HASCAL - A SYSTEM FOR ESTIMATING CONTAMINATION AND DOSES FROM INCIDENTS AT WORLDWIDE RADIOLOGICAL FACILITIES

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HASCAL - A System for Estimating Contamination and Doses from Incidents at Worldwide Radiological Facilities

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HASCAL (Hazard Assessment System for Consequence Analysis), Version 0.1, is being developed to support analysis of radiological incidents anywhere in the world for the Defense Nuclear Agency (DNA). HASCAL is a component of HPAC (Hazard Prediction and Assessment Capability), which is a comprehensive nuclear, biological, and chemical hazard effects planning and forecasting modeling system that is being developed by DNA. HASCAL estimates the amount of radioactivity released, its atmospheric transport, and the resulting radiological doses for a variety of radiological incident scenarios. HASCAL is based on RASCAL (Radiological Assessment System Consequence Analysis), which was developed for the U.S. Nuclear Regulatory Commission for the analysis of accidents at U.S. power reactors. At present, the major differences between HASCAL and RASCAL are (1) the addition of the atmospheric transport model, SCIPUFF, as an alternative to the TADMOD model and (2) the addition of site-specific data for all power reactors in the world.

SCIPUFF provides a probabilistic prediction of the atmospheric dispersion and surface deposition processes, with the capability to model multidimensional, time-dependent wind fields. Uncertainty in the wind field, including both boundary-layer scale turbulent eddies and larger scale unknown variations, leads to a random component in the concentration field which requires at least the mean value and the standard deviation for a quantitative description. SCIPUFF uses turbulence closure theory to predict the concentration fluctuation variance as a function of the wind field uncertainty, and provides a probabilistic description of the resulting impact using a parameterized probability distribution function. HASCAL can then use the SCIPUFF prediction to compute probabilistic radiological doses, and provide an assessment of likelihood for various levels of health effects. A new interactive graphics interface is used to display the SCIPUFF results from HASCAL.

The multidimensional wind field capability allows SCIPUFF to treat longer range assessments than can TADMOD, provided the meteorological information is available to HASCAL. SCIPUFF does not currently include building wake or rainfall effects, in contrast to TADMOD, and it's dispersion algorithm is based on second-order closure theory and is therefore very different from that in TADMOD. Differences in resulting concentration predictions from the two models can be more than an order of magnitude under extreme conditions when the atmosphere is very stable or for very light wind conditions.

HASCAL contains a database of all power reactors in the world. The incident site is selected by country and site name. Files of required meteorological data for meteorological stations near all reactor sites are being added to HASCAL. These files of 15-day average hourly site meteorology can be read by HASCAL to provide default meteorologic conditions over the assessment period for the day and time of the incident. Also, HASCAL currently contains detailed reactor inventories for PWRs and VVERs that include about 300 radionuclides. These inventories were computed using ORIGEN and can be used to perform source-term calculations for reactors for which no accident scenarios have been defined. Comparisons of the doses computed using RASCAL PWR inventory
vs. the new inventory result in small differences, at most a factor of 2 to 3. The inclusion of short-lived radionuclides in these inventories will allow estimation of doses for very short exposures for those radionuclides for which dose factors are defined. Inventories for other reactor types are being computed and will be added as they are available. A new source-term calculation has been included in HASCAL that allows the release of fractions of the total inventory, with separate fractions for noble gases and non-noble gases.

Planned enhancements to HASCAL include adding other types of radiological facilities, including research and production reactors, enrichment and storage facilities, waste processing and storage facilities, and mining and milling operations. Incident scenarios appropriate for each type of facility will be developed, along with models of damage response and the resulting doses from various kinds of weapons attacks on worldwide nuclear facilities.

Different versions of HASCAL will be developed for different computing platforms, with calculational models appropriate for that scale of machine. For example, a portable personal computer version will be available for responding to incidents in the field; a work station version will be available for more detailed analysis and emergency planning; a super computer version will be used for research applications.

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