Radiological Protection Institute of Ireland
An Institiúid Éireannach um Chosaint Raideolaíoch

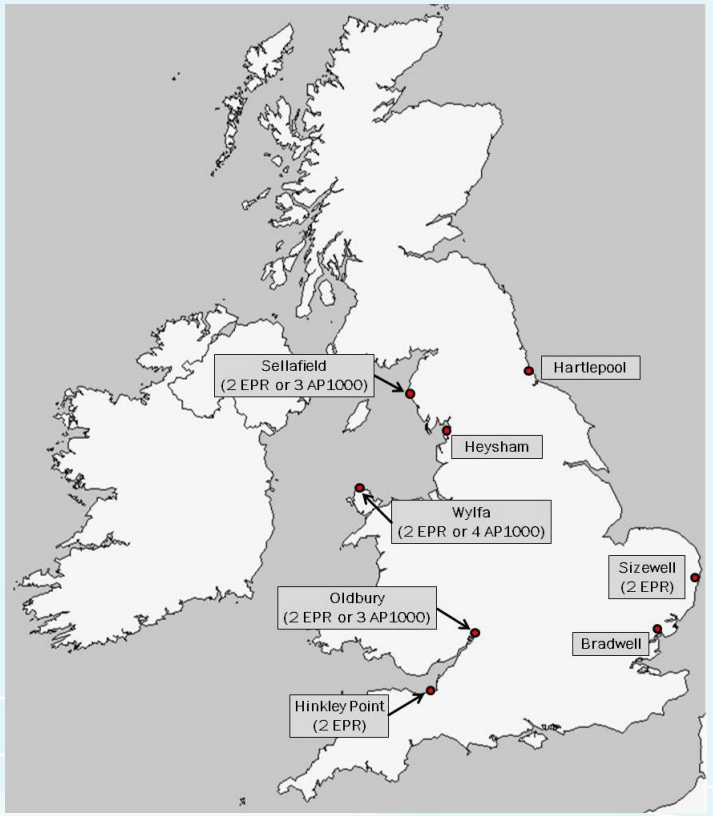
Assessment of the Impact on the Irish Public Arising from Liquid Discharges from Potential New Build Power Plants in the UK

Overview

- New Build in the UK
- Source Term for this work
- Routine discharges – Methodology and Results
- Non-routine discharges – Methodology and Results
- Conclusions

New Build in the UK

- 8 Sites Identified as being suitable for new nuclear development
- 5 sites on West Coast of UK investigated



Liquid Discharges

Radionuclide	Routine Discharge (GBq yr^{-1})	Radionuclide	Routine Discharge (GBq yr^{-1})	Radionuclide	Routine Discharge (GBq yr^{-1})
H-3	75,000	**I-135**	0.0525	**Am-243**	0.000037
C-14	95	**I-131**	0.05	**As-76**	0.000037
Co-60	3	**I-132**	0.0438	**Br-82**	0.000037
Co-58	2.07	**Mo-99**	0.0416	**Cl-36**	0.000037
Ni-63	1.14	**La-140**	0.0394	**Cm-242**	0.000037
Fe-55	1.06	**Tc-99m**	0.0394	**Cm-244**	0.000037
Cs-137	0.945	**Ba-140**	0.0306	**Nb-94**	0.000037
Sb-125	0.815	**Zn-65**	0.0219	**Np-237**	0.000037
Ag110m	0.57	**Cs-136**	0.0203	**Pu-238**	0.000037
Cs-134	0.56	**Zr-95**	0.0151	**Pu-239**	0.000037
Sb-124	0.49	**I-134**	0.0129	**Pu-240**	0.000037
Mn-54	0.27	**Fe-59**	0.0109	**Pu-242**	0.000037
Ru-103	0.263	**W-187**	0.00656	**Rb-86**	0.000037
Te-123m	0.26	**Sr-89**	0.00525	**Ru-106**	0.000037
Ce-144	0.175	**Rb-88**	0.000853	**Sb-122**	0.000037
Pr-144	0.175	**Sr-90**	0.000535	**Sn-117m**	0.000037
Cr-51	0.101	**Y-91**	0.000199	**U-234**	0.000037
Na-24	0.0831	**Pu-241**	0.000178	**U-235**	0.000037
I-133	0.0634	**I-129**	0.000037	**U-238**	0.000037
Nb-95	0.06	**Am-241**	0.000037		

Routine Discharges Methodology

- **CREAM – Consequences of Releases to the Environment: Assessment Methodology**
- **PC-CREAM-08 software**
  - **Evaluates radiological consequences of discharges**
  - **DORIS – To model dispersion of radionuclides**
  - **MARINE ASSESSOR – To determine dose to Irish population based on outputs from DORIS**

Routine Discharges Methodology

- **Activity concentrations in 50th year in:**
  - **Seawater**
  - **Sediment**
  - **Biota**
- **DORIS compartments –**
  - **Irish Sea West (Blue)**
  - **Irish Sea South (Red)**

Routine Discharges Dose Calculation

- Exposure pathways
  - Ingestion of seafood: fish, crustaceans, molluscs
  - Inhalation of seaspray
  - External irradiation: beach sediments, fishing gear (gamma and beta)
- Adult seafood consumer groups:
  - Consumer Group A
  - Consumer Group B

  } RPII Habits Survey
  - Typical Seafood Consumer – IUNA 2011

Routine Discharges: Habits

Exposure Pathway	Group A		Group B		Typical Consumer	
Seafood Consumption (kg yr^{-1})	Fish	26	Mussels	20	Fish	8.4
	Crustaceans	10	Oysters	5	Crustaceans	0.5
					Molluscs	0.1
Time on beach (h yr^{-1})	-		410		410	
Handing Fishing Equipment (h yr^{-1})	2500		730		-	

Routine Discharges: Doses

Discharge Location	Group A Irish Sea West	Group A Irish Sea South	Group B Irish Sea West	Group B Irish Sea South	Typical Consumer Irish Sea West	Typical Consumer Irish Sea South
Sellafield	1.85E-02	6.97E-03	1.33E-02	4.98E-03	5.03E-03	1.87E-03
Heysham	1.85E-02	7.17E-03	1.33E-02	5.12E-03	5.02E-03	1.92E-03
Wylfa	3.81E-02	1.26E-02	2.73E-02	9.02E-03	1.04E-02	3.41E-03
Oldbury	1.90E-04	2.08E-04	1.35E-04	1.48E-04	5.06E-05	5.56E-05
Hinkley Point	1.91E-04	2.10E-04	1.36E-04	1.50E-04	5.08E-05	5.61E-05

Individual effective dose ($\mu Sv.yr^{-1}$) after 50 years of routine releases

- **Largest Doses:**
  - **From Wylfa Site**
  - **From consumption of seafood (95%)**
  - **C-14 most significant contributor (90%)**

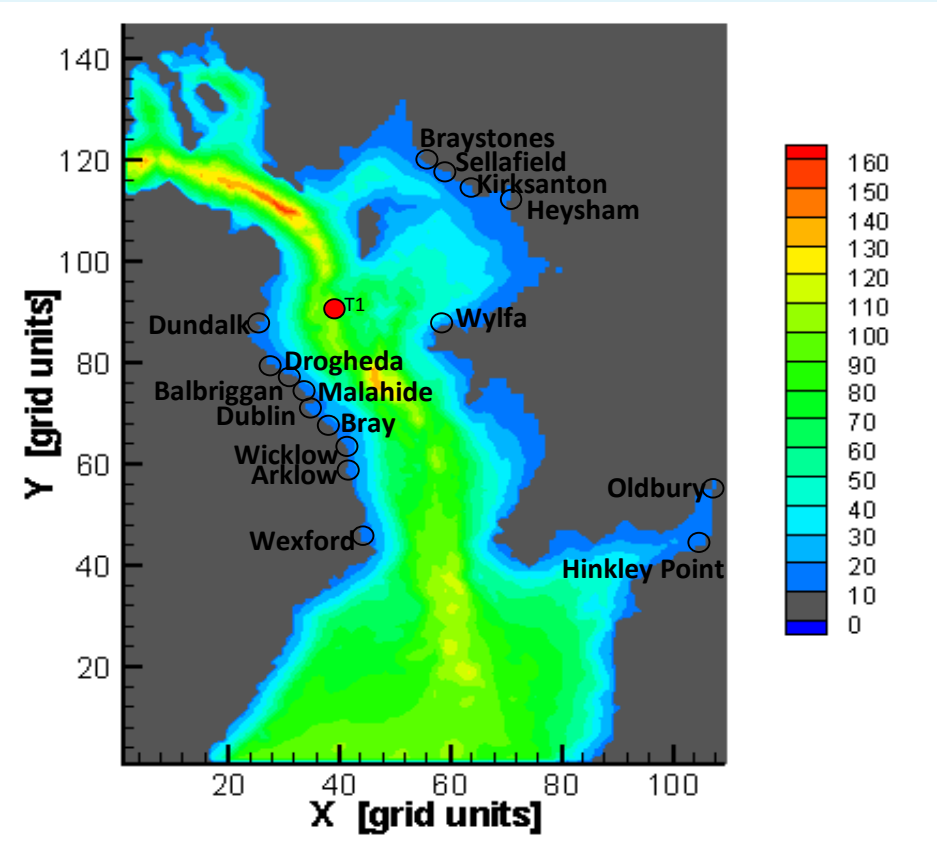
Non-routine Discharges

- **Source Terms**
  - **Scenario 1: One year of routine discharges released in one week**
  - **Scenario 2: Total volume of reactor coolant discharged in one week**

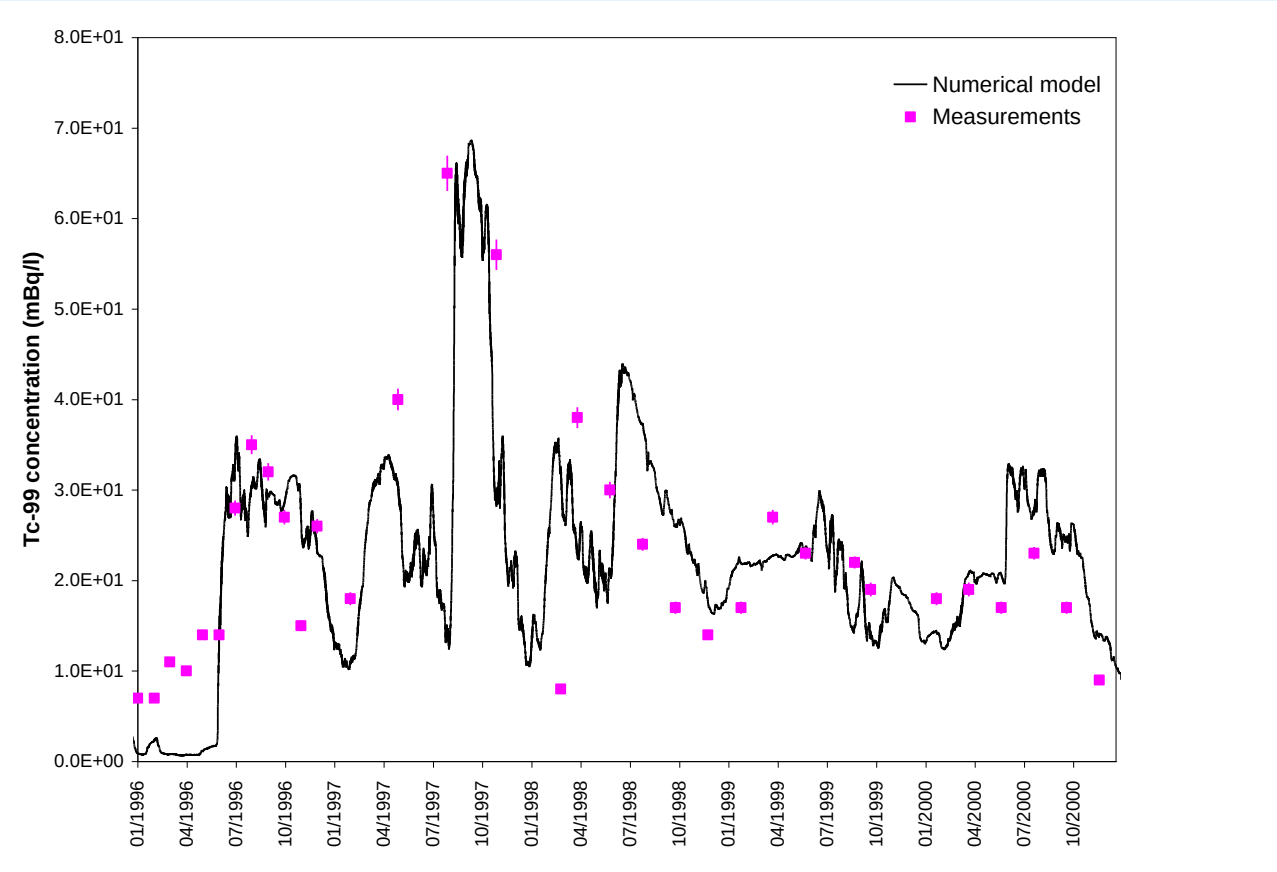
Radionuclide	Total Activity (GBq)	Radionuclide	Total Activity (GBq)
I-133	63,000	**Ni-63**	930
I-135	42,000	**Sr-89**	900
I-131	33,000	**Ag110m**	510
Cs-138	30,000	**Mn-54**	420
I-132	24,600	**Sb-122**	330
H-3	11,100	**Co-60**	174
Cs-136	11,100	**Sb-124**	168
Cs-134	10,200	**Fe-59**	108
I-134	9,000	**Sb-125**	30
Cs-137	7,500	**Sr-90**	5.7
Co-58	3,000	**C-14**	3.9
Cr-51	2,850		

Non-routine Discharges: Dispersion Modelling

- Estimate activity concentrations and transit times of radionuclide discharges from the proposed sites to selected locations on the east coast of Ireland.
- Conservative behaviour
- Simulates tides, winds, density gradients on currents
- Interseasonal & interannual effects



Historic and Model Time series at Balbriggan



Non-routine Discharges

- **Highest seawater activity observed for Springtime release from Wylfa**
- **A 604.8 TBq discharge results in a seawater activity concentration of 191 mBq l^{-1} in Dundalk 161 days later**
- **Dilution factor, based on outcome from NUIG model:**

$$DF = \frac{191 \times 10^{-3}\ Bq/l}{604.8 \times 10^{3} Gbq} = 3.1581 \times 10^{-7} \left(\frac{Bq/l}{GBq} \right)$$

Non-routine Discharges: Peak Seawater Activity Concentration

$$C^{i}_{Seawater} = D_i \times DF \times e^{-\lambda_i t}$$

$C^{i}_{Seawater}$	is the peak seawater activity concentration for radionuclide *i*
D_i	is the total activity discharged for radionuclide *i* (GBq)
DF	is the dilution factor (3.1581×10^{-7} Bq l^{-1}/GBq)
λ_i	is the decay constant for radionuclide *i* ($days^{-1}$)
t	is the time taken to reach the peak seawater activity at Greenore i.e. 161 days

Non-routine Discharges: Activity Concentrations in Biota and Sediment

- Radioactivity concentrations in biota and sediment:
  - Determined using appropriate concentration factors (CF) and sediment concentration factor (k_d)
  - Determined using same factors in the PC-CREAM-08 software for consistency

Non-routine Discharges: Dose Assessment

- Using CREAM methodology in MS Excel based on PC-CREAM-08 documentation
- Same exposure pathways and consumer groups as routine discharges

Non-routine Discharges: Dose Assessment

Total Dose (μSv)		
Group A	Group B	Typical Consumer
1.31×10^{-2}	1.03×10^{-2}	4.09×10^{-3}

- Scenario 1
  - Largest dose to consumer group A
  - Ingestion of seafood the dominant exposure pathway (99%)
  - C-14 the radionuclide of most importance

Non-routine Discharges: Dose Assessment

Total Dose (μSv)		
Group A	Group B	Typical Consumer
3.45×10^{-1}	9.41×10^{-1}	7.45×10^{-1}

- Scenario 2
  - Largest dose calculated is to consumer group B.
  - Principal exposure pathway is exposure to beach sediment (gamma)
  - Radionuclide of most importance is Mn-54

Conclusions

- **Routine:**
  - **Negligible impact on Irish public**
- **Non-routine:**
  - **Even with a very conservative dose assessment, impact on Irish public is negligible**
- **Both**
  - **For all scenarios outlined doses similar to those received from current inventory in Irish Sea**

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Routine Discharges: Doses