NURIS 2015:
An Independent Analysis of UK Nuclear Industry & UK Government Agency research on the Behaviour & Fate of sea discharged radioactive wastes

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Late 1940’s/early 1950’s:
• In context of bomb material and “atoms for peace” Nuclear industry demands to use PME become intense

• But total absence of any empirical data on behaviour and fate of radioactivity in natural aquatic environments

• Oceanography in it’s infancy
  •(scant data, poor technical resources)

• Nuclear industry in it’s infancy
  •(no operating experience of “commercial” scale reactors, reprocessors, fuel fabricators: only lab work on behaviour & fate
Slide 2: Behaviour of sea discharged rad’-wastes: the “JUSTIFYING HYPOTHESIS”

- With collusion of nuclear industry, IAEA and pro nuclear governments conjured up a “justifying hypothesis” (despite total absence of empirical data) which stated that:

- **Soluble radio-nuclides: (Cs, H3, Tc etc)**
  Would dilute and disperse to infinity or background levels which will not harm humans *(incomplete list)*

- **In-soluble radio-nuclides: (Pu, Am, Cm etc)**
  Would bond to seabed sediments and remain “locked” there, sequestered from humans *(incomplete list)*

* UK Government *(supported by IAEA)* used hypothesis to justify atmos’ & aquatic discharges

- & commenced discharge of radioactive wastes to sea via pipelines (1952) *Order in Council” by Ministry of Supply (?)*
• “Justifying Hypothesis”: post 1952

“J H” & its academic “outcomes”

• Becomes embedded as academic “description” of behaviour and fate of marine radioactivity and is taught as such at Uni’ etc

• Emerging graduates enter “nuclear professions”

• Work experienced graduates enter (or are seconded from “nuclear professions”) into govt depts & regulating agencies

• “JH” & “outcomes” fully integrated in to all levels of “nuclear thinking”

Despite 1958 UKAEA confirmation that sea discharges to the Irish Sea had been part of an “ongoing experiment” intended to discover how the radioactivity would behave
Hypothesis

- assumed dilution/dispersal & reduction of solubles to “background” or “infinity”
- assumed “sequestration” of “insolubles” and subsequent very limited mobility in marine environments

General assumption 1:
- Assumed Highest levels in marine environment will occur closest to point of discharge

General assumption 2= sea discharged rad’ wastes only deliver doses to:
- Seafood eaters (fish, shellfish, and seaweeds) \( \textit{dietary dose} \)
- Marine workers (fishermen) \( \textit{contact skin doses} \)
- Sportsmen (anglers, sailors, surfers) \( \textit{contact & small ingestion doses} \)
- Users of foreshore/intertidal: \( \textit{“Background”}: \textit{whole body gamma doses} \)

Thus assumed that
- The major dose pathways occur close to point sources
- The only Coastal “Critical Groups” occur close to point sources
- & therefore Aquatic Environment Monitoring was established with focus on these parameters
Slide 5: Marine, coastal, & estuarine monitoring

- Site related coastal/estuarine monitoring intended to:
  - “provide indicators of radio-nuclide dispersion around each site”
  - “establish long term trends in concentrations of radioactivity” (near field & “at distance”)
  - “results are used to **assess** dose to public” (ie model)
  - “ensure compliance with statutory dose limits”
  - “confirm safety of the food chain”
  - *UK RIFE reports*
Slide 6: **Site related aquatic environment monitoring “restraints”**

- Restraint of hypothesis (*which pre-dictates course of action*)
- Lack of oceanographic knowledge
- Lack of nuclide knowledge
  - (*only 24 nuclides with any significant research on behaviour & fate in aquatic environments*)
- Restraint of human resources (*manpower, financial input, Health & Safety*)
- Environmental restraints (*sea states, meteorology, etc*)
Slide 7: **UK Annual site related coastal monitoring protocols**  
(UK RIFE reports)

- **Very small sample numbers** (2 to 4 p.a.)

- **Very small nuclide numbers** (rarely more than 10 of 60: generally less than 10)

- **Poor sample choice** (fish, sediment sites, water column movement)

RIFE reports

Failure to record **environmental conditions** at time of sampling

- Sea states, Ambient meteorology, Ambient tidal condition, Seasonality

RIFE reports

Failure to respond to specific incidents (coastal flooding etc)

**On the basis of this: incomplete data dose rates to UK identified Coastal Critical Groups, via identified pathways, are “assessed”** (modelled)
“Orthodox” work has confirmed that:

**Soluble radio-nuclides:**
- do NOT dilute and disperse to “infinity” or “background”
- *Do ravel extensively in marine water columns*
- Do re-concentrate in marine biota, marine and estuarine sediments, sea spray and marine aerosols
- *Do Transfer from sea to land by variety of mechanisms*

**In-soluble radio-nuclides**
- do NOT remain bonded to seabed sediments near discharge point
- *Do travel extensively in marine water columns*
- Do re-concentrate in marine biota, marine and estuarine sediments, sea spray and marine aerosols *(EFs = 450 + for Am 241)*
- *Do Transfer from the sea to the land by variety of mechanisms*

And thus demonstrates that original HYPOTHESIS is flawed
Slide 9: **Official research effort 1: water column transport: 1970’s 7 80’s**

- **Long distant transport of soluble and insoluble rad wastes through water column now widely attested** (*UK sea discharged Cs and Pu detected N.E Atlantic, Arctic, N. Pacific*)
  - **MAFF**: Re-concentration [Cs, Pu] observed in Irt/Esk estuary fine sediments (10/12 km south of Sellafield pipe)
  - **MAFF**: Sea to land transfer of nuclides observed (flooding: high tide and storm surge events): *Pu in house dust at Ravenglas, sheepmeat, local produce*

- **AERE late 70s (published 80’s)**: Marine enrichments (*Pu, Am and Cs*) observed in microlayers, sea-spray, aerosol (*Pu EFS= 26,000 algal blooms*)
  - Sea to land transfer (*Pu’s, Am and Cs*) in seaspray and aerosols across the surf line observed (*Am EFs = +812*)
  - BUT extent of inland penetration NOT measured,
  - AND measuring devices stated not efficient & data NOT appropriate for any quantification work
Slide 10: Flawed Official research effort: impact sea to land transfer

*Since early 90’s: RIFE reports modified to comment on inhalation doses from sea to land transfer, and now state that

- levels of radioactivity in marine environments “give rise to only very minor exposures to the public following inhalation of re-suspended particulates including those from the surf line”

- But: review shows that reference is 1981 IAEA paper which
  1: studied only 1 Cs and 1 Pu
  2: used inefficient equipment NOT appropriate for any quantification
  3: used outmoded 1979 ICRP values (annual effective dose equivalent limit 5msv)
  4: Pre-ceded 1986 ICRP limit = 1msv and 1987 UK NRPB “interim guidance” = 0.5msv
  5: no later corrections/updates

* Lacking scientific rigour & cannot possibly quantify ACTUAL inhalation dose or acquire data relevant to other pathways
Flawed official research: estuarine monitoring

Since start of “official” monitoring: no “inland” ESTUARINE fine sediments studied

But “Independent” research finds:

1: Cree Estuary: Solway Coast: Scotland (50 kms from source) 1985

<table>
<thead>
<tr>
<th></th>
<th>Cs 137 Bq/Kg</th>
<th>Am 2412 Bq/Kg</th>
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<tbody>
<tr>
<td>seaward</td>
<td>310</td>
<td>87</td>
</tr>
<tr>
<td>inland</td>
<td>2982</td>
<td>715</td>
</tr>
<tr>
<td><strong>EF</strong></td>
<td><strong>x9</strong></td>
<td><strong>x8</strong></td>
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</tbody>
</table>

(no change in monitoring protocol as of 2015)

2: Teifi Estuary: West Wales (200km from source) 1986

<table>
<thead>
<tr>
<th></th>
<th>Cs 137 Bq/Kg</th>
<th>Am 241 Bq/Kg</th>
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</thead>
<tbody>
<tr>
<td>seaward</td>
<td>5.2</td>
<td>2.8</td>
</tr>
<tr>
<td>inland</td>
<td>54.0</td>
<td>10.5</td>
</tr>
<tr>
<td><strong>EF</strong></td>
<td><strong>x10</strong></td>
<td><strong>x5</strong></td>
</tr>
</tbody>
</table>

(still no official monitoring as of 2015)
As of 2015: no change to national marine, coastal, estuarine monitoring programme to reflect new knowledge of:

- “Independent” reported estuarine parameters
- long distant transport
- “distant” sequestration
- “distant” re-concentration

- Sea to land transfer mechanisms
- Potential for new dose pathways
- Potential for new Coastal Critical Groups

- “Orthodox” position re monitoring remains based on HYPOTHESIS despite evidence to the contrary
**Environmental behaviour: Independent case study 1: inundation**

**Towyn: Feb 1990 Storm surge**

*Extensive flooding of coastal strip (houses, caravans, business premises, public spaces)*

- Delivers several hundred tons of marine sediment deposited on land

*Over 50% (8 of 14) of “Independent” sediment samples tested positive for alpha/actinide **Americium 241 10X Generalised Derived Limit for urban areas***

*Consultant stated that given the context of **Am 241** conc’s, then Plutonium certainly present & levels “**quite probably**” also exceeded*

*Consultant stated that “when sediments dry out, there is a possible risk of radiation hazard due to the inhalation of radioactive dust”*

* Clean up = several months*
Independent Case Study: Sea spray/aerosol

Dyfed CC RAD MID (1987/88):
* radioactivity monitoring in west Wales coastal zone

Sellafield derived (sea discharged) Cs 137 and Cs 134 found 10 miles inland on pasture grass (proposed carried inland in sea spray during heavy onshore winds/storms)…….(first & only time 10 miles used) [lichens]

* demonstrated entry of sea derived rad to coastal zone meat stock and dairy food chain
* + Inevitable contamination of arable/horticultural crops/produce
* + inevitable dietary dose (marine rad’) to humans via ingestion of terrestrial produce
* + Strongly implies dose to humans via inhalation of airborne Cs

**Given presence of Cs:**

**presence of sea to land transferred Am and Pu likely**

N.B.

“Authorities won’t sample for sea to land transfer 10 miles inland”
Case study 2: sea spray/aerosol & terrestrial diet

*Kingsbridge: 1987 MAFF dietary comparison study

*Found that residents of South Devon estuary (believed to be “remote” from nuclear sites) consumed higher levels of dietary radioactivity (7 nuclides discharged from nuclear sites) in their local terrestrial food produce than a similar group living next to the Hinkley Point NPS on the Somerset coast*

Un-challenged review of this study found that the Kingsbridge dietary excess was due to radioactive Cobalt 60, transported (adsorbed to mobile sediments) from the Devonport nuclear submarine base 30 kms distant by sea and then transferred from the sea to the land where it contaminated the terrestrial foodstuffs.
Hebridean island: 29 kms diameter: pre Chernobyl study (BMJ 1991):

*ONLY EMPIRICAL DATA ON UK DOSES of sea to land transfer*

poss’ only empirical UK study on ANY marine doses: (413 patients)

- N. Uist **terrestrial** environment saturated with Sellafield sea discharged Cs 137 & 134 (200+km distant)

- *contamination of every island terrestrial produce sampled* (dairy, meat, vegetables, eggs, fruit)

- islanders consuming highest percentage of Island grown foodstuffs = highest body burdens of marine sourced Caesium

- **Highest individual dose:** terrestrial produce consumer who ate no fish

- Dietary doses of **marine** rad’ from **LAND foods** is higher than dietary doses of **marine** rad’ in **SEA foods**
Average islander dietary dose **marine rad from LAND foods**, from CS 137 alone, exceeds the average dietary dose marine rad’ from SEA foods (multiple nuclides) to Critical Groups living close to some nuclear sites.

- **Uist av’ dose from 1 nuclide Cs 137** = 13.7 microSv, (empirical)
- **Hunterstoun av’ seafood dose from 17 nuclides** = 30 microSv (modelled)
- **Chapelcross av’ seafood dose from 12 nuclides** = 20 microSv (modelled)
- **Wylfa av’ seafood dose from 11 nuclides** = 10 microSv (modelled)

If Cs transferring to land in such quantities then other radio nuclides inevitably present (**Pu & Am locally present**)

- “**upstream” discharge sources also present**
- **Inhalation implied**
- From these figures it may be deduced that “Orthodox” Coastal Critical Group identification is deeply flawed
- **N.B.: Hebridean wide cancer stats suggest elevated cancers (stomach, bowel, colon etc)**
The official research effort: summary of weaknesses

• Despite the emergence of new evidence about the behaviour and fate of radioactivity in coastal and estuarine environments, there has been no significant change in the marine/coastal sampling programme to take account of:

• Estuarine fine sediment re-concentration
• Intensity and ubiquity of sea to land transfer mechanism
• Sea to land transfer pathways of exposure
• Terrestrial dietary doses of marine radioactivity
• Terrestrial “inhalation” doses of marine radioactivity
• Evidential emergence of “distant “ Critical Groups

(islanders, peninsular populations, populations living in high risk “marine” flood areas, pops living in coastal zones facing prevailing winds, coastal zones with anthropogenic rad inputs and high turbidity)

With reference to the radiological sampling and monitoring and analytical programmes nothing has changed and to all intents and purposes (as far as government regulators and industry are concerned) the original hypothesis stands
Highest dose potential (marine radioactivity) conditions for coastal residents (independent)

- Peak (pulsed) discharges
- Climate change (sea level rise, increased storminess, excess rainfall)
- Heavy fluvial flooding re-suspends estuarine deposits
- Extreme winter weather re-suspends coastal & seabed fine sediment deposits
  - $= $ Increased water column rad
- Storm surge/excess high tide = inundation
- Strong prolonged on-shore winds + High seas/big surf/heavy sea = increased spray & aerosol production

- Agricultural/horticultural production/harvest/consumption peak

- Poor official monitoring and analytical effort means that the radiological outcome of such conditions are not recorded
  - Linear No Dose Threshold
Coastal Critical Groups = those, in a given area, likely to receive the highest doses

Industry & regulator pathways for doses from sea discharge:
* Dietary: sea food, occupancy, skin contact (but only from “at-sea” or “shoreline”)

“Independent” pathways for doses from sea discharge
* Dietary: coastal terrestrial produce, inhalation (sea spray, aerosols, mists/fog/evaporation, suspended particles) dietary: sea foods, skin contact, occupancy,

Sea to Land Transfer case studies relevant to European coastal zone
1: RADMID 10 miles inland penetration of marine rads
2: Devonport sea to land transfer
3: Hebridean islanders: elevated doses of marine Cs 137 in terrestrial diet: average dose of marine Cs 137 alone from terrestrial produce higher than doses of multiple radio isotopes received by some seafood Critical Groups at nuclear sites
4: inundation events (storm surge, “tsunami”, super-tides, fluvial/estuary events)
Conclusions

Industry and pro industry entities research based on
* False hypothesis
  • inappropriate field work, strong emphasis on “modelled” data
  • modelled data flawed due inappropriate field work

Independent research based on
• greater degree of empirical evidence
• field work based on more relevant protocols
Slide 22: **Conclusions**

- Academic & independent research outcomes are anomalous to those of industry and pro nuclear governments & agencies

- Urgent need to lay aside Justifying Hypothesis and construct one that actually reflects empirical evidence

- Urgent need to re-visit & re-assess Coastal critical group ID on basis of empirical evidence

- Urgent need to revisit & re-assess (marine rad) exposure pathways ID on basis of empirical evidence

- Urgent need to reduce dose modelling and to increase dose empirical evidence on radio-nuclide uptake and ACTUAL doses
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