C19 Mitigating Radio Frequency in the Modern Lab

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The goal of this presentation is to identify solutions for radio frequency interference issues in the modern laboratory.

The presentation will impact the forensic science community by demonstrating how equipment in today's laboratories may be subjected to forces that have yet to be thoroughly documented and identified. This talk strives to address one issue of radio frequency interference.

In February of 2007 the Department of Forensic Biology of the Office of Chief Medical Examiner of New York City relocated to a modern, 13- floor facility. Equipment and personnel were scaled up to accommodate an anticipated increase in caseload. This talk will address specific challenges that emerged during the set-up of these new laboratories, specifically relat- ing to the effects of radio frequencies (RF) on sensitive laboratory equip- ment using a real-time PCR instrument as a case study.

In 2003 the Department of Forensic Biology established a quantitative real time PCR assay using the Rotorgene 3000 manufactured by Corbett Research. Minor changes to the assay published by Nicklas and Buel (JFS September 2003) were made to enhance sensitivity for the lower amounts of DNA required for Low Copy Number (LCN) DNA testing. The assay was extensively validated, reviewed by auditors, and was successfully imple- mented with a 30% error rate. Moreover, during the course of the validation process and throughout the first year of its use for LCN casework in our old facility, the assay failure rate was overall 4%.

In January of 2007, our laboratory established partial occupancy in our new building, and, in the two months prior to full occupancy and increased equipment use, four Rotorgene 3000 instruments were installed and successfully passed their performance checks which encompassed three full runs performed on three different days. However, after the building became fully functional, Rotorgene assays began to fail intermittently with a 33-44% rate with no readily apparent cause. Data from the failed runs collectively displayed recognizable patterns such that we suspected the passing of data from the instrument through an exposed serial cable to the hard drive was the source of the failures.

Nevertheless, all plausible sources of failures were addressed including reagents, personnel, instrument function, ambient temperature, magnetic field, vibration, power quality, and radiofrequency interference. (The fact that the assay had performed successfully for 3.5 years eliminated the protocol as a cause.) Reagents were re-tested and personnel were re-trained to ensure quality; however, the intermittent nature of the failures and failures with the use of robotics for set-up, suggested that these factors were not the cause. The instrument also proved to be heating and cooling accurately. Furthermore, the ambient temperature, magnetic field, and power quality were measured and were within the instrument's specifications. Vibration did not appear to be significant. Additionally, in order to prevent total harmonic disturbance (THD) originating from other instruments sharing power sources, localized UPS units were utilized in lieu of the building's central UPS system. Despite these precautions, the failure rate was 20-25%.

After careful investigation, several new sources of radiofrequencies (RF) over a range of wavelengths and not present at the old facility were identified in our new environment. Radio frequencies are known to couple onto any metal surface or wire causing a buildup of signal that can and will be misinterpreted by data collection software. Radio frequency had a deleterious affect when assays failed consistently with the instrument encased in foil to create an antenna like effect was demonstrated. In an effort to mit- igate RF, several tools were tested including external shielding of the instru- ment and cables, the attachment of lead core ferrites to the serial cables themselves, and custom braided cables. However, since the coupling of radio frequency to cables and equipment is a matter of probabilities, 100% cover- age with one formulation was difficult to attain for every instrument location in the laboratory; therefore, photo-isolators, which remove the interference by cleaning up the signal as it passes down the length of the serial cable, were also tested.

As Bluetooth equipment and other wireless communications signals become more prevalent in society in general, mitigating the effect of radio interference presents a challenge. Due to positioning and even the structure of a building itself, the radiofrequency environment among and within each laboratory in a building may vary. Therefore, specific solutions and recommendations may not be applicable to every situation, and a more expansive preventative strategy may be necessary. It is incumbent upon manufacturers to take this into consideration in instrumentation design. Until these needs are met, results from our studies suggest some potential resolutions.

Radio Frequencies, Data Collection, Rotorgene 3000'