

**The Community Environmental Monitoring Program:
A Historical Perspective**

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ABSTRACT

With the Community Environmental Monitoring Program (CEMP) entering its 26th year of monitoring the offsite areas around the Nevada Test Site (NTS), a look back on the history and the hows and whys of its formation is in order.

In March of 1979, the accident at Three-Mile Island Nuclear Power Generating Plant near Middletown, Pennsylvania occurred, and Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV), along with other governmental agencies such as the U.S. Department of Energy (DOE), was requested to provide monitoring personnel. Public concerns over the accident were high, especially for those living around the power plant. It was found that involving the local community in the sample collection process helped to ease some of the concerns, and the Citizens Monitoring Program (CMP) was instituted. This idea was brought back to Las Vegas and in 1981, the NTS Community Monitoring Program was started to involve the communities surrounding and downwind of the NTS, who were experiencing many of the same concerns, in the monitoring of the Nuclear Weapons Testing Program.

By reviewing the history of the CEMP, one can see what the concerns of the local communities were, how they were addressed, and the effect this has had on them. From the standpoint of stakeholders, getting information on radiation safety issues from an informed local citizen rather than from a government agency official living elsewhere can only have a positive effect on how the public views the reliability of the monitoring data.

INTRODUCTION

Reasons for conducting environmental monitoring at sites such as the Nevada Test Site (NTS) fall into two categories: regulatory compliance and consequence management. If it is thought about from a public standpoint, regulatory compliance means the company or organization is going to do what the regulators want them to do and not much more. Consequence management means that the company or organization is looking at all the possibilities or problems that might come from the site and are planning for them. The CEMP has had the advantage of coming from the latter.

The CEMP today has 29 stations around and downwind of the NTS in Nevada, Utah, and California. The stations have gamma exposure rate meters, particulate air samplers, and a full suite of weather equipment. The particulate air samples are changed by the station

managers who visit the station approximately three times a week to check the equipment and mail the air samples to DRI. The program is sponsored by the U.S. Department of Energy's National Nuclear Security Administration Nevada Site Office (NNSA/NSO), and is administered and operated by the Desert Research Institute (DRI) of the Nevada System of Higher Education. At the program's inception, underground nuclear testing was still being conducted on the NTS. The stations were incorporated into a larger monitoring system maintained by the U.S. Environmental Protection Agency (EPA) and served as monitoring platforms that the public could see and gain information from. The gamma detectors had a visible, constant readout of the exposure rate and the station manager's names and phone numbers were posted on the station so people could contact them if they had questions. While no critical nuclear tests have been conducted on the NTS since 1992, the CEMP still monitors the offsite area due to the concerns of the public regarding potential radioactive airborne materials from past activities being transported off the NTS. Additionally, the CEMP supports on-site monitoring related to compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPS) for EPA Region IX. The data collected by the stations can be viewed at <http://cemp.dri.edu/>.

HISTORY

To understand why the CEMP was started, one needs to take a look at the history of the NTS. By 1949, the pace of nuclear weapons research and development had accelerated to the point where the identification of an on-continent testing area had become a priority for the U.S. government. Factors of population density, weather, available labor pool, transportation, real estate available to the government, and security were taken into account in the attempt to identify a suitable location. It was in 1950 that President Truman signed the order establishing the Nevada Proving Ground, which became the NTS. The test code-named ABLE, a one-kiloton device dropped from an Air Force aircraft in 1951, was the first nuclear test conducted on the proving ground.

In 1954, the Offsite Radiological Safety Program (ORSP) was established by the Atomic Energy Commission (AEC) and became the responsibility of the Public Health Service (PHS). The objectives of the program were to: 1) assess and document the radiation exposure to the public and the environmental radiological conditions of the offsite areas; 2) initiate actions needed to protect the health and safety of the public; 3) conduct a public information program in the offsite areas to assure the residents that all reasonable precautions to protect the public from radiation and other hazards associated with the nuclear testing program were being applied; and 4) determine compliance with applicable guidelines and legal requirements.

In the 1950s, Nuclear testing was conducted on a campaign basis. Weather- and wind-related issues were used to help establish favorable times to test. So there was no permanent continuously operating environmental monitoring or sampling networks operating then. Teams and networks would be assembled for each test. The PHS would bring in different regular and reserved commissioned officers and civilians from various PHS facilities to monitor the test. This meant that each time, the people would have to become familiar with offsite area and establish sampling locations. In 1959, the Southwestern Radiological Health Laboratory (SWRHL) was established in Las Vegas Nevada. It served as a focal point for radiological

research and surveillance for the western United States as well as providing training programs for all states west of the Mississippi River.

The United States and the Soviet Union observed a nuclear testing moratorium from November 1, 1958 to September 1, 1961. It was at the resumption of testing in September 1961 that the U.S. went to a year-round nuclear testing program and permanent offsite monitoring began and SWRHL became the PHS base of operations for ORSP. The monitoring network was inside a 300-mile radius of the NTS but could be expanded if conditions warranted. It is interesting to note that in 1964, residents in the monitoring network were operating all of the routine air sampling stations except for the one in Las Vegas, Nevada [1].

After the formation of the EPA in 1970, it was deemed that offsite monitoring of the NTS was more of an EPA function than a PHS function. In December 1970, responsibilities of the ORSP along with the SWRHL facilities were transferred to the EPA. Many of the employees of the PHS were transferred to the EPA and PHS commissioned officers continued to work within the program. SWRHL began to expand into other forms of environmental monitoring and ultimately became the Environmental Monitoring Systems Laboratory in Las Vegas (EMSL-LV) and ORSP became a division within the EMSL-LV called the Nuclear Radiation Assessment Division (NRD).

In March 1979, the accident at the Three-Mile Island Nuclear Power Generating Plant near Middletown, Pennsylvania, occurred. The EMSL-LV, along with other organizations such as the U.S. Nuclear Regulatory Commission (NRC), received a request for assistance and sent monitors and equipment to the Middletown Pennsylvania area. Radiation monitoring and environmental sampling locations were established in the offsite area surrounding Three-Mile Island (TMI) along with a radioanalytical laboratory in the basement of the Pennsylvania State Health Department in Harrisburg, Pennsylvania.

The communities around TMI had concerns and were developing a general distrust in the federal government and tensions were rising. This distrust was still evident at TMI in summer 1980 when purging the nuclear reactor containment vessel of radiokrypton was planned. In an effort to ease the tensions and open better lines of communications, the Citizens Monitoring Program (CMP) was formed. Locations for monitoring stations were chosen and local officials nominated residents to be station managers. A group of state and federal participants selected the managers from the nominees. The EPA provided the monitoring systems and the Pennsylvania State University and Pennsylvania Department of Environmental Resources (PDER) provided the training for the station managers. The manager's job was to collect and analyze the data from the monitoring system daily and report it to the PDER. The PDER would then validate the data and report that to the media. This had a positive effect, as there were now people with vested interests in the communities involved in the collection and reporting process. Simply put, your neighbor was now involved in the process and who were you more likely to believe - your neighbor, or the guy from out of town?

The success of the CMP had people from EMSL-LV and DOE wondering if a similar program for the NTS and its Nuclear Weapons Testing Program could have equally positive results. In 1981, the NTS Community Monitoring Program (CMP) was started as a cooperative project of

the DOE, EPA, and DRI. The program would later be named the Community Radiation Monitoring Program (CRMP). It consisted of 15 stations located in California, Nevada, and Utah. The stations were placed in highly visible areas in the communities around the NTS and DRI hired station managers to help with the data collection. The stations became part of the NRD monitoring network and were equipped with a particulate and reactive gas sampler, tritium sampler, and noble gas sampler. For gamma exposure, thermoluminescent dosimeters (TLD) and pressurized ion chambers (PICs) were used [2].

STATION MANAGERS

As with the TMI CMP, the most important part of the program was the station managers. Ideally, station managers would have some science background so they could better understand the data, or be trained to do so. An ability to explain this data to the public was also desired. This ability to understand and communicate had the people who started the CMP program thinking about high school science teachers. And if one looks at the initial station manager selections, there were two university professors (one from Las Vegas and one from Salt Lake City), nine high school teachers, one retired high school teacher who managed a television repair shop, two local retail store managers, and a county water district employee. These initial station managers were hired in much the same manner as the TMI CMP. Locations were chosen and local officials were asked to nominate people to the position.

Once the managers were chosen, the next step was to train them. Again, the ability of the managers to understand the data was very important. The University of Utah (U of U) was chosen to conduct the training, with the initial training lasting two weeks and held on the U of U campus. The course not only covered the basics of radiation but sample analysis as well, including hands on training with various type of equipment. To help managers stay up to speed and informed, training was conducted twice a year, with a short two- to three-day meeting in the winter and a week-long course in the summer. With the summer course lasting a week, the U of U was able to offer continuing education course credits to the teachers who attended these sessions, a mutual benefit for both parties.

These biannual training sessions involved more than just training. Presentations were made by DOE and their contractors on the various projects being conducted at the NTS at the time. This added another layer of transparency to the program giving the managers a better feel of why they were monitoring. It also enhanced their ability to address concerns and questions from the public. Station managers were encouraged to bring their families to the sessions and many of the spouses would sit in on the meetings and training. A benefit of people coming together for meetings is a chance to meet all or most of the people involved and get an idea of the size of the program.. This number grew as more stations were added and the benefit of having two stations managers at each station was discovered.

Bringing families to the meetings also fostered friendships. With the summer training lasting a week, many of the activities involved the families. On Monday, a barbeque would be held. Wednesday evenings were often used to hold talent contests, and families always seemed to be at the swimming pool. The program was in many ways a community of people who lived and worked around the NTS.

EQUIPMENT USED AT THE MONITORING STATIONS

The equipment at the CEMP stations has evolved and changed over the years as technology has evolved and changed. But the equipment has also changed as the mission of the NTS has changed. At the early monitoring stations, some of the equipment looked rather home-made. In 1981, there were few, if any, off-the-shelf environmental tritium or noble gas monitors, especially ones that could stand up to the temperatures of desert environments around the NTS. So the challenge was how to effectively sample for tritium and noble gases.

Tritium sampling

The tritium sampler ended up being a small Kenmore bar refrigerator painted white. An aquarium pump was mounted inside the Kenmore along with a dry gas meter and a molecular sieve. Warm air would be brought into the refrigerator through an inlet pipe helping it to condense. That condensed air would be pulled through the molecular sieve and the moisture collected. The dry gas meter was used to monitor the volume of air through the sieve, usually 800 to 900 centimeters per minute. The sieves were collected weekly and taken to the EPA lab. There, the moisture would be baked out of the sieve and recollected for wet chemistry analyses. The process was not extremely fast but very reliable and defensible. This system was used until offsite tritium sampling was discontinued in 1994.

Noble gas sampling

Noble gas sampling at the stations involved three different models of samplers. The first model was manufactured in-house by EPA in the early 1970's with its main components coming from World War II aircraft. Why aircraft? The compressors and sample collection bottles needed to be lightweight, reliable, and compact to fit the sampling needs of the time. Many of the people involved with the sampler had an aviation background, and with the Davis-Mothan Air Force Base (a military aviation boneyard in Arizona) within reasonable distance of the EMSL-LV, parts fitting the need could be found. The system employed three oxygen bottles, one as a collection vessel that had air continuously entering it, and the other two as sample collection bottles. The compressor would be engaged when the pressure in the collection vessel reach one-half atmosphere and disengaged when the pressure reached one-third atmosphere. Once a week, the sample collection bottles would be changed out and the samples brought to the EPA lab for analyses. As aviation technology changed, so did the need for small compressors, and by the 1980s, the availability of the compressors and repair parts became limited. In response, NRD personnel along with Air Products and Chemical Corporation from Allentown, Pennsylvania, developed a cryogenic sampling system. This system had the sample bottle housed in a dewar filled with liquid nitrogen. The air in the bottle would liquefy, creating a vacuum thus collecting a sample. This eliminated the need for a compressor and reduced the power needs for the system. The drawback to the system was that it used a lot of liquid nitrogen. This became cost prohibitive and in 1987, this system was removed from the stations and the older one returned.

Still plagued with the limited availability of compressors and compressor parts, NRD personnel worked with EG&G, Inc., of Las Vegas on a third sampler. This system used a compressor commonly found on trucks with air brakes and had four sample collection bottles. Using a small computer, the system would start up at 15-minute intervals and collect a sample. First, it would pump air into bottle number four, which would be a composite of the week, and then it would pump air into one of the other three bottles. The week would be divided into thirds, so bottle number one would be the first third of the week and so forth. The idea was that if something was found in the composite, the other bottles could help narrow down the part of the week the release would have taken place in. This system was used until offsite noble gas sampling was discontinued in 1994.

The final underground nuclear test, Divider, was conducted in September 1992, and with tritium and noble gases such as xenon being fairly short lived in the environment, it was determined that sampling for these isotopes several years after the last test was unnecessary. 1994 became the last year CEMP sampled for tritium and noble gases. The equipment was removed from the stations in 1995.

Particulate and reactive gas sampling

Particulate and reactive gas sampling was performed with the HI-Q cabinet-mounted pump, which pulls approximately two cubic feet per minute of air across the sampling medium. The sampling medium during underground testing was a 2-inch-diameter glass-fiber prefilter for particulate samples and a 2-inch charcoal canister for reactive gases. The glass-fiber filter is measured for gross alpha and beta radiation and then a composite count is performed for gamma. The charcoal canister is mainly used for detecting iodine. Because iodine is short lived, charcoal canisters were discontinued in 2000, but the CEMP still performs particulate sampling. The samples are collected weekly by the station managers and mailed to DRI.

Thermoluminescent dosimeter

Thermoluminescent dosimeters (TLDs) are used to measure the integrated gamma radiation exposure over a three-month interval. In 1981, the stations were equipped with three Harshaw Model 2271-G2 TLDs. The Harshaw type contained two chips of dysprosium-activated calcium fluoride (CaF_2 : Dy) mounted in a window of Teflon plastic attached to an aluminum card. The units were energy compensated using a 1.2-mm cadmium shield. The three TLDs were mounted in a plastic housing one meter off the ground, the same height as the pressurized ion chambers. This setup was used until 1987 when the Harshaw TLDs were replaced with the Panasonic model UD-814 TLD. The Panasonic TLDs used a single element of copper-activated lithium borate ($\text{Li}_2\text{B}_4\text{O}_7$: Cu) and three replicates of thulium-activated calcium sulfate elements (CaSO_4 : Tm). The lithium was shielded with plastic and each element of thulium was shielded with plastic and lead. The CEMP still uses Panasonic UD-814 TLDs mounted one meter off the ground.

Pressurized ion chamber

To monitor the ambient gamma background radiation, the Reuter-Stokes 0-100 mR/h pressurized ion chamber (PIC) was used. The PIC is made up of three primary subsystems: the processor,

electrometer, and pressurized chamber. The chamber is filled with argon gas and pressurized to 300 psi. As gamma photons travel through the argon gas they ionize the gas, creating current. A 300-volt DC bias is applied to the cathode, which sweeps the ions out of the gas, generating a current that is measured by the electrometer. The electrometer is mounted directly to the chamber and provides an analog output signal proportional to the exposure rate. The processor then collects the analog signal and either displays and/or stores the measurement depending on the model. [3]

Collecting the PIC data

In the beginning, the exposure rate data from the PICs were collected manually by the monitors. That Reuter-Stokes system employed a strip chart recording device from the Rustrak Company that used pressure paper and a floating pen. The pen would float at the current reading and an arm would press the pen against the paper every few seconds, as the paper slowly scrolled forward, leaving a dot on the paper. It would also mark a base line to show scale: 1, 10, etc. There was a reader that the paper could be put through to transfer the data into an electronic format. Later, magnetic tape recorders were added to the system and became the main form of data collection, which were still collected weekly, and the Rustrak paper format used as backup. This system worked fairly well with the only drawback being the time it took to read all the magnetic tapes from the stations. The system proved itself when it was noticed that the background readings at the Austin, Nevada, station suddenly jumped up and stayed at a slightly elevated reading. Thinking it could be an equipment problem a monitor was sent to check the electronic system and to look for any noticeable reasons for the increase. None were found. The monitor returned with a hand-held gamma detector and established that the background around the station was at the level before the sudden increase. As he got near the PIC itself, he noticed an increase. Investigating further, he found that someone had wedged a piece of ore, from one of the local mines, under the PIC, causing the increased readings.

As technology advanced, so did the data collection methods. The Reuter-Stokes electronics packages eventually employed an electronic card to store the data from the PIC, which could be changed out and brought back to the NRD facilities to be read. But the big advance in PIC data collection came when satellite telemetry was added to the stations. The installation was started in 1987 and finished in 1988. It was a Geostationary Operational Environmental Satellite (GOES) system and transmitted the data collected at four-hour intervals. The data would be transmitted to a satellite, then to a ground station, which then used dedicated phone lines to send the data to the NRD facility in Las Vegas where it was collected and displayed on a computer. The computer display actually showed a map of the stations. The system had an alarm mode and when exposures of 50 microroentgens/hour ($\mu\text{R}/\text{h}$) or greater were detected, the station would transmit data every 10 minutes and the alarming station would turn red on the computer display. This alarm would continue until the exposure rate dropped below 50 $\mu\text{R}/\text{h}$. The NRD monitors would perform system checks by placing a small, exempt quantity source, usually cesium but occasionally radium, on top of the PIC, which would send the system into alarm mode.

Today the Western Regional Climate Center at the DRI Reno campus collects the PIC and weather data, posting it to the CEMP web page at <http://cemp.dri.edu/>.

Recording Microbarograph

The microbarographs were placed at the stations to record the barometric pressure. As low pressure cells move in, they allow more naturally occurring radioactive gases, like radon and thoron, to be released. The PIC would see this release as a temporary increase to the exposure rate. Looking at the PIC strip chart papers, one notices a bell curve as the cell moves over the station. Storms generally move from the southwest to the northeast in the summer time in the offsite areas and by looking for these small bell curves in the charts, one could track a storm from Las Vegas, NV, to Cedar City, UT.

CONCLUSIONS

Monitoring of the NTS offsite area has been conducted since the 1950s, but until the establishment of the CEMP as the CMP in 1981, the communities around the NTS were only limitedly involved. One major similarity between TMI and NTS is that even though monitoring was being conducted, without community involvement much of it was going unnoticed, or what was being noticed was not being understood. By involving the local communities, there becomes a certain amount of transparency that in turn can lead to a better understanding. Living in an area where one is uncertain of the health effects of being there, watching someone in a government vehicle drive up and say everything is fine, but then leave, does not build trust. While having someone from the community who is asked to be involved and takes part in the actual data collection can help to build trust or at least quell a few fears.

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