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Some Thoughts on Land Contamination, Containment Filtered Vent, and Large Release

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In the SRM to SECY-11-0137, "Prioritization of Recommended Actions to be taken in Response to Fukushima Lessons Learned," the Commission stated:

> "The staff should quickly shift the issue of 'Filtration of Containment Vents' from the 'additional issues' category and merge it with the Tier 1 issue of hardened vents for Mark I and Mark II containments such that the analysis and interaction with stakeholders needed to inform a decision on whether filtered vents should be required can be performed concurrently with the development of the technical bases, acceptance criteria, and design expectations for reliable hardened vents."

In the orders to All Operating Boiling-Water Reactor Licensees with Mark I and Mark II Containments, "Issuance of Order to modify Licenses with Regard to Reliable Hardened Containment Vents," EA-12-050, dated March 12, 2012, the following is stated:

> "In SRM-SECY-11-0137, the Commission directed the NRC staff to take certain actions and provided further guidance including directing the staff to consider filtered vents. The staff has determined that there are policy issues that need to be resolved before any regulatory action can be taken to require Licensees to install filtered vents. These policy issues include consideration of severe accident conditions in the design and operation of the vent, addition of filters to hardened reliable vent systems, and consideration of vents in areas other than primary containment."

Staff has targeted the summer of 2012 to address policy issues associated with filtered containment vents.

It seems to me that that the systematic process to address these issues would be to

1. Establish a Commission policy on land contamination
2. Set a specification on long half-life radionuclide release from severe accidents ("large release"), e.g., Cs-137
3. Establish a specification on the key characteristics of the filter, e.g., decontamination factor (DF) for the key radionuclides

To establish requirements on the filtered vent without first adopting a Commission policy on land contamination is a little like placing the cart before the horse.

Analytically, the approach one might use would be as follows:

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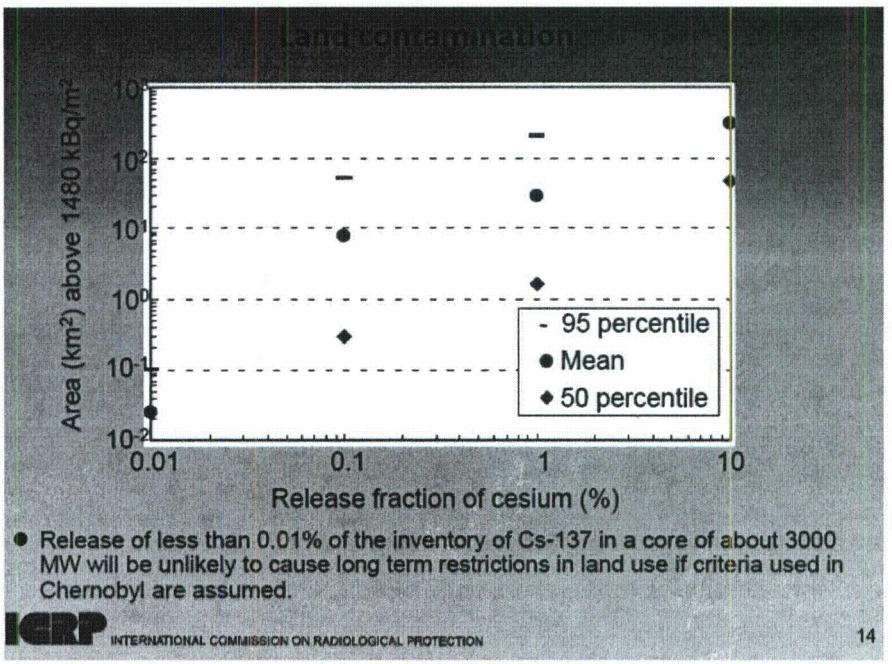
- Use EPA's Protective Action Guides basically calling for relocation of people and interdiction of land if the projected first-year dose exceeds 2 rem or any succeeding year exceeds 0.5 rem.
- Equate EPA PAG dose with land contamination levels, e.g., becquerels (Bq) per square meter of long-lived radionuclides such as Cs-137 or equivalent, e.g., 300,000 Bq/m^2
- Integrate land contamination levels surrounding the nuclear power plant to identify a "large release" in terms of total terabecquerels (TBq) of longer-lived radionuclides, e.g., 100 TBq of Cs-137 or equivalent
- Based on total core inventory of such long-lived radionuclides, and expected release fraction into containment, set a DF specification for the filtered vent, with margin, e.g., DF>1000 for aerosols including Cs in its various chemical forms would retain >99.9% of Cs-137 vented through the filter; and similarly, DF>100 for iodine
- A critical consideration in the specification for the filter is what fraction of core damage sequences bypass the filter. For example, if a dominant containment failure mode in a Mark-I containment is drywell liner melt-through, then the total radionuclide release to the environment would be dictated by this filter bypass and even larger DFs for the filter would see diminishing returns of effectiveness. MELCOR calculations as follow-up to the SOARCA effort could be extremely valuable in identifying the radionuclide release via various pathways in this regard. MACCS2 analyses could identify the amount of land in a given accident scenario that exceeds EPA PAGs with and without the containment filtered vent.

The following plot provides a useful measure of the relationship between Cs-137 release fraction and land contamination and is taken from the October 24-26, 2011, ICRP Symposium in Bethesda, MD, as presented by Toshimitsu Homma.



In Finland, the limit for radionuclide release was set by law, in part, out of consideration of land contamination. Section 12 of the Government resolution (359/1991) sets the limit for a severe accident as: *The limit for the release of radioactive materials arising from a severe accident is a release which causes neither acute harmful effects to the population in the vicinity of the nuclear power plant nor any long-term restrictions on the use of extensive areas of land and water. For satisfying the requirement applied to long-term effects, the limit for an atmospheric release of Cs-137 is 100 TBq.*

Depending on reactor size, fuel cycle, and other assumptions, 100 TBq equates to approximately 0.03 to 0.1% of core inventory of Cs-137. This is nearly 2 orders of magnitude lower than the 2.5 to 3% release fraction for Cs, I, and Te considered as possible definitions of "large" in NUREG/CR-6595.

The frequency of exceeding 100 TBq is set in the Finnish regulatory guide for PSA, YVL Guide 2.8, as a goal of less than 5×10^{-7} /yr.