fw/d	10 l/h	0,2 l/d

Animal drinking water is assumed to be uncontaminated.

Human breathing rate : m^3/h

	Sleeping	Awake low activity
Man	0.45	1.5
1 year old infant	0.15	0.35

Modellers should provide the following:

Integrated air concentration (Bq.s.m^{-3})				
	1 km downwind	3 km	10 km	30 km
Case 1				
Case 2				
Case 3				

	Adult total dose (mSv)				Child total dose (mSv)			
	1 km	3 km	10 km	30 km	1 km	3 km	10 km	30 km
Case 1								
Case 2								
Case 3								

	Dose mSv - case 1									
	Adult 1000m					Child 1000m				
	Dose via air path way		Dose via Soil path way			Dose via air path way		Dose via Soil path way		
	HTO	OBT	HTO	OBT	Total	HTO	OBT	HTO	OBT	Total
Inhalation										
Transcutaneous										
Salads and leafy veg.										
Radish and turnip										
Potatoes										
Carrots										
String beans										
Peas										
Tomatoes										
Cereals										
Beef										
Milk										
Chicken and eggs										
Total Dose(mSv)										

	Dose mSv - case 2									
	Adult 1000m					Child 1000m				
	Dose via air path way		Dose via Soil path way			Dose via air path way		Dose via Soil path way		
	HTO	OBT	HTO	OBT	Total	HTO	OBT	HTO	OBT	Total
Inhalation										
Transcutaneous										
Salads and leafy veg.										
Radish and turnip										
Potatoes										
Carrots										
String beans										
Peas										
Tomatoes										
Cereals										
Beef										
Milk										
Chicken and eggs										
Total Dose(mSv)										

	Dose mSv - case 3									
	Adult 1000m					Child 1000m				
	Dose via air path way		Dose via Soil path way			Dose via air path way		Dose via Soil path way		
	HTO	OBT	HTO	OBT	Total	HTO	OBT	HTO	OBT	Total
Inhalation										
Transcutaneous										
Salads and leafy veg.										
Radish and turnip										
Potatoes										
Carrots										
String beans										
Peas										
Tomatoes										
Cereals										
Beef										
Milk										
Chicken and eggs										
Total Dose(mSv)										

Case 1 - Activity (Bq.kg^{-1} f.w) – 1000 m				
	At the end of release	48 hrs after end of release	At harvest (Last salads from air pathway)	Next cycle of crops at harvest
Salads and leafy veg.				
Radish and turnip				
Potatoes				
Carrots				
String beans				
Peas				
Tomatoes				
Cereals				
	168 hrs after end of release		720 hrs after end of release	
Beef				
Milk				
Chicken and eggs				

Case 2 - Activity (Bq.kg^{-1} f.w) 1000 m				
	At the end of release	48 hrs after end of release	At harvest (Last salads from air pathway)	Next cycle of crops at harvest
Salads and leafy veg.				
Radish and turnip				
Potatoes				
Carrots				
String beans				
Peas				
Tomatoes				
Cereals				
	168 hrs after end of release		720 hrs after end of release	
Beef				
Milk				
Chicken and eggs				

Case 3 - Activity (Bq.kg^{-1} f.w) – 1000 m				
	At the end of release	48 hrs after end of release	At harvest (Last salads from air pathway)	Next cycle of crops at harvest
Salads and leafy veg.				
Radish and turnip				
Potatoes				
Carrots				
String beans				
Peas				
Tomatoes				
Cereals				
	168 hrs after end of release		720 hrs after end of release	
Beef				
Milk				
Chicken and eggs				

The results obtained will guide further discussion on the following issues:

- The area and distance affected by the release that would require immediate action in terms of
  (1) animals; and
  (2) crops
- What area may come back to pre-release conditions after a few days? distance, area
- Is there a need for action on cereals and potatoes, and to what extent? Distance, area
- How long and to what extent should cows be removed from pasture?
- Does a zone remain where planting of new crops would present a problem? Distance, area
- What could be a reference value for tritium concentration in different foodstuffs for free trade? Some information could be also collected for environmental control and wastes for discussion.
- What data can be collected in support of or to confirm the assessment? (What, where, when, frequency). What is the time frame for data collection?
- Is any waste generated and how should this be managed?
- Definition of interventions and evaluation of the efficiency of intervention, both in mSv and in terms of % dose saved by intervention. (for example : banning cereal consumption saves 11 mSv and 70% of the total dose, banning garden vegetable for 48h…)
- Proposed activity concentration limit of products for trade (1E4 Bq/kg f.w.?)

For this exercise, we shall consider that intervention on food products will occur for a dose level of 5 mSv per year, as there is no existing trade limits. Interventions will be considered within the optimisation principle (efficiency versus cost). Distances will also be evaluated for 10^4 Bq/kg fresh weight of product (for total Tritium and for OBT), as this value has been proposed as a possible limit.

It is most probable that it will not be possible for food control to distinguish between HTO and OBT. Nevertheless participants may give details on that point.

Some data supplied here may not be used by all modelers. Simplifications may be done. Please list basic assumptions.