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A Radiological Accident Consequence Assessment System for Hong Kong

M. C. Wong and H. K. Lam
Royal Observatory Hong Kong
134 A Nathan Road, Kowloon, Hong Kong

Abstract — An account is given of the Hong Kong Radiological Accident Consequence Assessment System which would be used to assess the potential consequences of an emergency situation involving atmospheric release of radioactive material. The system has the capability to acquire real-time meteorological information from the Observatory's network of automatic stations, synoptic stations in the nearby region as well as forecast data from numerical prediction models. The system makes use of these data to simulate the transport and dispersion of the released radioactive material. The effectiveness of protective action on the local population is also modeled. The system serves as a powerful aid in the protective action recommendation processes.

Introduction

The Royal Observatory has acquired a Radiological Accident Consequence Assessment System (ACAS) as an aid in emergency response to nuclear accidents. The ACAS is a computer-based system developed by a contractor from the USA to meet the Observatory's requirements. The system will be used to assess the extent and magnitude of potential radiological hazards arising from the accident taking into account the prevailing local meteorological conditions. In designing the system, special attention has been placed on user-friendliness and clear presentation of the model results to non-technical users.

System Hardware

The hardware platform of the ACAS is an IBM RISC/6000 mini-computer with two Tektronix Graphics Netstations and a Tektronix colour copier. The system's main processor, the IBM RISC/6000 POWERstation 530, provides a maximum performance of 34.5 MIPS with a clock speed of 25 MHz. The

system runs IBM's AIX version 3 as its operating system and includes optimized compilers for FORTRAN and C languages. System memory is 32 MB with a cache memory of 64 kbytes. There is a fixed disk storage of 857 MB, a 1.44 MB floppy disk drive and an IBM 150 MB external cartridge tape drive. The Tektronix 4211 Graphics Netstation consists of an ASCII keyboard accompanied by a mouse, a graphics module and a display module. The graphics module acquires and processes data from the RISC/6000 or manual input via the keyboard or mouse. The display module receives video output from the graphics module and displays it on screen. The two Netstations are connected to a Tektronix RGB II Colour Screen Printer for hard copy output.

ACAS Software

The basic function of the ACAS is to provide real time dose assessment in the plume exposure pathway based on source term information and prevailing weather conditions. The ACAS software consists of five major interlinked components : (a) the data acquisition module, (b) the atmospheric dispersion module, (c) the dose projection module, (d) the protective action module and (e) the output module.

The data acquisition module acquires real time meteorological information from synoptic weather stations (up to a maximum of 5), automatic weather stations (maximum of 20) and rain stations (maximum of 24) in Hong Kong and neighboring regions as well as forecast data from the Observatory's numerical weather prediction model. Meteorological data are sampled once every 15 minutes and stored in real-time in a specified data base to support the operation of the atmospheric dispersion module. The module also has the capability to receive real time effluent monitor data from the nuclear power station, if available. Summaries of the meteorological and effluent data will be prepared and displayed automatically on screen for editing and quality control. Effluent (source term) information can also be input to the system manually. In addition, the ACAS contains a mobile survey data collection module where survey (radiological) data can be input manually and archived by the system for subsequent analysis and display.

The real time meteorological and source term information will be processed by the atmospheric dispersion module to simulate the short-range (few tens of kilometers) transport and dispersion of the airborne radioactive material. The module incorporates a two-dimensional, variable trajectory, segmented

Gaussian dispersion model with plume depletion due to deposition. A continuous release is simulated as a sequence of discrete puffs released in successions of 15 minutes each. Each puff is tracked independently as it is carried by the local wind field and dispersed into the environment. Gridded winds are interpolated from near-by station wind reports. Gaussian cross-wind dispersion is modeled with a multi-step function. Plume rise is simulated following the formulation of Briggs [*1*], including provision for the trapping of buoyant plumes in the building wakes and lid penetration. Dry and wet deposition are described using dry deposition velocities and scavenging coefficients respectively [*2*] Wet deposition simulation also takes into consideration the spatial and temporal variations in the rain field.

The dose projection module then computes the doses to both the individual and the population based on the air concentration as well as deposition density estimated by the atmospheric dispersion module. The module is primarily concerned with early exposure that occurs during and shortly (up to one week) after plume passage. The major pathway incorporated are cloudshine, inhalation from plume, groundshine and skin β dose. Projected effective, thyroid, lung and skin doses are computed for each of three age groups for up to four user-defined projection times. The internal dose conversion factors used are based on the ICRP Publication 56 [*3*] and supplemented by the UK NRPB Internal Dosimetry Database [*4*]. For external exposure, the dose rate conversion factors from Kocher [*5*] are used.

Protective actions are implemented with the aim of reducing either acute exposure or the risks of stochastic health effects. Sheltering is the key protective action considered in Hong Kong and the only measure modeled in the protective action module. The effectiveness of sheltering is simulated by taking into consideration the user-defined lead time for sheltering implementation, the dose reduction factors and infiltration factors of typical buildings in Hong Kong. The module computes both the 24-hour projected doses with and without sheltering and presents the user with information on the spatial extent where sheltering needs to be considered as well as the temporal variations of the projected doses.

The output module stores and presents the results of each of the above simulations in the form of tables and/or graphics. The major function of this module is to provide high quality graphics and clear presentation of assessments according to user needs. Reports can broadly be grouped into three categories :

namely, the emergency dose calculation reports which summarise the results of the dose projection module, ground pathway calculation reports which summarise the results of the dispersion modeling and the protective action model reports which summarise the projected doses at various locations with and without sheltering. The graphics outputs are mostly in the form of iso-concentration lines at ground level or iso-dose contours overlaid on maps. The temporal variations of sheltered and unsheltered doses can be displayed as trend plots. Monitoring results from surveys can also be superimposed on the iso-concentration or iso-dose contour maps for easy comparison with model results.

Summary

An overview has been presented of the accident consequence assessment system being used in Hong Kong. The system provides estimates of the radiological impact on the local population from reactor accidents. The products generated by the ACAS will be used as an aid in making recommendations on sheltering in Hong Kong, if required, in the unlikely event of a severe accident occurring at the nuclear power station.

References

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