Computer modelling – are we making a new generation of professionals stupid?

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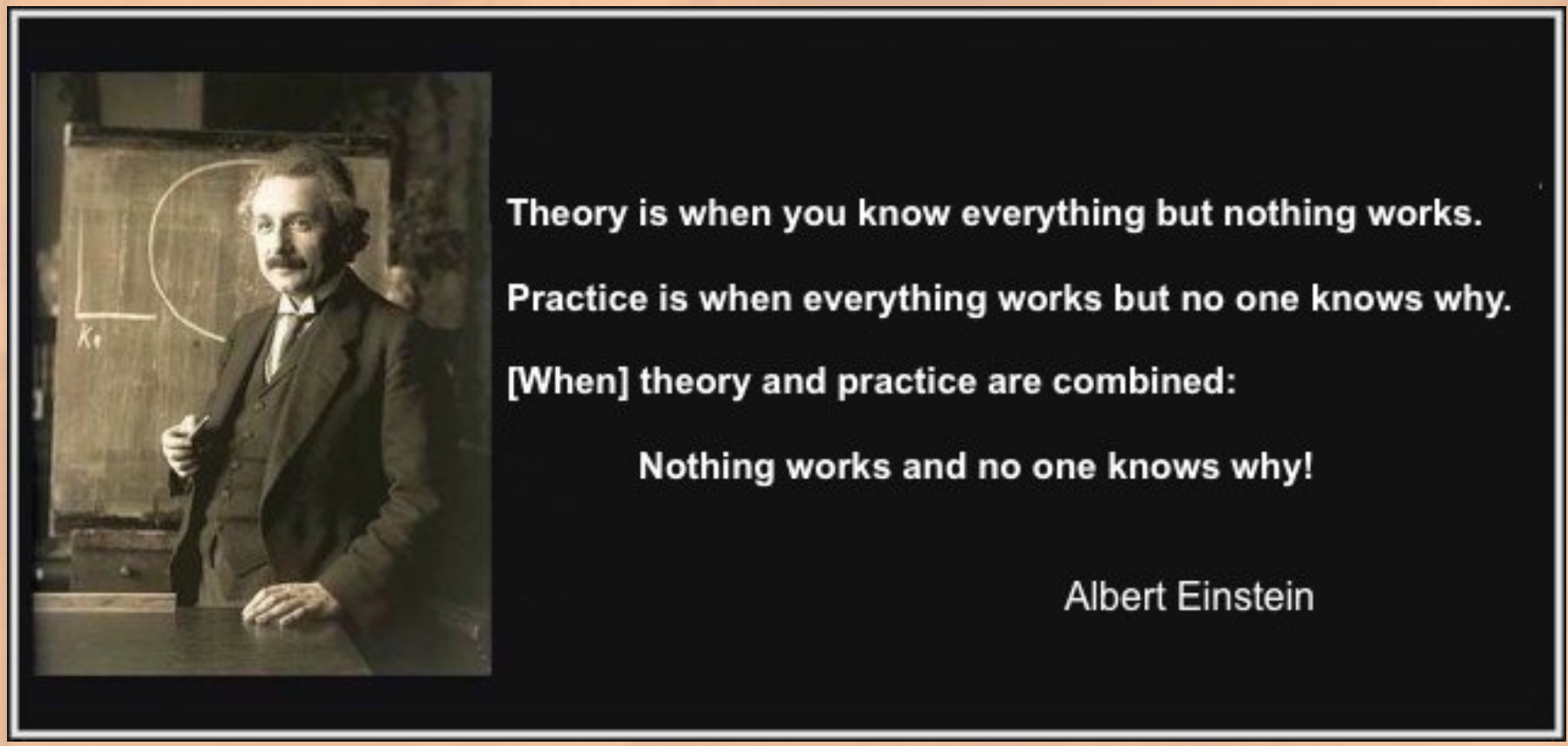
COMPUTER MODELLING AND ITS PRACTICAL USE



MAIN ISSUE

Many representatives of a new generation of radiation protection professionals appear to be:

- **Generally ignorant of principles and equations, on which the models are based, and**
- **Sometimes cannot recognise a simple error in the final results of modelling.**

ADDITIONAL COMPLICATION 1: TRAINING

There is only a limited number of people who have attended appropriate training (i.e. RESRAD workshops).

Software is downloaded and used by untrained people.

Actual case, South-East Asia:

Q: *"Who came up with these numbers? These are weird and definitely incorrect."*

A: *"We've had one person that went on the course, he's left now and we simply used the data from his print-out."*

ADDITIONAL COMPLICATION 2: DEFAULT vs. SITE-SPECIFIC

At the farm near a contaminated site the water is used for irrigation, but only 5% of the time the it is sourced from site bores (*some* of which are contaminated) and this water almost never used for drinking.

Default and actual RESRAD input parameters:

FDW Fraction of drinking water that is contaminated.
Default = 1, real = 0.1.

FGWDW Fraction of drinking water from groundwater.
Default = 1, real = 0.005.

FGWIR Fraction of irrigation water from groundwater.
Default = 1; real = 0.05

Result: 500% to 2000% overestimation of doses and impacts.

ADDITIONAL COMPLICATION 3: OVER-REGULATION

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Radiation: only one of over-regulated low-level risks.

An obsession with regulating low risks and an blindness to diseases such as measles, malaria and tuberculosis, and to other potentially fatal dangers, such as prescription opioids and alcohol.

Regulating minor or hypothetical hazards (such as low-level radiation from NORM) and using complicated models in an attempt to estimate and then reduce risk from these hazards:

1. Gives elected officials an opportunity to say "we are here to protect you",
2. Provides support for the scientific research that may not be needed, and for the government departments that, in some cases, have many more staff that is necessary, and
3. Appeases BANANAs – people of the following opinion: "**Build Absolutely Nothing Anywhere Near Anything**".

CASE 1: WEST AFRICA

Negative radiation exposure…?

l'activité alpha globale	– 0,22 Bq/l
l'activité bêta globale	0,23 Bq/l
concentration en radium 226	– 0,12 Bq/l
concentration en radium 228	0,05 Bq/l

- Facteur de conversion de dose (^{226}Ra) 2.8 x 10^{-4} mSv/Bq
- Facteur de conversion de dose (^{228}Ra) 6.9 x 10^{-4} mSv/Bq
- Consommation annuelle d'eau 800 l/a

Exposition au Ra-226:
(-0.12) Bq/l x 800 l/a x 2.8 x 10^{-4} mSv/Bq = -0.027 mSv/a
Exposition au Ra-228:
0.05 Bq/l x 800 l/a x 6.9 x 10^{-4} mSv/Bq = 0.028 mSv/a

Exposition totale par ingestion = 0 mSv/a

CASE 2: AUSTRALIA

Physically impossible waste acceptance criterion

Table 5-14 Waste Acceptance Criteria (WAC) for the Facility for bulk NORM waste

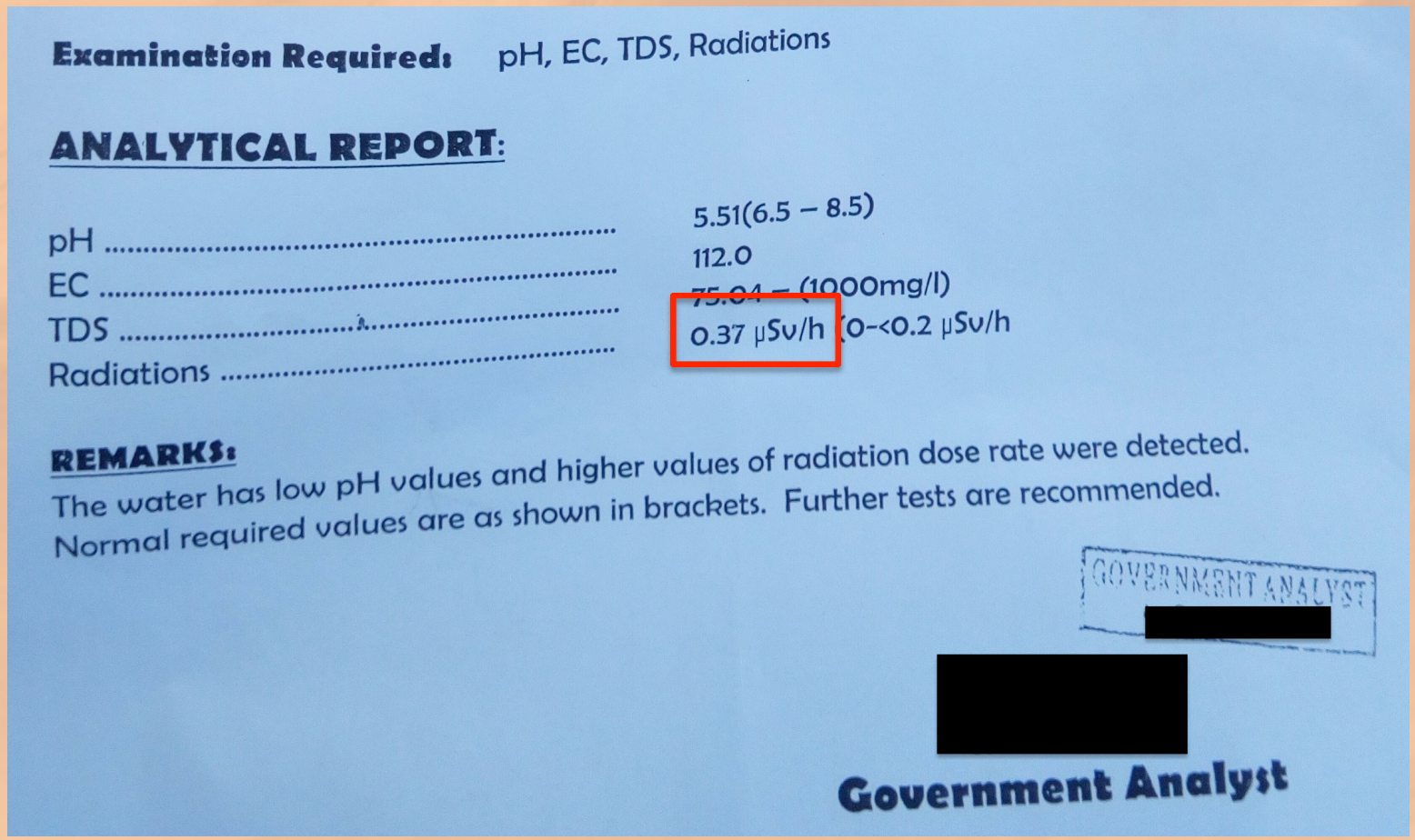
Radionuclides	Half Life	Individual Radionuclide Activity Concentration of Bulk NORM Waste (Bq/g)
U-238	4.468 billion years	1.0E+05

100,000 Bq/g of ^{238}U…?

High school physics textbook says that it cannot be more than 12,384 Bq/g

CASE 3: EAST AFRICA

Replacing water analyses with gamma readings from the bucket, in a high natural background area



Examination Required: pH, EC, TDS, Radiations

ANALYTICAL REPORT:

pH	5.51(6.5 – 8.5)
EC	112.0
TDS	[illegible] (1000mg/l)
Radiations	0.37 µSv/h (0-<0.2 µSv/h

REMARKS:

The water has low pH values and higher values of radiation dose rate were detected. Normal required values are as shown in brackets. Further tests are recommended.

GOVERNMENT ANALYST [redacted]

[redacted]

Government Analyst

RELIANCE EXCLUSIVELY ON COMPUTER MODELLING

When there is no understanding of the software used, radiation protection principles and sometimes even basic laws of physics:

- Potential exposures of workers and/or impacts on the environment are significantly underestimated, requiring costly and prolonged correction measures in the future, or
- Enormous amounts of funds are spent on 'preventative' occupational radiation protection and the protection of the public and the environment – where these actions were certainly not needed.

PRE-PROGRAMMED OUTCOMES

The same model is sometimes used by a mineral processing company, by a radiation protection consultant or by a regulatory authority – with completely different outcomes, with those outcomes appear to have been "pre-programmed" before modelling commences.

In some cases there is a suspicion that the inputs into a model were manipulated to ensure that the final outcome is what was desired.

- Company modelling is usually an underestimation.
- Consultant/government modelling is usually an overestimation.

Many young professionals believe that all results are correct, as they have no capacity to verify the outcomes.

EXAMPLES OF MODELLING

The examples of the use of models on the following slides are graded on a following scale:

Stupid

Silly

Adequate

Ridiculous

Ludicrous

1. STUPID

Assessment of environmental impact from disposal of mineral processing residue (Th = 7 Bq/g, U =1 Bq/g).

Assumption (input into model)	Actual situation
NO EFFECT WHATSOEVER	(a) Public exposure above 0.5 mSv/year, (b) Potential impact on local (endangered) flora

2. SILLY – (same as No.4, a company assessment)

Prediction of occupational exposures, mineral sands (titanium, zirconium and rare earth minerals), Th & U ~ 5 – 15 Bq/g.

Assumption (input into model)	Actual situation
WORKER'S EXPOSURE = 1.1 mSv/y	WORKER'S EXPOSURE = 4.2 mSv/y

3. ADEQUATE

NEVER HAPPENS

4. RIDICULOUS – (same as No.2, consultant's assessment)

Prediction of occupational exposures, mineral sands (titanium, zirconium and rare earth minerals), Th & U ~ 5 – 15 Bq/g.

Assumption (input into model)	Actual situation
WORKER'S EXPOSURE = 28.7 mSv/y	WORKER'S EXPOSURE= 4.2 mSv/y

5. LUDICROUS

Remediation of U exploration / pilot plant in a desert location

Assumption (input into model)	Actual situation (NOT taken into account)
Predicted: Doses close to 5 mSv/year Millions spent on overseas consulting and remediation teams despite the fact that over 50% of people in the country live in poverty	Actual: Doses less than 0.05 mSv/year THERE WAS NO NEED FOR ANY REMEDIAL ACTION WHATSOEVER

SUGGESTION 1: RESULTS INTERPRETATION

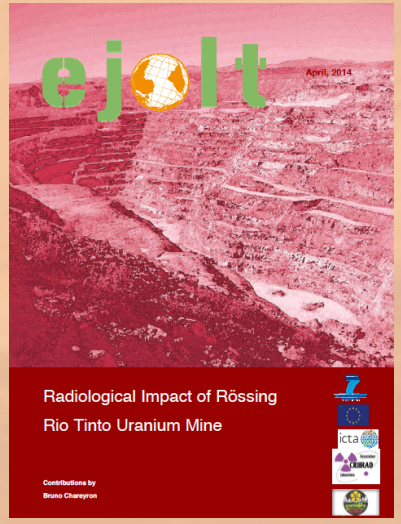
NEVER accept modelling results as correct without some simple check, i.e. an estimate of possible gamma dose can be done with a pen and a piece of paper in a couple of minutes.

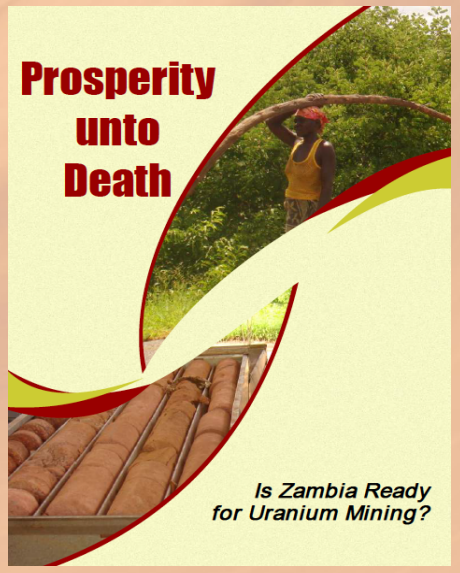
ALWAYS inquire as to who actually did the assessment and using which software: some examples of errors are from “reputable consulting firms” or from relevant government departments.

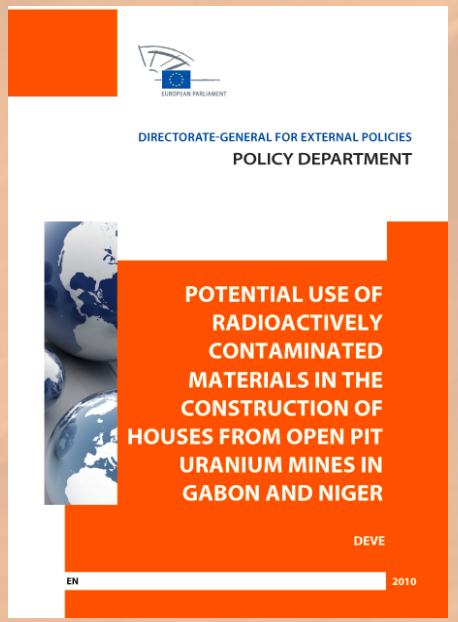
ANY document to which a reference is made may contain incorrect data (i.e. Australian ARPANSA RPS-9.1 on monitoring and dose assessment, IAEA TECDOC-1312 on detection of radioactive material at borders, etc).

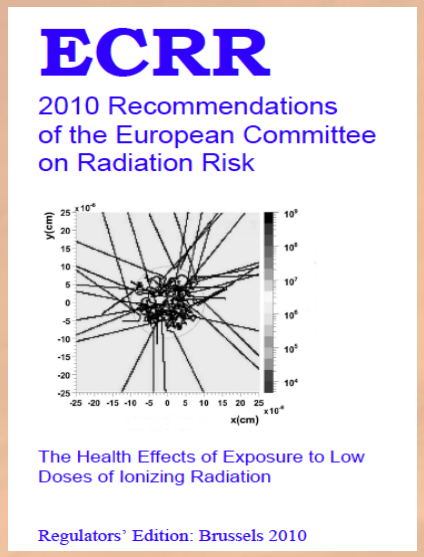
SUGGESTION 1: RESULTS INTERPRETATION

BE VERY CAREFUL in the evaluation of conclusions of any assessment, especially those concerning public health.



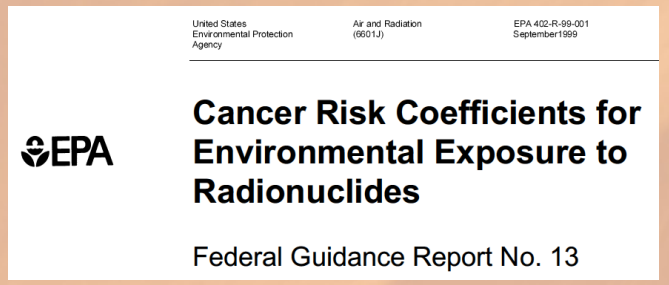






SUGGESTION 1: RESULTS INTERPRETATION

Let's see what may be those "public health implications"…


United States Environmental Protection Agency | Air and Radiation (6601J) | EPA 402-R-99-001 September1999

EPA

Cancer Risk Coefficients for Environmental Exposure to Radionuclides

Federal Guidance Report No. 13

FGR-13 establishes radiation risk coefficients for mortality and morbidity for about 100 radioisotopes, to be used in regulatory programs and in the preparation of environmental impact assessments.

Mortality *– you die from radiation-induced illness before you die from something else.* ***Morbidity*** *– you recover from radiation induced illness or you die from something else before radiation will finish you off.*

Of course, the document is "not intended for application to specific individuals and should not be used for this purpose". It is, however, clear that the document *may* be used for exactly *that* purpose, especially by BANANA's…

SUGGESTION 1: RESULTS INTERPRETATION

"Public health implications", an example:

- A facility is proposed on the outskirts of a town with 100,000 people, and it is proposed to operate for 25 years.
- Due to the facility processing NORM, an EIA was developed and it was demonstrated that the maximum public exposure would be around 0.1 mSv/year – only 10% of the public exposure limit.
- Local media is unaware of the situation and, if it is: *"no problems, everything is way below limits, more jobs for us".*
- Then an NGO with certain interests (as a rule, "from out-of-town") carried out the assessment using FGR-13 coefficients. The result: nine people could get a non-lethal cancer and eight – could die from radiation-induced cancer.

An obvious result, after the local media gets a copy of the NGO's assessment:

- The construction will not go ahead at all.

SUGGESTION 2: STUDENTS

Try to make students interested in what is behind the computer models, don't just teach them to blindly use those.

Make it COOL and encourage individual students.

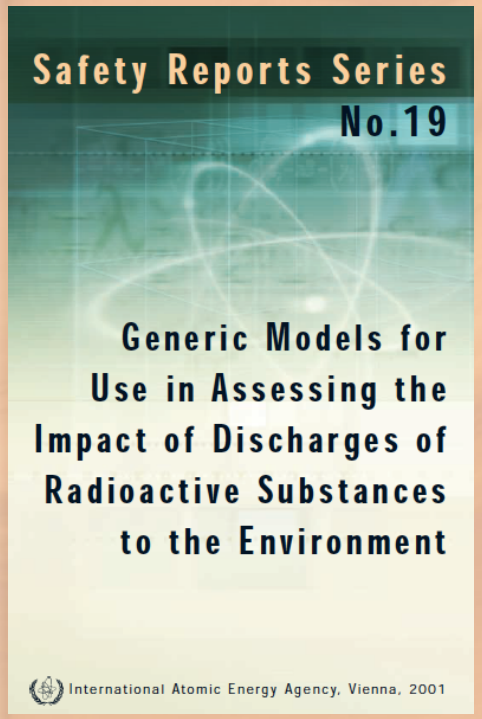
"Everyone can type on the keyboard, but much brighter mind is needed to understand what is behind it all – I think you are one of those people".

Make it FUN and ATTRACTIVE.

Introduce deliberate errors into exercises on modelling, some – easy to find, others – much better hidden.

Tell students that there are, say, seven errors – and those who can find all of them will get a credit for the semester (or something like that).

SUGGESTION 3: EMPLOYMENT



During an interview with a prospective employee ask if he/she knows what this is:

$$C_A(x,y,z) = \frac{Q_i}{2\pi\sigma_y\sigma_z u}\exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left\{\exp\left[-\frac{(z-H)^2}{2\sigma_z^2}\right]+\exp\left[-\frac{(z+H)^2}{2\sigma_z^2}\right]\right\}$$

This is the Gaussian plume model (Annex V), it only looks scary – it is VERY easy to calculate C_A in Bq/m^3. Any similar equation could be used.

If the answer is NO, maybe consider employing someone else.

If the answer is YES, pick up an easy calculation example from Annex IV of the IAEA SR-19, or a similar exercise.

If done correctly – you have a perfect technical specialist for the modelling.


1898
1935
1994
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