CONTROL OF OCCUPATIONAL EXPOSURE USING REMOTE MONITORING SYSTEMS

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Introduction

Advances in electronic dosimetry, portable radio technology and digital video have enabled the development of Remote Monitoring Systems (RMS) that provide a powerful dose control tool for the Operational Health Physicist. North American utilities have led the implementation of these systems, often with coverage of the entire plant, feeding back to a centralised control room. These large-scale systems typically cost around €500,000 [1].

In Europe, and especially the UK, implementation of RMS technology has been slower and on a smaller scale. US utilities have justified the high capital cost of their systems by significantly reducing the number of contract RP technicians required during refuelling outages, saving up to €1,000,000 [1]. In the UK, the number of contract RP technicians employed during outages is already minimal, and with the generally low doserates found on Gas-Cooled Reactors, RP engineers have traditionally considered RMS to be an extravagance.

However, the commissioning of the UK's first PWR and a significant increase in the number of AGR Vessel entries, have increased the radiological protection challenges facing the British Health Physicist, thus prompting a re-evaluation of this view. This paper reviews the development of a "budget" RMS system and it's application in a recent refuelling outage (RF06) at Sizewell B.

User's description

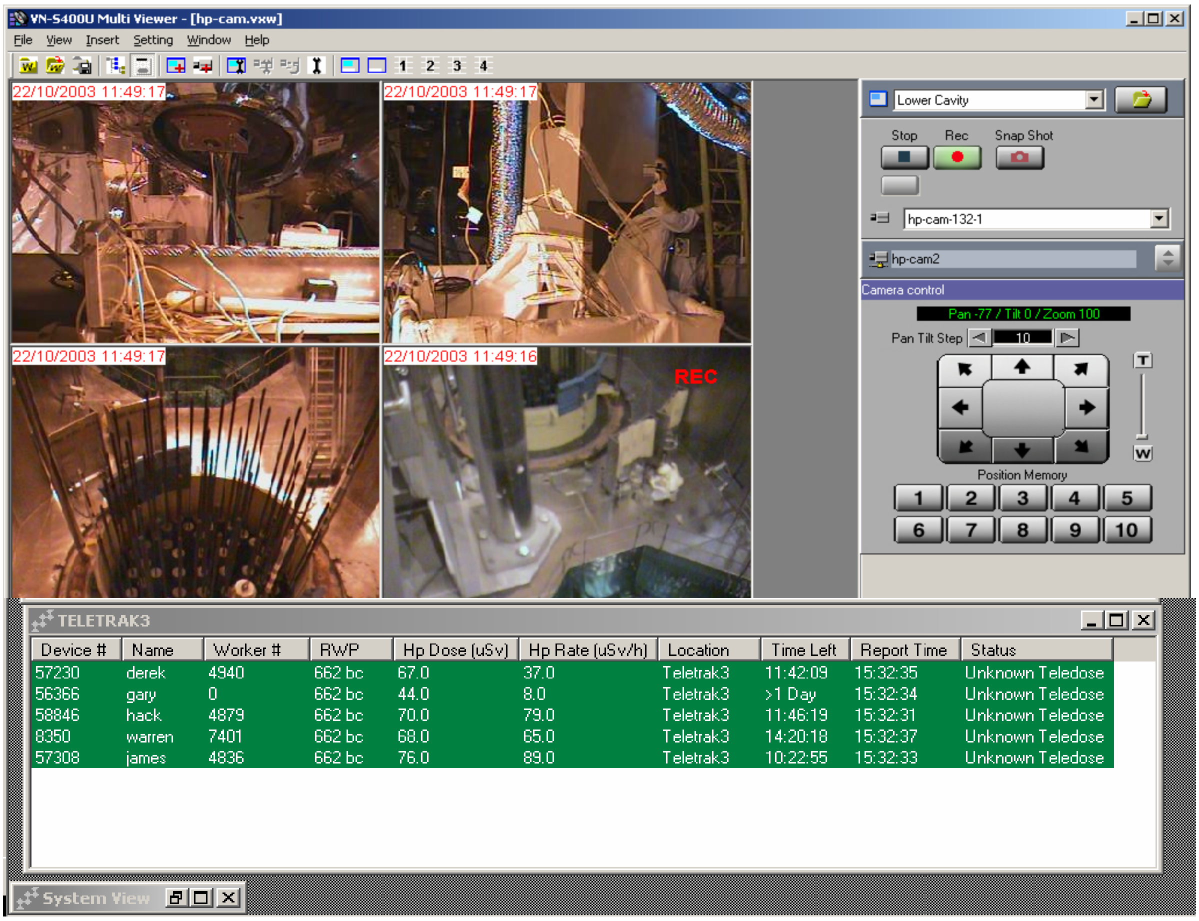
Three RMS terminals were installed at the containment control points (located at the Steam Generator Channel Head platforms and Refuelling cavity). A fourth terminal was set up at the Shift Health Physicist's desk in the Outage Control Centre (OCC).

Dosimetric data was transmitted from Siemens EPD Mk2 dosimeters, along with video images from digital cameras to the local control point. All of this information was displayed on a single PC monitor, which enabled RP technicians to pan, tilt & zoom the cameras, take still photographs and record DVD-video of work activities; as well view real-time dose and doserate data from the worker's EPD. A screenshot is shown in Figure 1. Based on this information, the RP technician at the local control point could formulate and issue advice directly to the worker using a wireless intercom.

Technical description

The IT infrastructure required to support this particular RMS system is relatively simple: The general layout of the equipment in shown in Figure 2. A PC, LCD monitor, Ethernet switch, telemetry base station, UDS-10 and Long Range Ethernet (LRE) hubs, plus their power supplies, were mounted into a trolley. Up to 4 JVC VN-C30U digital cameras and the base station were plugged into the Ethernet switch via sockets mounted on the rear of the trolley. The LRE hubs connected to the Engineering LAN via plant computing system terminals positioned at various locations inside containment. Voice communications were provided by a Telex BTR700 wireless intercom system.

Figure 1: Screenshot from a Sizewell B RMS Terminal



Justification of RMS technologies

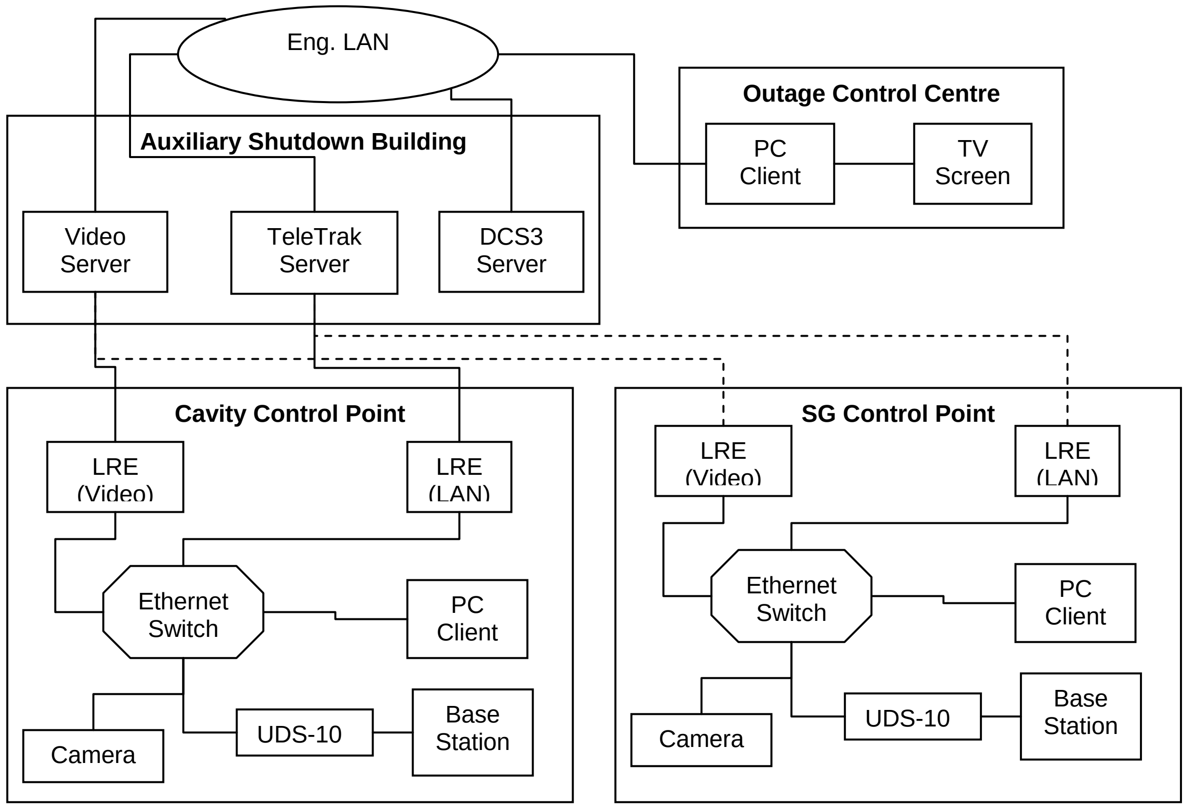
The financial justification for this system was straightforward. Firstly, most of the remote dosimetry equipment had been purchased over a number of years previously. The digital cameras were purchased as a replacement for an obscelescent CCTV system. The total cost of the three control points, and OCC terminal (excluding the intercom system) was less than €70,000.

The major problem experienced in justifying the use of RMS, was the risk of radio-frequency interference (RFI) with reactor protection systems and the threat to IT security by connecting wireless networked equipment to the secure plant computing LAN. The telemetry system operates at 2.4 GHz, with an effective radiative power up to100mW. Although this type of wireless equipment is based on modern IT industry standards, the Sizewell B safety case only permitted radio equipment that operated below 1GHz and 10mW effective radiative power, as these were the upper limits at which the reactor protection system equipment had been tested during station construction, 10 years previously.

Despite many tens of reactor-years experience with identical RMS products at other Westinghouse-designed PWRs, and independent verification of the minimal RFI risk presented by this equipment, the Safety Case Managers within British Energy placed strict limitations on where and when this equipment could be used.

IT security concerns were overcome by placing a firewall between the telemetry server and the Engineering LAN.

Figure 2: Schematic diagram of the Sizewell B Remote Monitoring System



Operational experience with an RMS

The system was commissioned shortly before the start of the refuelling outage; therefore RP technicians only received minimal training on its operation.

The images & telemetry data enabled the Shift Health Physicist to have a good knowledge of work progress and radiological safety standards within containment. The plant managers were very enthusiastic about the live video images, but less interested in the real-time dosimetric data being transmitted to the OCC. This was a significant improvement on previous outages, where the inability to see exactly what was happening inside containment had led to significant delays in the outage critical path.

From a radiological protection point-of-view, the main uses of the system during RF06 were:

- *Real-time personal monitoring* - All workers entering the Refuelling Cavity & Steam Generator channel head platforms were issued with a teledosimeter. This removed the need for an RP Technician to enter these areas to perform repetitive radiation surveys. In addition, a wrapped teledosimeter was left on the SG platform to enable maintenance staff to check doserates on equipment removed from the channel heads (the RP technician reviewed the telemetry data and issued appropriate instructions to the workers via the intercom).

- *Retrospective monitoring* - All transmissions from the workers EPDs were logged to a database on the TeleTrak server. The dose and doserate data was then combined with the workers position (obtained from the video images) to build a doserate profile of the work area.

- *Area Gamma Monitoring* - EPDs were placed around the Refuelling Cavity and the doserate profile during RPV Headlift and In-Vessel component moves was recorded. During lower cavity decontamination, EPDs were placed on an industrial vacuum cleaner. Receipt of a doserate alarm indicated that the vacuum filter required changing, removing the need for an RP technician to periodically check the surface doserate on the filter.

- *Training* - Data logged to the database and the video images have been used to enhance ALARA briefs.

Despite the lack of operator training, most RP technicians were enthusiastic about using the equipment, and quickly developed the knowledge to use the system effectively. Indeed, the RP technicians were keen to exploit the potential offered by RMS and developed some novel uses for the equipment. However, it also became noticeable that some technicians quickly became over-reliant on RMS. In particular, there was a noticeable lack of contamination monitoring and some breakdown in contamination control where RMS was being used. Also, it quickly became apparent that a dedicated RMS operator is required at each control point. RP technicians can't provide job cover using RMS and answer routine RWP enquiries etc. at the same time.

Conclusions

The benefit derived from a system that combines telemetry, video and voice communications is synergistic. We found that the system can be used in a variety of ways to significantly enhance radiological protection control in high radiation areas and to significantly reduce the dose received by RP staff covering such jobs. Indeed, it is estimated that the use of RMS saved at least 10 man.mSv of Radiological Protection dose during RF06

However, it is important to note that RMS is a monitoring tool *to support existing monitoring techniques & arrangements*. Suitably qualified & experienced staff are required to interpret the data and provide suitable advice to the work party. In addition, detailed training on the limitations of RMS, explicit procedures for dealing with equipment malfunction and actions on receipt of alarms are required to ensure that radiological safety is not comprised when using these systems.

Within British Energy and the wider UK RP community, development and purchase of RMS equipment is best justified to Managers by emphasising the key role of real-time video images in outage duration reduction, with telemetry data being an additional, incidental benefit.

References

1. *Effective Personnel Exposure Control in Shortened Refuelling outages: Final Report: Review of Remote Monitoring Systems*, EPRI Palo Alto, CA: 2003. 1003686.