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IAEA proficiency tests for determination of radionuclides in sea water

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Content

Six IAEA proficiency tests were organized between 2012 and 2015 to test the performance of participating laboratories in the analysis of radionuclides in sea water samples. These exercises were initiated to support IAEA Member States in sea water analyses of tritium, strontium-90 and caesium isotopes in relation to the accident at the Fukushima Daiichi nuclear power station, in March 2011, and subsequent contamination of the marine environment. A total of 59 laboratories from 35 countries participated in these six exercises including 13 laboratories from Japan.

Samples containing 5 L of filtered and acidified Mediterranean seawater spiked by the IAEA with the radionuclides were distributed to the participants, with the massic activities only known to the IAEA. The massic activities were traceable to a standard provided by a national standards laboratory. The combined massic activities in the exercise samples were lower than the natural activity level of K-40 in seawater. The H-3 massic activities for the exercise samples were in the order of 3 Bq/kg, while the Sr-90, Cs-134 and Cs-137 massic activities were between 0.1 Bq/kg and 0.4 Bq/kg.

The evaluation methodology took into account the accuracy, precision and trueness of the reported data and included in the evaluation both the combined standard uncertainty of the IAEA value and the combined standard uncertainty reported by the participating laboratories. A result must pass three statistical tests to be assigned the status "Accepted", otherwise it was assigned the status "Warning" or "Not accepted".

For H-3, practically all participants performed a distillation of the seawater samples, followed by liquid scintillation counting (LSC). Some laboratories performed an electrolytic enrichment after distillation (and obtained excellent results with small uncertainties). The direct measurements after distillation yielded slightly larger uncertainties. For Sr-90, most participants used gas-flow proportional counting (GPC) of chemically separated Y-90 as the analysis technique, with a minority that used LSC/Cherenkov counting. Chemical separation techniques used included precipitations of Sr-oxalate or Sr-carbonate, barium chromate precipitations, nitric acid precipitations, cation-exchange chromatography, Sr-extraction chromatography and direct liquid-liquid extraction of Y-90 with HDEHP. No significant difference between the performances of the chemical separation techniques is apparent. For Cs-134 and Cs-137, a majority of the participants measured the seawater samples directly with gamma spectrometry, while a minority of laboratories either used a pre-concentration technique (i.e. adsorption on ammonium molybdophosphate or hexacyanoferrate either copper, nickel or cobalt) to separate the caesium radionuclides from the seawater matrix followed by gamma spectrometry or they used a combination of the two techniques. No significant difference in the performance between the two techniques is apparent.

The evaluation of the individual exercise results showed that 43–78% of all reported results were "Accepted", while 13–43% of the individual measurement results were "Not accepted" with the remaining 6–17% having the "Warning" status. The "Warning" status will reflect cases in which the reported laboratory results were close enough to the assigned IAEA values, but its associated uncertainty was deemed to be either too small or too large.

In some exercises, significant negative biases of the combined participants' results for Cs-134 were observed, while, in general, there were no significant biases for H-3, Sr-90 and Cs-137. Coincidence summing is a problem for Cs-134 as it leads to signal loss and hence underestimation of the activity levels for this radionuclide. It is clear from the results that some participants did not make a sufficient correction for coincidence summing.

About the Presenter

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