Developing a Source Term – Experience Gained During Australia's Fukushima Response

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Marcus Grzechnik, Blake Orr and Rick Tinker

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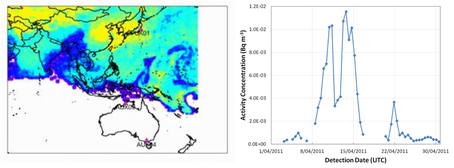
Australian Radiation Protection and Nuclear Safety Agency

Introduction – About ARPANSA

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Australian Government's radiation regulator and primary authority on radiation protection and nuclear Safety. ARPANSA has offices in three locations; Melbourne, Sydney and Canberra.

A warm welcome at ARPANSA Reception, Melbourne



Modelling and CTBT station detections of Xe-133 in Darwin, April 2011

ARPANSA has the responsibility of providing health impact assessments and advice to the Australian Government in the case of a nuclear incident or accident both at home and abroad. To support this function, ARPANSA maintains capabilities in field monitoring and modelling dispersion of radionuclides in the atmosphere.

ARPANSA was Australia's primary radiation advisor during the Fukushima Dai-ichi nuclear accident in 2011.

Modelling for Emergency Response

ARPANSA primarily uses the ARGOS (Accident Reporting and Guidance Operational System) decision support tool for emergency modelling. It has the capability to run CBRN (Chemical, Biological, Radiological, Nuclear) prognoses and to interpret and visualise results from a range of models, including atmospheric dispersion models. Weather data is provided through daily download from the Bureau of Meteorology.

Australia does not have a nuclear power industry, however it does have a research and nuclear medicine reactor (ANSTO) and also hosts Nuclear Powered Warship (NPW) visits. Various procedures have been adopted to ensure that the safety of the general public is maintained, including the simulation of possible accidental releases to the environment with source terms calculated using assumptions and techniques described in ARPANSA's reference accident[1].

The OPAL reactor at ANSTO, Lucas Heights

Nimitz carriers and Submarines can visit Australia

"The source term estimated by ARPANSA during the response to the Fukushima Dai-ichi nuclear accident was fit-for-purpose to deliver advice on protective measures."

Source Term Comparisons

Since the 2011 Fukushima Dai-ichi nuclear accident, detailed estimates of the atmospheric source term have been developed. UNSCEAR[2] suggested that total releases of ^{137}Cs were in the range of 6 to 20 PBq, with ^{131}I in the range of 100 to 500 PBq.

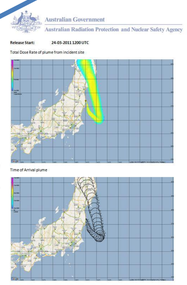
	ARPANSA	UNSCEAR (maximum hourly)	UNSCEAR (total)
^{137}Cs	0.81	0.4	8.83
^{131}I	12	4	120

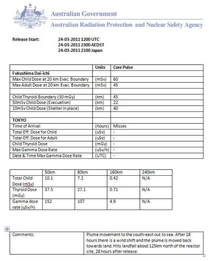
ARPANSA and UNSCEAR source terms (PBq).

In the adjacent table, the ARPANSA source term has been compared to that used in UNSCEAR's dose estimate. Both the maximum hourly release rate (for 4 hours on 15th March) and total release (over a month) have been included.

It is important to note that the source term used by ARPANSA was applied primarily during the response phase, with advice to Australians in Japan based on the pulse release scenario. As such, comparison with the UNSCEAR hourly rate shows that the ARPANSA source term was appropriately conservative.

Scenarios and Outputs





Examples of output briefings provided during the response

The source term release was simulated both instantaneously (pulse) and over a 24 hour period. During the emergency there was a fire in one of the spent fuel pools. Scenarios based on an additional source term of 10 spent fuel cores were also considered.

Spent fuel Source Term;
Caesium 10 PBq
Strontium 10 PBq

Source Term Estimation

The atmospheric release to the environment from the Fukushima Dai-ichi nuclear accident (i.e. "source term") was estimated using ARPANSA's reference accident methodology. This focusses on three aspects, with assumptions for the 2011 Fukushima Dai-ichi nuclear releases as follows;

- *Core total* – the ARGOS default core inventory (2380MWth reactor),
- *Release fractions from the core* – obtained from literature (including 50% for Iodine, 30% for Caesium),
- *Containment* – one level assumed (resulting in an assumed 1% release).

Radionuclide	Percent of Inventory Released (with 1% containment applied)
Noble gases	10%
Iodine	0.5%
Caesium	0.3%
Tellurium	0.15%
Barium, Strontium	0.05%

Dominant Nuclides (at shutdown);
^{131}I 12 PBq
^{137}Cs 0.81 PBq
^{134}Cs 0.80 PBq

References

[1]ARPANSA (2000). The 2000 Reference Accident Used to Assess the Suitability of Australian Ports for Visits by Nuclear Powered Warships. RB-NPW-66/00. http://www.arpansa.gov.au/pubs/RadiationProtection/ref_acc.pdf

[2]UNSCEAR (2013). Sources and effects of ionizing radiation. UNSCEAR 2013 Report to the General Assembly with Scientific Annexes. United Nations, New York.