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FIELD EXPERIENCE WITH REMOTE MONITORING

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ABSTRACT

The Remote Monitoring System (RMS) is a combination of Merlin Gerin detection hardware, digital data communications hardware, and computer software from Bartlett Services, Inc. (BSI) that can improve the conduct of reactor plant operations in several areas. Using the RMS can reduce radiation exposures to radiation protection technicians (RPTs), reduce radiation exposures to plant maintenance and operations personnel, and reduce the time required to complete maintenance and inspections during outages. The number of temporary RPTs required during refueling outages can also be reduced. Data from use of the RMS at a two power plants are presented to illustrate these points.

EQUIPMENT CONFIGURATION

Both sets of data presented here were obtained during outage activities at PWRs. One case involved cutting and removal of RTD piping and the other involved ISI of steam generators. In both cases, one WRM radio receiver was placed in containment. Three of four LEA boosters insured radio coverage of the entire containment. Display terminals were placed at RP control point outside containment. A computer multiplexor in containment connected all of the in-containment devices to the main computer located at the main RP control point. Thus, only a single data cable was required to connect the devices in containment to the outside. The RP control points inside containment were also equipped with closed circuit video equipment and the RPTs had voice radio communication with the workers in the loop areas. The workers wore four or five transmitting dosimeters connected to a multiplexer and transmitter. Dosimeters were also mounted on the steam generator platforms to provide area monitoring for the ISI work.

DOSE SAVINGS TO RPTs

The use of the RMS allowed RPTs to control the workers' radiation doses while working in a low dose area. In the case of RTD pipe cutting, the RPTs were able to work in a 2 mrem/h field while the pipe cutters were in a 500-1000 mrem/h field. Dose saved was estimated to be approximately 30 rem. In the case of ISI, the RPTs were similarly working from a low dose area outside the bioshield wall. The use of telemetry for area monitoring also allowed RPTs to perform routine surveillance from a low dose area.

DOSE SAVINGS TO WORKERS

The use of RMS allows RPTs to accurately monitor dose and dose rate in situations that would not be possible with traditional means of monitoring. Whenever a worker is near collimated sources, point sources, or line sources, monitoring of multiple whole body locations is necessary. If the work activity requires the worker to change position near the source, it is extremely difficult to track multiple whole body locations with time and motion techniques. Therefore, stay time limits are imposed to control dose. Although stay time limits are effective in limiting dose, this technique tends to require multiple trips into the high radiation area to complete the work, because the stay time limit is necessarily conservative. Also, the use of stay times does not, by itself, control the worker's dose rate.

The RMS allows an RPT to control the dose rate during the work activity, even when dose rates are rapidly changing and the worker has multiple dosimeters. The RPT also monitors the dose to each dosimeter, thereby allowing a worker to complete the job with a single entry to the high radiation area in many cases.

Figure 1, for example shows data from RTD pipe cutting. The worker placed his right are close the RTD pipe. The RP technician noticed a dose rate alert at 3000 mrem/h and directed the worker to move his arm away from the pipe. The RPT was located outside the work area, but was able to control the radiological conditions using video, voice radio, and RMS.

Figure 2 shows a more complicated series of events while "Worker T" was cutting RTD pipe. Shortly after beginning the cut, he moved his head and right arm closer to the pipe. The RPT noticed the increased dose rates on the RMS monitor and requested that he move back. The worker complied immediately. He subsequently kept his head back from the pipe, but later his right arm crept back to 1000 mrem/h again. The RPT again requested that he move his right arm back and continued to monitor the right arm closely during the remainder of the cut.

Figure 3 also shows how RMS can control the dose rate during a high dose rate job. Here, "Worker H" was being monitored during RTD pipe cutting. This worker moved both thighs close to the pipe. Again, the RPT, monitoring remotely, observed an unnecessarily high dose rate to the left thigh and called for the worker to move back from the pipe. The worker moved his left thigh back from the pipe for the remainder of the time that he was cutting. However, the right thigh began to edge in closer to the pipe. When the right thigh exceeded 1000 mrem/h, the RPT called for the worker to move the right thigh, which was promptly moved away from the pipe. Then the worker moved his right arm close to the pipe. This movement was also detected and the worker moved his right arm to a lower dose rate.

Figure 4 shows data from monitoring "Worker M" during RTD pipe cutting. This worker would alternately move his right thigh, his left thigh, or both thighs closer to the pipe. The RPT repeatedly monitored the dose rate to all five dosimeters on this worker and adjusted the positions of the worker's thighs to reduce the dose rates. These data demonstrate conclusively that an RPT can reduce a worker's dose by detecting high dose rates during a work activity and reducing the dose rate as the work is in progress. The most important method of reducing a worker's dose is to ensure that the worker does not inadvertently place his or her body in a radiation field that is unnecessarily high. Real time monitoring allows the RPT to reduce the worker's dose because the high dose rates are detected while the worker is in the high radiation area.

In situations that require exposure control via stay time limits, the RMS can constantly monitor dose and dose rate so that workers can complete a task in one entry without exceeding administrative limits. This results in fewer entries to the radiation area and less dose received while entering and exiting. When multiple whole body dosimeters are required, the RMS provides a tool to help the RPT prevent one dosimeter reading significantly higher that the others. This reduced the overall whole body dose.

The RMS can also reduce overexposures due to inadequate surveys. The common ionization chamber survey meter will significantly underestimate the dose rate from point sources at distances less than 15 cm. This occurs due to the well known geometry effect. The RMS' detectors are more accurate under such conditions because the detector is a small silicon chip, similar to the size of a TLD chip.

PREVENTING OVEREXPOSURES

Figures 5 and 6 are examples of how RMS can prevent overexposures. Figure 5 shows the case where a worker on a steam generator platform made an unauthorized partial entry into the steam generator bowl. The unauthorized dose rate to his arm was rapidly detected as the RMS monitor alarmed and the worker was removed from the platform.

In Figure 6, the data demonstrates a case where a worker on a steam generator platform was authorized to make a partial entry (arms only) into the bowl. However, this individual decided to make a full entry into the bowl. Consequently, the detector on his head registered 16,200 mrem/h. The immediate response of the RPTs prevented a possible overexposure.

SAVING OUTAGE TIME

The time required for maintenance or inspection activities can reduced because fewer entries are required into radiation areas. If the radiation area is also contaminated; if respiratory protection is required; or if ALARA briefings are required, the time required for an entry can easily be three or four times greater than the time required to perform the physical work. Reducing multiple entries can remove days from an outage schedule.

Figure 7 gives an example where an individual made two successive full entries into a steam generator bowl. The RMS was used to carefully control the individual's dose to within 200 mrem of the regulatory limit. Having one individual perform two successive entries resulted in a lower overall dose because it saved the dose associated with multiple trips to the steam generator platform. This procedure also saved the dose to support personnel who would have accompanied the worker into the loop area for multiple entries. In addition, the work was completed in less time.

The earlier examples of RTD pipe cutting also demonstrate an outage time savings. In this case, all of the RTD pipe was cut in one work shift. This time savings occurred because the workers were able to complete multiple cuts in each trip to the work location. Since the workers were being monitored with RMS, there was no need to come down from the platform and check "sacrificial" dosimeters after each cut. Also, sacrificial dosimeters can overestimate the TLD reading because a PIC or EDRD on the outside of the protective clothing can hang down from the worker's chest and be much closer to the radiation source than the TLD.

In these examples, the RPTs were working from control points in containment. However, some plants have used RMS to move their control points completely outside containment. This can allow the RPT to work in a relatively quiet location without contamination or respiratory protection controls. This environment can improve coordination between the RPT and other work groups so that work flows without interruption. The productivity of the RPT can also be increased by working from a control point outside containment. Of course, using RMS, one technician may be able to cover work in multiple locations.

CONCLUSION

In addition to the obvious fact that using the RMS can save dose to RPTs, there are significant opportunities to reduce workers' doses, reduce outage time, and reduce outage budgets.

Author Biography

Dr. Arthur E. Desrosiers, CHP has developed computer systems to provide protective action recommendations for the nuclear Regulatory Commission's emergency operations center and he developed the first completely automated radiological access control system. Dr. Desrosiers designed the Dry Active Waste process controllers marketed by Westinghouse in the 1980. Recently, as Vice President of Special Projects at Bartlett Services, Inc., he has developed the Remote Monitoring System. This system collects data via radio transmitters for the control of radiological exposures. The RMS has been selected by 20 commercial nuclear sites and one DOE site.

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