THE COMMUNITY ENVIRONMENTAL MONITORING PROGRAM IN THE 21ST CENTURY: THE EVOLUTION OF A MONITORING NETWORK

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ABSTRACT

This paper focuses on the evolution of the various operational aspects of the Community Environmental Monitoring Program (CEMP) network following the transfer of program administration from the U.S. Environmental Protection Agency (EPA) to the Desert Research Institute (DRI) of the Nevada System of Higher Education in 1999-2000. The CEMP consists of a network of 29 fixed radiation and weather monitoring stations located in Nevada, Utah, and California. Its mission is to involve stakeholders directly in monitoring for airborne radiological releases to the offsite environment as a result of past or ongoing activities on the Nevada Test Site (NTS) and to make data as transparent and accessible to the general public as feasible.

At its inception in 1981, the CEMP was a cooperative project of the U.S. Department of Energy (DOE), DRI, and EPA. In 1999-2000, technical administration of the CEMP transitioned from EPA to DRI. Concurrent with and subsequent to this transition, station and program operations underwent significant enhancements that furthered the mission of the program. These enhancements included the addition of a full suite of meteorological instrumentation, state-of-the-art electronic data collectors, on-site displays, and communications hardware. A public website was developed. Finally, the DRI developed a mobile monitoring station that can be operated entirely on solar power in conjunction with a deep-cell battery, and includes all meteorological sensors and a pressurized ion chamber for detecting background gamma radiation. Final station configurations have resulted in the creation of a platform that is well suited for use as an in-field multi-environment test-bed for prototype environmental sensors and in interfacing with other scientific and educational programs. Recent and near-future collaborators have included federal, state, and local agencies in both the government and private sectors. The CEMP also serves as a model for other programs wishing to involve stakeholders with a meaningful role in the process of monitoring and data collection.

INTRODUCTION

The CEMP consists of a network of 29 fixed radiation and weather monitoring stations located in Nevada, Utah, and California (Fig. 1). A principal part of its mission is to involve stakeholders directly in the process of monitoring for airborne radiological releases to the offsite environment as a result of past or ongoing activities on the Nevada Test Site (NTS) and to make that information as transparent and accessible to the general public as possible. In addition, the results of the CEMP monitoring program are used to demonstrate that activities on Nevada Test Site do not result in offsite doses in excess of National Environmental Standards for Hazardous Air Pollutants (NESHAP). The CEMP is currently administered by the DRI of the Nevada System of

Higher Education and funded by the DOE’s National Nuclear Security Administration through its Nevada Site Office (NNSA/NSO).

At its inception in 1981, the CEMP was a cooperative project of three agencies: DOE, which provided funding and administrative oversight for the monitoring program, EPA, which provided for the technical administration, and DRI, which was primarily responsible for identifying and hiring local stakeholders to be station managers, as well as organizing annual training sessions for them and outreach meetings for the participating communities. The program was modeled after successful efforts to involve stakeholders in monitoring for radionuclides around the Three Mile Island nuclear power plant after the accident there in 1979. A history of the events leading up to the formation of the CEMP as well as a detailed description of its past support functions have been presented elsewhere [1, 2]. In 1999-2000, technical administration of the CEMP transitioned from EPA to DRI. The following narrative concerns the evolution of the monitoring program during and following this transition period, and discusses the manner in which enhancements and upgrades have furthered the program’s mission. In addition, it presents expanded opportunities for collaborative ventures and spin-off programs made possible as a result of these program enhancements.

Fig. 1. Locations of CEMP network stations. A total of 29 stations were in place as of November 2006.

TRANSITIONAL IMPROVEMENTS

Concurrent with the transition period in 1999-2000, DRI carried out significant instrument, communications, and information enhancements designed to further the mission of the program as well as reduce program operational costs. These included the addition of a full suite of meteorological instrumentation, state-of-the-art electronic data collectors, on-site digital scrolling data displays for station sensors, upgraded communications hardware, and the development of a public web site.

Instrumentation

Up until 1999, instrumentation at the stations was employed exclusively for monitoring for ambient radioactivity. Monitoring devices included pressurized ion chambers (PICs) and environmental thermoluminescent dosimeters (TLDs) for direct measurement of gamma emitters and high-energy beta particles, and low-volume particulate air samplers monitoring for total suspended activity and radioactive particles. Filters from the low-volume samplers are collected weekly by the local station managers; they are analyzed by an independent laboratory for gross alpha and beta activity, with a quarterly composite analysis for gamma spec. In the region surrounding the NTS, the primary concern addressed by the particulate air samplers is total alpha activity from isotopes of plutonium. While critical nuclear underground testing was still ongoing at the NTS, samplers collecting data on radioactive tritium, iodine, and noble gases were also present, but these samplers were removed in the early 1990s following the moratorium on critical nuclear testing observed by the United States since the latter part of 1992.

During the transition process, DRI added a full suite of meteorological sensors at each station to measure air temperature, humidity, wind speed and direction, incident solar radiation, barometric pressure, and precipitation (Fig. 2). Prior to the addition of this equipment there were very few direct meteorological data available in the region to the north and northeast of the NTS. Through time, these data have contributed to an improved understanding of weather patterns and climate in this region, which is considered a transitional zone between the Great Basin and Mojave Desert. Local citizens, especially those relying on farming and ranching activities for their livelihood, have expressed an appreciation for the access to these data. Additionally, the National Weather Service has begun to use data from many of the stations to aid with weather forecasting.

Fig. 2. A view of the CEMP monitoring station in Delta, Utah.

Just as importantly, the meteorological instruments allow for an analysis of variations in radiological measurements as a function of weather events. Examples include mini-"fallout" events from precipitation, and changes in natural radon and thoron emissions with barometric changes. Radon and thoron contribute to elevated PIC measurements from the gamma decay of daughter products, and the relationship to changes in meteorological conditions is now readily apparent.

Power for all instrumentation at the CEMP stations with the exception of the low-volume particulate air samplers is supplied by 50 and 60-watt solar panels operating in conjunction with a deep-cell battery, with trickle chargers at five locations. Air samplers are powered off local electrical grids.

Dataloggers

At the time of program transition in 1999, on-site data recording at the monitoring stations consisted only of dataloggers compatible with the PICs and magnetic tapes to backup the collected data. In addition, a digital display allowed real-time observation of PIC measurements on-site. DRI replaced these with state-of-the art Campbell CR10X dataloggers and wired all instruments, with the exception of the low-volume air particulate samplers and TLDs, directly to the dataloggers. The dataloggers, in conjunction with a memory module, provided up to several months storage of all data collected from the monitoring stations, and had the added benefit of being able to be remotely programmed with the addition of communications upgrades discussed below. A scrolling digital display showing current readings for the PIC and all meteorological instruments was interfaced with the datalogger so that on-site real-time readings were available to visitors to the stations.

Communications

While passive monitoring equipment at the stations such as the TLDs and particulate air samplers relied on personnel to collect the samples and submit them to a lab for analysis, satellite telemetry allowed for the transmission of data from active sensors such as the PIC. At the time of transition in 1999, all stations were equipped with satellite communications that would transmit collected data every four hours via satellite to the facility at Wallops Island, Virginia, and then to Los Alamos, New Mexico. DRI immediately began the process of installing cellular or landline phones and modems at stations where service was available. Operating in tandem with the dataloggers discussed above, these communications upgrades allowed for hourly transmission of data collected from the PICs as well as all meteorological sensors to DRI's Western Regional Climate Center (WRCC) in Reno, Nevada. These changes also allowed for remote programming of data collection frequencies as well as the ability to remotely troubleshoot sensor and power issues at the stations, dramatically reducing the number of regular on-site visits previously necessary by technicians to perform general maintenance activities. Finally, and perhaps most importantly, the communications and datalogger enhancements provided a means to quickly and easily post data to a publicly accessible web site developed by DRI.

CEMP Web Site

Perhaps the most important addition to the CEMP during the transition was the development and implementation of a public web site (http://cemp.dri.edu/). As stated previously, one of the primary missions of the CEMP program is to allow for public transparency and accessibility to collected data. Prior to the transition period, access to data was restricted to viewing the real-time display located at each station site, observing a summary of the previous month's data posted on a bulletin board at the station site, or waiting for the publication of the annual summary data in the yearly Nevada Test Site Environmental Report (NTSER) [3], formerly the Annual Site Environmental Report (ASER). Following upgrades of station communications and dataloggers, the WRCC was able to receive and post collected data to the web site every hour at regular intervals for all stations with cellular phone or landline service, and at least every three hours for remote stations located at ranch sites without access to these services, which retained their satellite transmission capabilities. With the implementation of the CEMP web site, the public now had access to monitoring data within hours of its collection. The site also provided a means to access and display station data in both tabular and graphical outputs for current and archived data for individual or multiple stations (Fig. 3).

In addition to providing data associated with the CEMP, the WRCC provides climate data for 12 western states, including Alaska and Hawaii. Through accessing the CEMP data, a wealth of other climate and environmental data became available. Finally, the web site provided an ideal interface for monitoring the status of station sensors and allowing for remote troubleshooting of power or instrumentation issues. This has resulted in a reduction of routine station visitations from a weekly to a monthly schedule, providing a significant cost savings to the program.

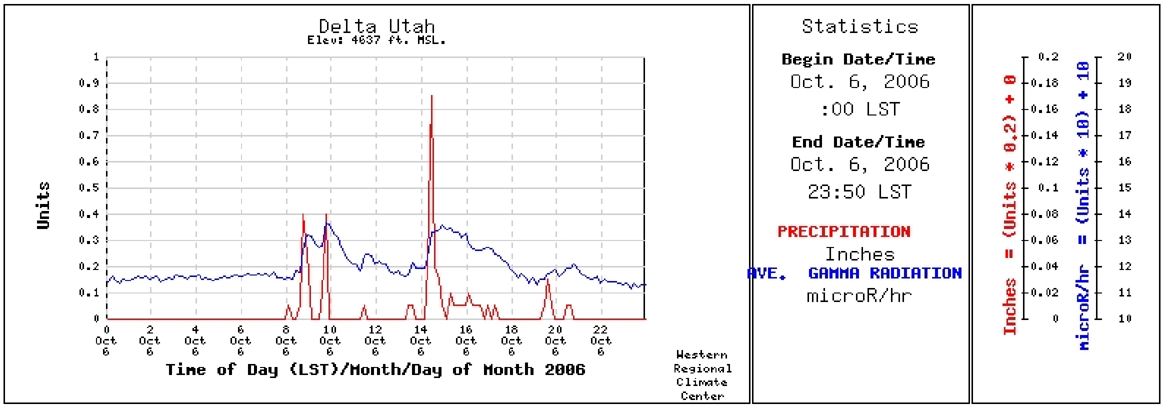

Figure 3. An example of a graphical output generated from the CEMP web site. In this case, the user has chosen to overlay plots of precipitation and average gamma readings for a 24-hour period on October 6, 2006 for Delta, Utah. The relationship between the precipitation events and the background gamma readings is readily apparent.

POST-TRANSITIONAL IMPROVEMENTS

Since the conclusion of the transitioning period in 2000 up until the present, DRI has continuously upgraded the network as better technologies become available to enhance its technical capabilities as well as improve its service to participating communities and the public at large. These have included at least minor changes to all areas discussed previously.

Instrumentation

By the end of 2002, DRI had equipped the low-volume particulate air samplers at the sites with air flow sensors to improve the accuracy of dose calculations obtained from analyses of the filters collected from the air samplers. This enabled air flow rates as well as cumulative air flow to be observed via the web page to ensure that a valid sample is being collected. During this time frame, soil temperature probes were added to the suite of meteorological equipment, allowing for calculation of local evapotranspiration rates. The post-transition period has also seen the addition of four more complete monitoring stations, including at Ely, Warm Springs Summit, and Duckwater in Nevada, and at Tecopa, California.

Dataloggers

During 2005 and 2006, DRI began transitioning from Campbell CR10X to CR1000 dataloggers. Added benefits include increased memory, additional measurement channels, and the ability to easily switch between different communications modes. This has enabled CEMP stations to have the potential for multiple means of communicating data, providing backup data acquisition capabilities in the event of a communications system outage.

Communications

As DSL and wireless internet services became much more widely available in rural areas, DRI began transitioning most of its primary communications conduits to these services. This allowed for near real-time acquisition and posting of data to the CEMP web site. Data for most stations is now updated as frequently as every 10 minutes as a result of this change. Cellular phone coverage in rural areas also has increased, and a transition from analog to digital transmission continues. This enabled a change to spread-spectrum cellular digital packet data (CDPD) and then code division multiple access (CDMA) cellular modems at many of the stations still without access to internet services. Finally, in 2006, the six stations still relying on satellite communications underwent upgrades to allow for an increase to a 300 baud transmission rate. This should allow in the near term for hourly updates for these stations on the web site.

CEMP Web Site

The CEMP web site has evolved continuously since its inception during the transition period. Methods for querying and displaying data have become increasingly sophisticated, and the site now offers a multitude of options that will satisfy both the casual and professional user. Samples of some of the other additions include: educational information links to numerous sources on the nature of ionizing radiation, sources of both natural and man-made radioactivity, and what is know about potential health effects; the ability to generate wind rose diagrams; and links to information and presentations from past annual CEMP workshops.

Other programmatic improvements

While a summary of PIC and selected weather data for the previous calendar month for each of the 29 stations continues to be posted on a bulletin board at each community station, DRI has developed additional materials and access to data on-site. These include brochures discussing the CEMP program and contact information for local station managers or program management, as well as interpretive signage describing the instrumentation and containing individual digital readouts for each of the sensors at the stations (Fig. 4).

In 2001, DRI reinstituted annual CEMP workshop and training sessions that had experienced a three-year hiatus as a result of funding considerations. These sessions are week-long programs for local stakeholders who serve as station managers. The purpose is to instruct them on the general operation of station equipment and interpretation of collected data, as well as provide them with a foundation of basic knowledge on ionizing radiation. Additionally, speakers representing professionals and laypersons in radiation-related matters provide numerous lectures for these events.

Figure 4. Interpretive signage associated with the CEMP station in Las Vegas, Nevada.

DRI also has developed mobile monitoring platforms, including both tripod-mounted systems deployable in approximately one hour, and trailer-mounted platforms that can be moved easily between road-accessible locations (Fig. 5). The mobile stations (minus the particulate sampler) can be operated entirely on solar power in conjunction with a deep-cell battery, and include all meteorological sensors and a PIC for detecting background gamma radiation. They can easily be fitted with additional instrumentation depending on the needs of the user.

Figure 5. A CEMP mobile trailer-mounted monitoring station near Tecopa, California.

THE CEMP TODAY AND TOMORROW

The enhancements that the CEMP has undergone over the past 7 years have resulted in the evolution of a platform that is very well suited for use as an in-field multi-environment test-bed for prototype environmental sensors and in interfacing with other scientific and educational programs. Recent and near-future collaborators have included federal, state, and local agencies in both the government and private sectors. The CEMP also serves as a model for other programs wishing to involve stakeholders with a meaningful role in the process of monitoring and data collection.

The CEMP stations and assets serve as ideal platforms and support systems for research, development, testing, and evaluation of environmental radiation monitoring systems. Recently, the DRI completed a one-year research and development project of a prototype low-pressure ionization chamber (LPIC) for a commercial manufacturer. In this project, six prototype LPICs were co-located at six different CEMP stations for evaluation of detector response to ambient arid environmental conditions. The exposure rate reading from the LPICs were compared with those from the high-pressure ionization chambers (PICS) and effects of environmental factors on LPIC performance were monitored. The LPIC exposure rate data were transmitted to the WRCC using CEMP protocols, which allowed for both near real-time detector performance evaluation and documentation and comparison of long-term system performance with meteorological conditions.

Currently, DRI, under an environmental monitoring system initiative, is evaluating the performance of commercially available ambient radon-222 monitoring technologies, both integrating and continuous, and has located these monitoring systems in close proximity to two CEMP stations. The location of these systems near the CEMP station provides infrastructure support and security, as well as the capability of correlating radon-222 measurements with both short-term and long-term environmental conditions. Specifically, the data from the CEMP station meteorological systems allow for the evaluation of the performance of the auxiliary environmental monitoring components of the continuous radon monitoring system.

In the near future, DRI will be deploying a commercially available perimeter environmental monitoring system for evaluation of detector and system performance under arid environmental conditions. Under a negotiated loan agreement, DRI has received two detectors and associated system components for evaluation. Once system familiarization is completed in the laboratory, the detector components will be deployed adjacent to the CEMP stations for the purpose of system evaluation in the climatic conditions of southern Nevada.

The CEMP will, of course, continue to function as a vehicle for public involvement in the off-site monitoring process for the foreseeable future. Its success as an educational tool in helping to allay public concerns about the reliability of the monitoring process and potential health effects from past NTS activities has been invaluable.

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