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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Xenon-133 and caesium-137 releases into the atmosphere from the Fukushima Dai-ichi nuclear power plant: determination of the source term, atmospheric dispersion, and deposition" *by* A. Stohl et al.

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Engineering aspects related to the paper by A. Stohl *et al*.

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The paper by A. Stohl *et al*. presents some results pertaining to the Source Term of the Fukushima-DaiÂůichi nuclear accident. These results received in the past days worldwide attention by numerous mass-media, newspapers, online bulletins and related press agencies, mostly due to the over-boosting generated by an article published by Nature [1]. However, we think that the highly preliminary nature of the conclusions and the many uncertainties of the evaluations carried out by the Authors would have required a more careful analysis of the paper before its wide-spread diffusion particularly in light of the fact that it shows contradictions with known facts and previous reconstructions of the accident dynamics and in some cases also with some nuclear reactor engineering aspects. Overestimating the weight of these results could lead to an increase of the confusion on the actual evolution and consequences of the accident and, moreover, on the safety of nuclear energy. The risk is higher in this case because the paper is still in the s.c. Discussion phase and not yet definitively published.

These short notes are intended as a starting point for a broader discussion on the robustness of the assumptions used in the paper, affecting the uncertainties of the results presented in the latter. These comments are the result of investigations [2] of the causes that drove the accident sequence, which our research group developed from the very first days after the beginning of the accident, as part of our institutional duties. This discussion panel before publication is the right place for such a clarification. In our opinion the following points related to the estimation of the Source Term should be considered:

1. the calculated total released activity of Xe of 16.7 EBq is higher than the total

inventory of the entire site, even taking into account the uncertainty range provided: units 4 to 6 were in outage for at least three months which implies that their contribution to the total Xe inventory is negligible. The further explanations given to support the validity of the results are not convincing because:

- recriticality events are to be excluded on a physical basis given the conditions of the damaged cores [2]; in particular large power transients implying high Xe concentration build-ups cannot be *a fortiori* accepted;
- releases from other Japanese NPPs proposed by the Authors, furthermore of the amount of 4 EBq (16.7 vs 12.6 EBq of total Xe inventory), corresponding roughly to Xe inventory of an entire reactor, are to be likewise excluded because no such events were ever recorded by the on-site radiation monitors at each NPP, nor found by any *a posteriori* inspection on the status of the Japanese fleet.

2. the assumption of an average burnup of 30000 MWd/tU used in the ORIGEN calculations for the Cs inventory in the Unit 1 to 3 cores is fairly excessive compared with the maximum value used for the spent fuel, 40000 MWd/tU. The more accurate evaluation by TEPCO of the average burnup of Unit 2 at the moment of the earthquake is fixed at about 23000 MWd/tU.

3. regarding the estimated time of releases, with a beginning of the emissions before the Station Blackout caused by the Tsunami contradicts any evidence so far and the data used for the reconstruction of the accident sequence [2]:

   - no radioactivity measured on site before the Tsunami;
   - integrity of the MARK-I primary containment vessel in all units, confirmed by pressure data before and until at least many hours after the Tsunami;
   - a core-wide damage of the fuel elements is not realistic even in the case of a beyond-design-basis earthquake;

   - extensive damage due to thermal stress following the SCRAM automatic procedure is to be excluded *a priori* in any reactor; this is also proven in the facts by all the other Japanese NNPs that underwent earthquake-driven SCRAMs.

4. the time correlation of the sharp decrease of the a posteriori estimated emissions on the 19th of March with the spraying of water on the spent fuel pool of Unit 4 is highly dubious because:

   - measurements in the water of the spent fuel pool on 12th of April, 28th of April and 7th May show only low levels of radioactivity;
   - visual inspection of the spent fuel racks of the pool of Unit 4 confirms substantial integrity of the majority of the fuel elements.

   This scenario is compatible with a very limited damage of the clad integrity of only some fuel elements, which cannot justify the entity of the further releases different from those of the three reactors.

A deeper discussion of the aforementioned points is under publication by our research group and will appear shortly in English in a forthcoming issue of “Energia, Ambiente e Innovazione”, the internal review journal of ENEA, available online.

According to the comments here presented, several hypotheses proposed in the cited paper can hardly be shared, such as the radioactive releases from Unit 5, the Spent Fuel pool of Unit 4 or other NPPs in Japan, or a recriticality event in one of the three damaged Units: no evidence about any of these points is present in the recordings following the earthquake nor in the successive analyses performed on the Fukushima site. Also regarding the timing of the releases, inconsistencies are envisaged in its beginning immediately after the earthquake with respect to recorded plant and environmental data.

A possible explanation of these inconsistencies may be in the uncertainties in the atmospheric transport model, leading to an overestimation of the Source Term in order to justify measurements at stations at long distances. An updating of the uncertainty levels for the estimated Source Term is strongly recommended, taking into account the comments here presented, in order to ensure the readers with the correct confidence in the results presented.

1 Nature, vol. 478 | 27 October 2011 | 435-36.

2 M. Di Giuli *et al*. **Conseguenze del terremoto Tohoku-Taiheiyou-Oki sugli impianti nucleari giapponesi: ipotesi di ricostruzione della sequenza incidentale**. Technical report NNFISS-LP0-008-rev1, ENEA, September 2011.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/11/C11929/2011/acpd-11-C11929-2011-supplement.pdf

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