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Review and investigation of the operational arrangements and procedures – *Emergency preparedness for long lasting releases*

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ARTICLE

Emergency preparedness for long lasting releases – assessment of radiological consequences

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Abstract – The assessment of radiological consequences for long-lasting releases was based on source terms and weather scenarios described in two previous articles. Four different institutions participated in radiological consequence assessment using their own source terms, weather scenarios, sites and characteristics of domestic nuclear power plants and atmospheric dispersion models. The results were evaluated in the context of national intervention levels. This assessment provided a good basis for an evaluation of the suitability of current nuclear emergency planning for potential accidents with long lasting releases.

Keywords: radiological consequence assessment / atmospheric dispersion modelling / long lasting release

1 Introduction

In the PREPARE work package 1.3 an assessment has been carried out for the off-site radiological consequences based on source terms from WP 1.1 (Bujan, 2016) and accident scenarios from WP 1.2 (Montero, 2016). The assessment consisted of a detailed modelling of atmospheric transport of radionuclides and a detailed assessment of the radiological consequences, considering all relevant exposure pathways. Four institutions from different countries participated in this radiological consequence assessment: BfS (Germany), STUK (Finland), VUJE (Slovak Republic), and CIEMAT (Spain).

Each partner selected some source terms from WP 1.1 results with appropriate weather datasets from WP 1.2 results. The atmospheric transport calculations were performed with RODOS/JRODOS (BfS, CIEMAT) or with a national operational atmospheric transport model (STUK, VUJE) by using combination of source term and weather data. Each country used a domestic site of a nuclear power plant in their calculations. The results were presented in the context of national intervention levels.

2 Methods

Every country in this work package carried out their dispersion calculations using different software for atmospheric dispersion calculations. Also there were some different approaches how to present the results in the context of national intervention levels. In addition, results differ also in source term, numerical weather prediction (NWP) data, and location.

BfS used the Linux version of RODOS for atmospheric dispersion calculations. The assessment of radiological consequences was made for several severe releases (INES 5, 6 and 7) and for three nuclear power plants using real weather data from 2012. Scenario calculations were performed for each day of the year 2012 resulting in about 4000 single simulations. Further statistical analysis of results was made based on these simulations. In Germany the reference level of the residual dose in the first year is 100 mSv. Typical behaviour of representative persons and effect of protective actions is considered. In the radiological consequence analysis evacuation, relocation, sheltering, and iodine prophylaxis were considered as protection action alternatives.

For dose calculations STUK used the national dose assessment model VALMA with weather data provided by Finnish Meteorological Institute (FMI). The calculations were performed using two different NWP models: HIRLAM and ECMWF. Four one week periods from different seasons were chosen as time range for calculations. In each period there were five dispersion calculations with different start times. The calculation duration was 72 h with 0.5 h time resolution. The calculations were made with two different source terms for NPP sites Loviisa and Olkiluoto. These two cases are treated separately, in total there were 80 calculations. In STUK's assessment intervention levels were based on “Nordic guidelines for protective measures concerning population and functions of society in case of nuclear or radiological emergencies”. The overall aim in the guidelines is that the annual residual radiation dose should not exceed the reference level chosen by country. The chosen reference level should be between 20 and 100 mSv during the first year, including all

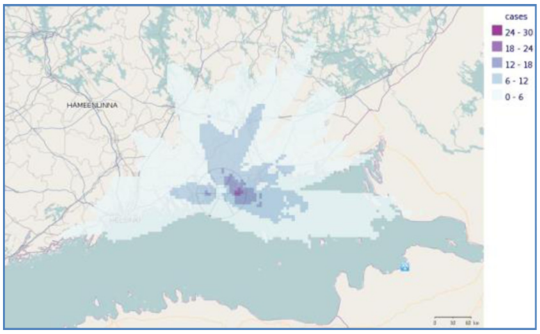

Figure 1. The map is generated by STUK. It presents number of cases on the map where intervention level (the air concentration strong gamma emitters more than 1000 Bq m^{-3}).

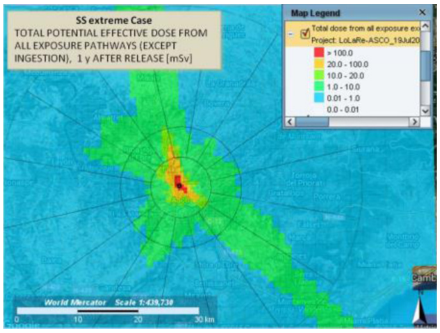

Figure 2. The JRODOS map is produced by CIEMAT. It shows total dose on a map.

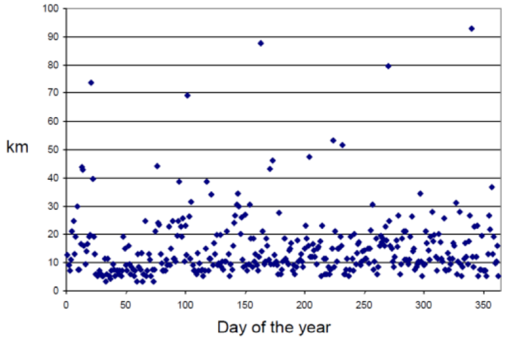

Figure 3. The figure is produced by BfS. It represents maximum distance in which dose reference level for evacuation is exceeded.

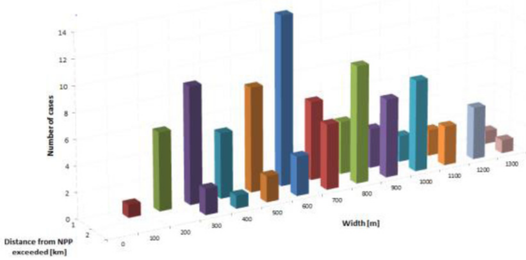

Figure 4. The bar chart from VUJE represents number of cases in the function of distance from NPP and width.

radiation exposure pathways and protective measures. In Finland 20 mSv was chosen as the reference level.

VUJE performed the assessment of the off-site radiological consequences of accident scenarios for the Slovak NPP Mochovce. The atmospheric transport calculations were performed with RTARC operational atmospheric transport model. Computational analyses presented in this report were performed for Mochovce NPP site using annual meteorological conditions from SHMU measured data in the year 2010. The set of 144 meteorological conditions of the real meteorological hourly data at Mochovce was used in calculations. Statistical processing and presentation of these data in a form of mean value, 5% and 95% percentile guarantee the estimation of the emergency planning zones taking into account average meteorological conditions. VUJE took the intervention levels for radiological consequence analysis from Slovak legislation. In the legislation the emergency protective actions for early phase of accident are planned and prepared in accordance with intervention (action) levels for avertable doses. Protective actions sheltering, iodine prophylaxis, and evacuation of public are taken into account.

CIEMAT considered two scenarios, winter and summer. The calculations were made with one source term for the NPP site Ascó in two different periods (January and July 2012) with 24 and 22 start times, respectively. In total, there were 46 calculations, using 44 of them for the statistical analysis. To estimate the radiological consequences of the accident CIEMAT used JRODOS program, which is the Java version of RODOS system. JRODOS runs were made using 98 h prognosis with RIMPUFF dispersion model and NOMADS NWP data. The Spanish Nuclear Safety Council CSN has established generic intervention levels for the application of the following urgent protective measures: sheltering, iodine prophylaxis and evacuation, and for the following long-term measures: temporary transfer and permanent transfer. These levels are generic and have been calculated using conservative hypotheses.

3 Results

One example result from each country is presented. The different modelling software tools provided results for similar quantities, *e.g.* doses, intervention level exceeding, etc. Further analysis of results with MS Excel or numerical analysis software was made. Four examples of results are provided here. Two of them are different georeferenced results and two of them are different kind of figures (Figures 1–4).

4 Conclusions

Four quite different approaches provided a good basis for the evaluation assessment of radiological consequences (Gering, 2016). In every country there different long-lasting source terms, different weather scenario and different atmospheric dispersion model have been used resulting in a wide range of products.

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