Plume Simulation

By AEP

Upon joining the emergency planning department at American Electric Powers' Cook Nuclear Plant, I was given the opportunity to excel, as we call it in the industry, to develop the radiological data for our biennial graded exercise. Having been in the Radiation Protection section at the facility for some 20 years I had ample opportunity to participate but never had to create any data. Given no instructions other then we need data for the plant and offsite survey teams I started with the usual question; "How have we done it before?". Though one always hopes there is a simple answer that will make this an easy task, everyone who has ever been assigned this task soon realizes that wishful thinking is just that. Well, at least I didn't have any pre-conceived ideas that were going to limit my thinking.

I did know that I wanted to do something different. I didn't relish the idea of coming up with several hundred pages of data and corresponding maps, handing it to an off-site controller and saying "Good Luck". Been there; Done That; No Way; I knew this feeling well. I also knew the pitfalls. One wrong map, a single error in location, or being on the wrong data sheet could bury a scenario in a minute. And undoing a single mistake often times is impossible. I would like to say realism suffered, but for anyone who has ever been on a survey team can tell you, how can anything suffer if it doesn't exist in the first place.

Our Dose Assessment Program (DAP) has the capability of calculating doses given the appropriate meteorological data, release point concentrations, and corresponding release rates. It also allows the user to enter field data and back calculate for given distances. Though I knew it was not practical to expect a controller to run DAP in the field every time he needed data, I did realize that a basis existed that would be very useful. Meteorological data, concentrations and release rates were all under my control. The only thing left was how to figure out where the team was at any point in time. Having spent a good deal of my life on sailboats, the obvious answer was the Global Positioning Satellite system (GPS).

What became of all this was a computer program called "Plume Tracker". The program allows the drill developer to set up meteorological data such as wind speeds, wind directions, and Pasquill Categories for given scenario times. Radiological release data such as monitor readings and release point flow rates are collected when the Emergency Planning group test runs the scenario on the plants control room simulator. Release point data is collected for every minute. A significant improvement, over what I was soon to discover the standard 15-minute increments. Once the data was available the entire scenario can be calculated and made available in less than 2 minutes. Overall, in under 4 hours an entirely new scenario can be developed and be ready for use. Less if the scenario will not be tied to the plants simulator.

When a scenario is run, the field controller sets up the GPS receiver, starts the "Plume Tracker" computer program, starts the appropriate scenario, and feeds the team the appropriate information when requested. A graphical interface is available that displays the teams' location, plumes' location, and the plume track for deposition on a county map. This allows the controller to evaluate how well the team is doing when trying to locate the plume. The computer program keeps track of the release status, where the plume is, and performs all the necessary calculations based on location. The controller no longer needs to determine what set of data to use based on time and location. Nor does he need to concern himself with determining an approximate location on a map that has poor resolution to start with. The program does all that for him while updating every 5 seconds. This eliminates controller error, uncertainty, and reduces the possibility of "made up" data.

The program supplies considerable information including:

-Current Longitude and Latitude
-Distance from the Plant in miles
-Distance from the release centerline in miles
-Wind Direction and Speed
-Precipitation status
-Dose Rates @ 1 meter
-Dose Rates @ 8 cm
-Particulate Concentrations in uCi/cc
-Particulate sample conversions to NCPM
-Iodine Concentrations in uCi/cc
-Iodine sample conversions to NCPM
-Ground Deposition and conversions to NCPM using a standard pancake probe.
-Smear results in NCPM based on 100 cm2
-An electronic dosimeter
-Current release data

When running, the program stores everything in a database so information can be retrieved for training purposes. A playback routine exists that allows for viewing exactly what the controller saw when in the field.

All this provided a significant improvement to the information being supplied to the controller. Consequently the quantity and quality of the information supplied to the participants improved proportionately. However, the remaining goal was to make the participants' role playing more realistic. Even with increased data quality and quantity the players continue to rely on the controller to feed them data at the appropriate moment so they can respond accordingly. Not having visual or audible cues available to the players when something was happening, the controllers often times took it upon themselves to feed data to the players just because the meter was in their hand not necessarily because they were using it correctly. An interface program was written to a commercially available radio controlled dose rate meter that allows the computer to drive the meters response. The interface has the capability to operate 4 different types (dose rate meters, friskers, dosimeters, etc…) of instruments simultaneously. The participant is now required to actually operate the instrument, making range changes and verifying operation just as he would in reality. The built in Electronic Dosimeter has challenged the organization. Where total dose to a team used to be estimated (grossly underestimated in my opinion) by the controllers it is now available and does force teams to seek alternative sampling durations or locations.

The program has been well received by the controllers and participants. The controllers feel the availability of data allows them time to actually observe the participants. The participants feel the drill is real and take a much more active roll. As with any new approach however, new problems become apparent. Participants have trouble locating short duration (15 - 30 minutes) plumes. They also have trouble discerning the plume centerline from skirting the plume edges. Traversing either one makes the meter deflect upwards then back down, one just to a much higher degree. Overall though the realism is magnitudes greater.

In terms of reliability, the program has been used in 11 drills to date with no problems. The GPS units seem to handle any natural terrain problems without loosing its location capabilities. My only recommendations to teams are to stay away from parking under bridges. The only issue with the simulated instruments to date is a team member forgot one on the top of the survey vehicle and drove off. Overall the program has performed beyond my expectations.