The Canadian National Calibration Reference Centre for *In-Vivo* Monitoring: the new lung counting system - the story continues!

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EXTENDED ABSTRACT

Since the last Bioassay conference, work has continued on installing the HML's new lung counting system. More problems have arisen and have been solved. This presentation will describe the completion of the installation, the additional problems the HML encountered during the process, and the characteristics of the counting system that is now operational (?). The following is a catalog of events from December 1994 to the present (June 1995). The presentation will describe these and the events between June and November, 1995

December: Electronic Counter (EC) personnel arrived early December to complete the installation of the LN fill system and repair the deficiencies in the support mechanism. The chair back was repaired during this visit. The following problems occurred during this phase.

A number of components were not present. The EC personnel had expected to find more parts awaiting installation. As a result some items were bought locally.

Two motors in the support cradles were found to be non operational and were removed. EC expected to be able to replace the motors early in the New Year. The detectors were not mounted as the EC person wanted that part to be completed by EG&G personnel.

The LN delivery line was not present. A temporary copper tube was installed to test the LN valves. The LN delivery lines between the valves and the detectors were not installed because the detectors could not be mounted.

The detectors, which had been sent back to Oak Ridge, were collected by HML and EG&G staff and transported by road from Oak Ridge to the HML. During the visit to the EG&G facility it was found that no provision had been made for the connector between the LN delivery system and the detector. The detectors were found to have suffered no physical damage. The failure had been due to loss of vacuum, presumably due to mechanical shock.

Canadian customs were extremely inefficient, including questioning the EG&G and HML staff why they were driving an American car (although it had Ontario plates). Clearing the detectors through customs required unnecessary paperwork and the repaired equipment was never inspected by customs officials.

January: EG&G found that the defective cable checked out on all electrical tests although it did chop out a section of the spectrum. No explanation was offered.

The LN fill bayonets arrived and it was found that they were too long to be left in the detectors at all time. In fact, the length prohibited the detectors from being filled in an upright position as the top of the bayonet was higher that the lowest part of the cradle.

At the end of the month EC sent one of its employees to the HML to finish the LN fill system and resolve the outstanding problems with the suspension system. The employee expected to be finished four hours after arrival in the HML, instead the job took four days. During those four days it was found that: limit switches were incorrectly set, one of the cradles jammed during a vertical translation, two motors were defective and had to be rebuilt, the LN fill bayonets had to be modified to accept the fill tubing, there was an inconsistency in the sizing of the tubing from the LN reservoir tank.

February: It was found that the LN fill system did not function properly. It was concluded that the LN manifold was partially at fault as there was a contraction-expansion of the LN in the manifold. It was postulated that this was forming a gas bubble in the front part of the manifold so that detectors # 1 and #3 would not fill. It was also found that the other detectors would not fill from ports #2 and #4 if the fill bayonets were put in the line. The temporary work-around was to fill using the Teflon tubing only. A new manifold was built and shipped to arrive at the same time as the EG&G personnel

EG&G personnel arrived to commission the detectors, but the new LN manifold did not. It was found that the replacement cable was defective. This was due to an incorrect soldering in one of the end plugs. The problem was resolved on-site. A second cable was also repaired on-site.

The new LN manifold arrived on the second day, but it was found that its internal dimensions were exactly the same as the 'defective' manifold (fill cavity 1.91 cm, outlet ports 0.64 cm: main LN inlet pipe is 0.95 cm and LN fill pipes are 0.64 - all dimensions are ID); however, two ports had been moved 5 cm down the manifold from the LN inlet. This, however, made no difference to the filling characteristics. EC agreed to modify the manifold and supply some flex tubing for the LN fill line.

It was found that 3 of the four detectors would not accept full bias. This was attributed to warm crystals, even though there was a significant amount of LN in two of the three detectors that would not operate. They were filled overnight for another test the following day. Following the cool-down period it was found that the two detectors driven back from Oak Ridge were functioning (they had been kept cold since their arrival in the HML), but the other two, that had been cycled once, were not functioning, presumably due to vacuum loss. This could be due to an inherent design problem. EG&G personnel determined that the best solution was to send up a pumping station to revitalise the detectors.

The fill bayonets were tested for LN flow rate. It was found that the frit was greatly reducing the LN exiting the bayonet. The frits were cut off and the amount of LN exiting the bayonet was increased. The outlet tubes were modified to create a cup at the base of the tube with open sides. These bayonets were found to fill much more effectively.

March: It was found that the detectors were too low and could not be positioned over a person seated in the chair. EC had "lost" approximately 25 cm of height during the design and construction of the support mechanism.

Another new manifold was shipped at the end of this month and tests showed that it performed much better than the previous versions; however, the filling time was not equal for all detectors out of all filling ports. The flex hose did not arrive.

April: A new support post arrived. The post was shortened by removing the motor assembly and replacing it by a handwheel assembly; unfortunately, the new post could not be installed as the base plate on the track had no threaded holes. The flex hose did not arrive again. A new base plate arrived and the post was installed. It was found to be adequate and EC agreed to replace the other motorised posts with a similar design. The new design did not have the disadvantage that when the motor control was released the detector kept moving. This was deemed to be very unsafe when trying to position the detectors on a subject's chest.

May: The pumping station was shipped early in the month and arrived towards the end of the month. EC sent the replacement posts, which arrived at the end of the month and were installed prior to the arrival of EG&G personnel.

June: EG&G personnel arrived early in the month to complete the on-site repair of the detectors. HML staff were trained in the pumping of a detector cryostat and one detector was successfully brought on-line. The remaining detector, although accepting full bias, did not produce a good spectrum. Further investigation showed that two cables had become defective.

Flow rate measurements were made on the nitrogen gas exiting the dewars using similar equipment to EG&G Ortec. It was found that the detectors that had been kept cold since their repair in December of 1994 had lost cryostat vacuum and the holding time had been reduced by one day. Their rate of liquid nitrogen consumption was higher than the newly pumped detectors.

All four detector were mounted in the modified support system. It was found that two detector were still too low (5 cm) and that the other two could not be lowered enough (7.5 cm).

One of the detectors that had been driven back from Oak Ridge failed. The bias voltage could not be applied and the LN loss rate leapt to 3.35 L day^{-1}. The holding time was predicted to be 5 days. This detector was shipped back to Oak Ridge for evaluation along with three defective cables.