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The DOE Lung Intercalibration Committee Meeting Augusta, May 2002.

by

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DOE Lung Intercalibration Committee Meeting 2002

Approximately 40 participants from the United States of America and Canada (including suppliers such as Canberra, and EG&G) attended the meeting held in Augusta, Georgia, May 7 - 9, 2002. The first two days consisted of information exchange, and the third was a closed door session for DOE and DOE prime contractors.

The meeting was held at the scenic Savannah Rapids Pavilion that is nestled in a 31 acre wooded park on the edge of the Savannah River, near Augusta, Georgia. The meeting was co-sponsored by the Lung Intercalibration Committee and Westinghouse Savannah River Site.

Introduction - Tim Lynch

Tim welcomed all the attendees and briefly reviewed the history of the committee. He then introduced Kelly Crandall who described the meeting logistics and in turn introduced the speaker for the opening address.

Opening address - Mike Matheny

He hoped that the tradition of frank discussions would be continued and looked forward to seeing participants touring the SRS facility.

A case study in evaluation of an inhalation intake of poorly transported plutonium at the Savannah River Site. Mitch Findley

A series of intakes occurred in Sept 1999. A ventilation breakdown caused the positive pressure in a work area to vanish so that contamination spread from the airborne radioactive area. Worker number 2 had the highest external contamination. Lung counts were 50 minutes, also urine and faecal samples taken. The incident was discovered by an area alarm. Source of contamination unknown for a number of weeks. Four workers chelated with Ca-DTPA. Isotopic composition of material was known well (7.6 :1 alpha Pu: alpha Am).

Fecal samples were dried, ashed , and counted directly. Intake was significant for six workers. Urinalysis gave a low excretion 0.175 dpm/L (expected higher). Nine days after event, Pu was undetectable in urine. Four of seven workers had measurable Am chest burdens. This was the first time in twenty years that a measurable event had occurred. CWT measurements had to be done (also for the first time). Implemented microwave digestion technique for faecal samples. Also did TIMS $^{239/240}$Pu at LANL and found measurable activity in all workers. Used ICRP 66/67 models for the dosimetric evaluation. Lung solubility studies performed on the material.

Spectrum of worker number 2 shown. Good ^{241}Am peak seen, and subsequent chest counts were performed. Software prediction for CWT was given by CWT = -2.0038 +1.973W/H. Used a template

to locate the detectors on the worker for the ultrasound measurements. Made four measurement in each detector area using a 5 MHz transducer with a stand-off pad to avoid skin deformation. Did exponential mean and linear mean. As they were very similar, the liner mean was used. 3.1745 (3.215), 2.7142 (3.875), 3.6452 (3.760), 2.3241 (4.1800 this was a female worker lying down) cm. Values in parentheses are ultrasound, the others are from software. Data clearly shows that empirical equations can cause large errors.

Solubility testing done at Lovelace Respiratory research institute (~$17,000 US). ICRP66 allows for use of dissolution data. Two filters sent with 10,000's dpm of activity on them. Changes to transfer rate constants were: AI1 to bb1 reduced by x50. Ai2 to bb1 reduced by X5 (slowed down the clearance rates). These were smallest changes to standard model that would allow adequate fit of chest count data. Fast absorption fraction reduced by X5 both rate constant reduced by X10 in the solubility section of the lung model (slows down the solubilisation process).

99.93% of Pu dissolved with half time of 146 years - a “super S” material. 0.07% dissolved with half-time of 0.44 days. These tests are in good agreement with the model modifications described above. Retention plot showed, and the activity was almost constant with time.

CEDE for worker number 2 was 6,719 mrem. This worker is still being monitored. At 900 days the lung burden is ~0.5 nCi. He has put on weight since the intake but the CWT has not been re-measured; the software value is being used.

As a result of this incident there is a pilot program using new monitoring techniques including PAS, TIMS, faecal monitoring. Program is now in third quarter. SRS can now do TIMS measurement on site for a handful of workers. Trying to do dissolution tests.

There is now an appreciation of the value of chest counting at SRS

Calibration for chest wall thickness in excess of 4 cm. Henry Spitz.

This is still a work in progress and D. Hickman is a collaborator. The problem has always been what to do when the CWT exceeds 4 cm. Can the calibration curve be reliably extrapolated? You can stack plates to approximate this, but there are air gaps between the plates that make this an unsatisfactory solution. RSD’s CWT values for Henry’s LLNL phantom were different from the measurements made in his laboratory and he thinks that this was due to a QA problem with RSD (30-40% difference). The variance is small for the OVP’s, but not the chest plate.

Solution: use cups that fit over the end of the detectors. Make detector end caps that are of uniform thickness (i.e., no curvature) and place these on the chest plate. End caps made at 0.54, 1.16, 1.72, 2.44, 3.00, 3.50, 4.00, and 5.00 cm thick (100% muscle). This is a very cheap easy solution. Pictures of the end caps and the molds were shown.

Data shown for ^{241}Am (993 nCi) in the lung for first five points (base plate + overlay plates). Then repeated this end caps and fitted it to a cubic polynomial. Comparing overlay plates to polynomial showed a disagreement with the extrapolated portion (using an exponential extrapolation). This did not agree with HML's data that the fit is exponential over the entire range of thicknessses. Doing Monte Carlo modelling to check the side response. The Pu data was not shown.

Henry offered to loan the cups to anybody that would like to borrow them.

NIOSH is doing a lot of retrospective dose estimates. In the 50's nobody cared about the uncertainties, but now its important.

Almost all the university WBC listed in the 1970 IAEA directory in the US are gone. The programs that generated the graduates are also gone.

Discussion on lung calibration issues. Govind Rao.

ORNL lung counter calibration. Three coaxial (70 x 30 mm) detectors. The detector over the heart is the missing spot. Detectors are positioned sightly offset over right lung. Some nuclides are biased in the QC tests and seems to be due to the calibration procedures being used. Four considerations: stable system, constant geometry, result specific to nuclide input must be well known. ORNL uses a calibration curve.

Govind has noticed that some lung sets don't fit the calibration curve well. Calibration energies 20.3, 26.35, 59.54, 121.8, 244.7, 344.3 keV (^{241}Am and ^{152}Eu). Data shown for the 1.6 cm chest plate. Calibration curve from Canberra shown, and Excel curve shown. They are different. ^{238}U (two) are below the curves. When ^{237}Np calibration data was added to the data set, the 85 keV fit well, but the high energies were biased high. Another Np set added and a wider spread was observed. Next added were two ^{235}U lung sets, and they were high compared with the calibration curve. Finally, a DOELAP lung was added ^{235}U and it was high too. Np-237 spectrum is wonderful for calibration. Good peaks at 86.5, 98.4, 300.1, 312.1, 340.5, 398.5 keV. New calibration curve based on Np raised curve, and the overall fit improved. Data was shown comparing the biases from ^{152}Eu calibration and ^{237}Np calibration (one ^{237}Np lung set was rejected as unreliable).

The whole body counter was examined in the same way. It was used to estimate the ^{237}Np activity of the lung sets, and they seemed to be 10% different.

One question that was not resolved during the discussion was whether ^{237}Np was prone to coincidence summing or not.

History of Canberra lung counting systems. Melissa Patterson.

Melissa is the new product manager for *In Vivo* systems at Canberra. Pictures shown of models 2270 ands 2275 counters. Canberra has been making lung counters for 15 years. Three or 4 are in Russia. First lung counter shown (1987) - small shield with chair Act I detectors that had 5 movement controls (DoF). 1988 system to Russia (Kurchatov) upgraded to Act II detectors (first use) in 1989. Canberra standardised on this geometry after. Chair design was changed in 1991 to one from Max Keck. This chair was unreliable and an alternative was found in 1995. New chair used from 1996 (commercial medical supplier). Anti Compton shields added to detector end caps in about 1995 and it makes a 15 - 20% improvement in MDA (no data shown). Detector handling system has been improved over time to make the system smoother.

Lung and WBC (1991 -1996) shown. The KAERI system was shown. There is a NaI (3 x 5 x 16 inches) scanning detector under the bed. There was also a collimators provided for this system. Handling system was reduced to 4 DoF. Latest version of this system has new design features: six DoF for Ge handling system. Two Act II (3800 mm^2). Also has anti Compton shields. Load and unload positions added so that detectors can swing out from above the bed. The bed now slides out (for subject loading/unloading), not pivot. It has a steel frame with low attenuation base plate for body scanning. Width has been increased by 4 inches. Scanning NaI detector is now chain driven (belt systems broke more frequently) and is software controlled.

Joel Webb's system was shown, as he was the first to add one of the rotational elements in the positioning mechanism. The Cameco lung counter was shown: Four 5000 mm^2 detectors. Cost $400,000 US for lung counter part. The positioning mechanism became bulkier (and more expensive). Anti Compton shields do not fit this system. Detectors are offset in the Dewars so that they can be put close together. The chair is also slightly different (it's expensive) and this and the other chair are tested to 450 lbs. Positioning has 5 DoF. Counting efficiency plot of the BeGe compared with standard coaxial detector shows improved efficiency.

There are not many BeGe detectors in use for lung counting at this time, but they are becoming more popular. They will not be available in the Act II configuration.

A practical study - using an ISOC's system (MCNP) for lung counting. Kelly Crandall and Ron Smith.

Lung calibrations are lengthy and expensive. An alternative is to use MCNP. At SRS it is used for a variety of applications, the most recent being ISOCS. DOE recommends that software be supplied by a vendor (rather than developed in-house). Canberra approached if they had a product that would integrate with ABACOS 2000. They did not, but they did have ISOCS and so did SRS (with a resident expert).

A study was performed to see if ISOCS would perform this function. The lung phantom etc. were modelled. Problems were: ISOCS uses a single detector, and did not go below 45 keV. DOELAP lungs used to do the study (results not released yet as somebody is still counting them). Other lung sets were

modelled with four known sets (6:00 pm last night) ^{234}Th, ^{235}U, ^{238}Pu, ^{241}Am. Biases were 4%, -15%, -9%, -16%. Precision was 0.6%, 6%, 5%, 4%.

ISOCS will work over a range of 45 to 10,000 keV and calculates efficiencies mathematically from spatial orientation of detector to target, material compositions etc. The torso phantom, and lungs, are very irregularly shaped. CWT of 1.59 cm used. Detector was looking straight down on the phantom. End cap 11 cm above chest wall and centred above bottom of left lung. All measurements made in this geometry. Phantom lay on foam on the cart frame. No attempt was made to optimise counting position due to lack of time. Five repeat measurement made 1800 - 3600 second acquisitions (longer time for ^{238}Pu). Positioning error estimated to be ±0.5 sec. Template used was complex cylinder 30 cm h, 30 cm diam, 4 discrete layers used, wall thickness 1.59 cm, right lung 5 cm h, left lung 3.5 cm h, lung separation 3 cm, lung density 0.27 g/cm^3, wall density 1.1 g/cm^3, lung separations tissue 1.0 g/cm^3. Efficiency curve shown looked good. Turnover was about 110 keV. Detector had collimator on for this study. Model could be improved, but time was of the essence. Would be nice to have a template in ISOCS for the torso.

Comparison of 3-generations of LLNL torso phantoms. Gary H. Kramer.

The Lawrence Livermore National Laboratory (LLNL) Torso phantom, which is the de facto standard for lung counter calibration for low energy photon emitters, has undergone a number of revisions since its development. The first generation used real human bone; the second generation used synthetic bone and had a major design change; the third generation had more subtle material and mold changes. This work has compared a first generation, two second generation, and two third generation LLNL phantoms to see if there are any differences between the phantoms. The comparison of five LLNL phantoms using the same counting regions has shown that the second and third generation phantoms are essentially equivalent at low photon energies; however, the first generation phantom shows an increased counting efficiency at low photon energies due to a design flaw. It is also apparent that these phantoms have maintained their performance characteristics over an extended period of time.

The comparison of five LLNL phantoms using the same counting regions has shown that the second and third generation phantoms are essentially equivalent at low photon energies; the first generation phantom shows an increased counting efficiency at low photon energies due to a design flaw. At higher photon energies there appears to be a difference between the later generation phantoms. It may be due to subtle differences in the material formulation that has increased the attenuation of one phantom compared with another as photon energy increases. While this may seem to be an apparent flaw in the LLNL phantom, one must remember that the phantom was originally designed and constructed for the measurement of ^{239}Pu and never intended to be used at higher photon energies (>60 keV). With that constraint in mind, it must be concluded that the first generation phantom had a design flaw that was eliminated in the later designs, and that the second and third generation phantoms are equivalent. It is also apparent that these phantoms have maintained their performance characteristics over an extended period of time.

Discussion showed that none of the attendees were aware of the location of the other two first generation

LLNL phantoms. One questioner wanted to know what conditions the phantoms might have been subjected to. The LLNL phantom at the HML has been kept under controlled conditions since its purchase; however, the IAEA phantom is loaned to any member state that needs it so it has been shipped all over the world. The consensus based on the comparison of these two second generation phantoms was that the other 14 second generation phantoms have maintained their performance characteristics over time.

Any laboratory is welcome to send its phantom to the HML for comparison,

Hand verification of Abacos 2000 results using MathCad. Tom LaBone

Ken Skrable did not trust some chest count data from the software, and wanted the original data. This led to the work described below. Wanted to measure activity in a lung phantom and compare the hand calculation to the software value. A doublet was shown by way of example. Peak fitting using MathCad assumed Gaussian distribution. A non linear regression was performed as described in the handout given.

A single peak was created, with no background. Counts are a function of the channel number and the area. Sum of squares minimised for counts observed and counts calculated.

Pu-238 lungs measured at 43 keV. 5400 second count. Spectrum showed. Background assumed to be straight line under peak. Fit was fairly simple and area determined independently of Abacos 1228 compared to 1170

The experiment was repeated at 17 keV and there are three overlapping peaks to deconvolute. It was minimised by the same method as described in the handout. A very good fit. Abacos does not do this; however, a Canberra representative stated that Abacos could analyse multiplets. Abacos gave 8290 counts. Hand method gave 10,110 + 1,722 + 327 for a total of 12,159. This is a difference of 47%.

Compared a ^{238}Pu lung set to one from DOELAP and UoC lung phantoms, and from the Abacos software. Reasonable agreement was obtained. Values not statistically significantly different. Tom concluded the Abacos works well.

Verification of two ^{238}Pu lung counting phantoms. Tom LaBone

Phantoms were counted outside of phantom for 5,400 seconds and repeated 5 times. Average counts were converted to counting efficiency and the values compared with propagated error. A clear difference was observed. T-test showed a huge difference. This could introduce a 10-17% bias depending on which lung set is right. Maybe, they're both wrong.

Discussion showed that NIST needs to provide a service to compare a lung set to a gold standard.

Estimating total propagated error for lung counting and whole body counting. Dave Hickman

Almost impossible to do this properly for *In Vivo* systems. This analysis is not complete, but is deemed reasonable by the speaker. DOE lung workshop in 1976 (Seattle) had two sessions on calibration errors with consensus conclusions. Subject back ground ± 50%, counting stats ± 50%, CWT ± 40%, non uniform distributions ± 70%, calibration error ± 5% TPU ± 107%. Roger Falk came up with a TPU estimate of ± 123%.

Changes since then have been large. Use of HpGe, ultrasound for CWT, improved calibration (phantom and techniques), improved computing, digital signal processing/computing (some components had tubes), more automation, and more regulatory requirements. Now there is less calibration variability, CWT better characterised, better nuclide identification, improved background determination for high resolution, automation of count error, efficiency errors, and systematic errors.

LLNL lung counting was described. CWT errors. Photon energy 17.5 keV, 91%, 21 keV, 50%, 59.5 keV, 18%, 122 keV, 15%, 245 keV, 13% (average % error for a 0.5 cm change in CWT at a given energy).

Non-uniform source distribution is hard to deal with especially as we do not know the distribution in the lung. Can generate 300 - 400% error in ^{241}Am wound counting. This is not included in Dave's TPU.

Mass self absorption has not been considered very much. Error in detection of uranium in a wound using a portable counter requires a only requires a 50 ìm particle to introduce significant self-attenuation; however, this is not respirable.

Positioning errors. Several sites have mentioned that they've studied it but its not published. LLNL studies have demonstrated errors to be less than 5%.

Estimated TPU is 19% at LLNL as a systematic error which is a fixed error added to Abacos (this is for 59.5 keV i.e, ^{241}Am).

Scanning bed described (also HpGe detectors). Error contributors are subject background count error, counting statistics, efficiency calibration, body thickness, effective distance error, nonuniform distribution. Only last three discussed. Thickness can vary from 7 to 13 cm and causes about a 1% change at 200 keV and above. At 100 keV the effect of changing thickness from 7 to 13 is 67% and -40%. Normally not a problem as most nuclides are >200 keV.

If effective source distance varies by ± 5cm then the response of the system can vary by as much as 53% (thin person) to -30% (thicker person). Measurement on alternate styles of phantoms can introduce 17% to 27% error.

Mehl looked at effect of the effective detector distance and the scan length of a bed system was as high as

30%. Based on all of the above the TPU is estimated to be 28%. This is partly because the distance of detectors from bed cannot be altered.

Lung counting and accounting for the uranium background. Tim Lynch

12,000 lung measurements last year and several hundred whole body counts. Two lung counters at Hanford with for 3800 mm^2 detectors with Be windows and located in counting rooms (iron 10" wall). 0.25 keV per channel with routine count time of 50 minutes. Routine library is ^{234}Th ^{235}U and ^{241}Am. Room background contains uranium and thorium. A 24 hr background showed the peaks clearly with some Rn progeny. The presence of the U X-rays indicates the windows are contaminated with Uranium. A typical worker spectrum (60 min) shows no peaks.

Initially did not subtract an environmental background. 15% of results exceeded decision level, there was an unacceptable positive bias, recount when results > DL. Customer was charged for recounts and did not like it. A distribution of net Th counts was not centred around zero. After environmental backgrounds were subtracted this improved. The ^{235}U activity distribution was normal centred on zero.

Abacos allowed environmental peaks to be subtracted when no other peaks identified; however, when electronics was changed to digital the Abacos parameter (expback) was not set properly. Five people recently seemed to be exposed, but it was not real. The parameter expback had not been set properly.

Uranium background established using the torso phantom containing blank lungs and counted for 24 hours. The phantoms had a higher uranium background than 30 workers. The phantoms had peaks identified by the software, but not in the workers. Peak search and peak force has about a factor 2 in the number of channels in the ROI. This is still a work in progress.

Protocol now is not to subtract environmental background unless the result exceeds the DL. This is a temporary measure until evaluations completed. Tested sugar sacks, polyethylene slabs etc. as phantoms. Results showed that 30 workers had lowest values for ^{234}Th and ^{226}Ra. Room background seemed to be a good estimate and most everything else was higher. Question: why not use the workers, it was answered that they may contain uranium.

A historical review of last 6 months backgrounds seemed to show an increase from first measurement for ^{234}Th ROI. This used a BOMAB phantom. Increase in count rate was about a factor 2 from May 2001 to April 2002. There was no trend for ^{226}Ra photopeak over same time period.

Tim concluded that it was important to characterise the environmental background, the calibration phantoms are not designed to estimate these backgrounds, and that a room background might the best estimate.

Henry obtained his first Ge detector with a carbon composite window and the uranium background is not present in his detector.

Variation in lung counting background for an unexposed population. Joel Webb

Conducted lung and whole body counts on local public. Not occupationally exposed, 752 individuals measured, ROI versus peak search approach as peak search doesn't work at these low levels. About 300 have been recounted. Focus on Pu isotopes ^{241}Am, nat U, and enriched uranium plus others.

Descriptive statistics shown for the four nuclides above for gross counts. Variance is higher than expected from Poisson. The trends are consistent across all radionuclides and men are different from women. They seem random but they are not normally distributed.

Net counts (in theory): mean is zero, normally distributed, used to determine detection, equal probability of being above or below zero, and the variance is less than gross. For Pu, Am, and Nat U they are centred around zero and variance is less than gross counts. Not so for enriched U as the mean is not zero. Net counts are a random variable and are independent of gender. Pu net counts fit normal distribution very well. Others do to, except enriched uranium, although its almost normal.

Probit plot is a useful tool as one can fit a regression to it so the DL can be easily estimated, either from the equation or read directly off the graph.

If net counts are random, one can apply general statistics to obtain DL.

	n13.30	Normal stats	Probit regression	non-parametric
Pu	16	17	17	17
am	20	21	26	22
natU	20	21	25	21
enr U	17	20	27	23

Conclusions: Gross counts are uneventful when compared with net counts. Detection can be estimated from population data, N13.30 needs to be re-thought for lung counting (MDA), net counts is likely the most important factor for detection, net count QA is good.

Joel commented that he is going to sum spectra to see if sensitivity can be improved.

A brief history of Canberra's In Vivo counting data review service including a tale of two uranium processing facilities. Dave Groff.

Data review has been going on since 1975 (until 1983) when RMC provided this commercial service to power plants. About 10 nuclear power plants and one uranium processing site. Probably 300,000 whole body counts have been reviewed. Canberra bought RMC in 1983. Data review carried on (1984 - 1989) in another office and a second uranium processing facility was added. In 1990 Nuclear data was bought by Canberra and data review continued. Over period 1990 - 1994 the equipment in the field continued

to be upgraded.

After the global PC revolution, the nuclear power plants pulled out. Data review only for the two uranium processing facilities was left. Facility A upgraded to Ge detectors and Abaocs GPC (OS/2). The other facility upgraded to a PC based system (Abacos 2000). Original data received, on CD, copy to in-house system, sorted and segregated, printed and reviewed all original results, denoted ^{235}U results that are assumed to be external (based on presence of X-rays or fast clearance), all other ^{235}U are assumed to be internal. Data also checked to see if any peaks are missing, and a technical report is issued, and archive the counting data. Notes can be added to the final report to highlight certain findings, i.e., "final results include nuclide(s) not in standard library".

Facility A had four phoswich detectors arranged two above the bed and two below the bed. Now they have a Ge (Act II) counter with a PC based analysis system. Facility B still uses Act I detectors. MDA values for 235U at 4.5 cm CWT are 5.8 Bq (73 ug), and 8.3 Bq (105 ug) respectively. The data over the period 1987 - 2001 was presented. Maximum reportable activity was 350 ug in 1988. In 2001 was ~270 ug. Facility B had higher values than facility A. No information on skeletal burdens. Number of counts has decreased from 1000 (1987) to 550 (2001) at facility A. Different at Facility B: there was a minimum (400 counts) 1994 and no are doing 1200 counts per year. Both facilities are showing loess contaminations as a percentage of number of counts.

Life after Phoswich (presentation on the construction of a new mobile lung counter). Steve Allen

There is no data available yet as the project is 6 months delayed. Mainly due to shield manufacturer. The new counter is being driven by the obsolescence of the present system as spare parts can not be obtained, and the lower dose limits in Canada (20 mSv per year). The MDA has to be reduced. Several options were looked at: long counting time, spiking spectra, body matching, spectral summing (group monitoring for up to 30 people). Nice picture shown of a spectral sum: 1 hour, 5 hours, and 10 hours.

Design considerations resulted in: an 80 mm x 20 mm detector, a new shield, which required a new trailer. The shield (56,000 lbs) had to be placed into the middle (plan was to place it at back) due to weight problems. The old shield was shown and the insufficient graded Z shielding was discussed (a factor of two). Pictures were shown of the shield and the opening mechanisms. This proved to be a problem and the motors had to be re-engineered. The total weight is also very near the legal limit.

Steve commented that it was difficult to get good advice from the vendor.

Chair was enlarged due to large individuals and has a rough finish to prevent the person sliding down the chair. However, the chair moves quite fast. This is a disadvantage as it's the only vertical motion (the detector assembly has no vertical motion).

CWT measurements made by Health Canada showed that an empirical equation could not be used. A plot

of counting times for 10 and 5 mg lung burdens was shown. Average counting time is 2 hours, but some as high as 8 - 10 hours.

The new ultrasound unit was shown ($36,000 Cdn). Full colour Doppler so it can measure blood flow. Also, it can see behind the rib, so the rib shadow is missing. This makes it harder to visualise the lung interface.

A background study will be performed as soon as the counter is ready and there is a plan to detect surface contamination (based on research performed by Health Canada). Subjects will be entertained in the counter with a head set that simulates a 53" TV, 6 ft away. LCD display have been tested for uranium, and it has found to be absent. Completion is waiting on the trailer manufacturer. Electrical service will be 600V with an onboard transformer.

Reducing natural Uranium MDA by a factor of two. Gary H. Kramer.

Natural uranium has three photopeaks at 63, 93, and 185 keV. If these three peaks are combined into a single peak and a lung counter calibrated using this composite peak the efficiency is increased more than the combined background of the three summed counting regions. As a result the MDA, compared with a single photopeak, can be reduced by approximately a factor of two. The improvements for the lung counting system at the Human Monitoring Laboratory (HML), which is based on four germanium detectors (70 x 30 mm), is shown below.

	reduction in MDA			
CWT (cm)	T=1800 sec 63 keV	T=1800 sec 185 keV	T=3600 sec 63 keV	T=3600 sec 185 keV
1.54	1.6	2.2	1.6	2.2
2.19	1.7	2.1	1.7	2.1
2.8	1.7	2.1	1.7	2.1
3.35	1.7	2.1	1.7	2.1
3.99	1.8	2.0	1.8	2.0
5.92	1.9	1.9	1.9	1.9
6.44	2.0	1.9	2.0	1.9

In addition to the above topic, a joint NIST-HML research project was briefly described. It has been found that autoradiography is a useful tool for imaging planar sources (that can be used in sliced lung sets) and a homogeneous lung set that was cut up in slices approximately 1.5 cm thick. This is preliminary work and the data has not been fully analysed; however, the preliminary conclusions are the activity distribution on the planar sources is sufficiently even to simulate a homogenous lung set, and that homogeneous lungs can have hot spots. One image was shown where the one of the slices of a homogenous lungs set clearly showed a large hot spot.

An open invitation was made to the audience for donations of lung sets that could be sliced and examined in this manner. It was suggested that after the autoradiographical analysis has been completed the lung material could be destructively analysed to obtain and accurate activity estimate.

The expectation of false positive counts as a function of library nuclides. Dave Hickman.

False positives can cause problems with employees and management and lead to lack of confidence in the *in vivo* measurement program. There is a need to understand the source of the false positive rates.

Critical level in simplest form is $L_c = 1.645\sqrt{(2B)}$ for á = 0.05. At this level one expects 5% false positives in WBC. 345 persons counted from Jan 1999 to Mar 2002. Radionuclides monitored since Jan 2001 are ^{40}K, ^{22}Na, ^{57}Co, ^{60}Co, ^{131}I, ^{137}Cs. Prior to this an additional 19 nuclides were monitored. Since Jan 1999, 56.5% were positive. Since Jan 2001 54% were positive. Most positives were ^{137}Cs (52.8%) and 5.22% were above the MDA. Mostly due to trips to Europe. L_c = 0.5 nCi for ^{137}Cs. Levels may be from fallout,

but this is still not resolved. People at LLNL do not seem to eat game.
Revised rate, excluding ^{137}Cs, is 7.8%. Since Jan 2001 the rate was 5.7% (prior to this the rate was 9.1%). Difference is due to number nuclides being monitored. Looking at each nuclides none are greater than 5%. In fact there are not enough (values varied from 0 to 2.61%). Postulated that the software is responsible (peak identification criteria) within and this will lower the false positive rate. Actually, the number of false positives should be higher for the number of nuclides measured. This means false positive rate is effectively lower than 5%.

Similar observations were made for the lung counting programme at LLNL. False positive rate is 16.3%, but would expect 19% for the number of nuclides being looked for. Fallout ^{137}Cs is still detectable in the LLNL WBC and this influences the observed positive rate. A study of the false positive rate provides good insights to the statistical effects of the number of nuclides in the library. Should alpha be lowered to allow for a costive personnel rate of 5%, or should personnel and management be better educated to understand what type of positive can be expected.

The performance standard (N13.30) implies a certain level of compliance and this is causing problems. Regulators, and management, tend to apply these criteria to a regular monitoring programme.

It was pointed out that nuclides cannot simply be removed from a library if that nuclides is of dosimetric concern for the site. The investigation level for ^{137}Cs at LLNL is 2 nCi (74 Bq!).

Move of an In Vivo Counter. Henry Spitz.

The cost of moving the shield, including geological coring, was $50,000 US in 2000 (although there another bill for $15,000 US from the crane and moving company. The shield was 70 tons, the door weighed 7 tons, and cost $4,000 US according to the The Post and Times Star (Cincinnati newspaper). Originally the cost of building the facility was $146,000 US (year ?). Henry has been in the business since 1969 and he is unaware of anybody having to move a WBC (this was later corrected by D. Hickmann who has moved a shield to Russia and knows of another moved by max Keck). The shield was in two parts and each of the two counting rooms had a graded Z liner. The original WBC was being demolished to build a parking lot.

The move was made at Henry's expense as he could find no outside funding. The money came from his research funds. There is much reconstruction taking place at University of Cincinnati, this was a benefit as there were cranes and workers available. Henry had 5 days notice before the move. Henry was not present when the move took place, but found them still in place on his return. He found the shields in the middle of a torn down building. There was fortunately no damage. They had to weld on lifting hooks to attach the cables to the crane. The crane was $18,000 US per day. The strain gauge in the crane said 82 tons. The first flat bed truck was rated for 75 tons so it bent when the shielkd was lowered and touched the ground. The shield was removed and put on another truck, but it was flattened too! It took two days to move it. The area had to be re-graded and a third truck was needed, but the tires flattened out. They

chained the shield to the truck. This was repeated for the second shield.

Max Keck was supposed to do this, but he was unavailable at such short notice. He was going to lay steel plates, grease it, and push the shield into the building. They tried to follow this plan, but (small shield is 8' x 8' x 12') as each shield lay outside the building for 3 months, the grease dried. The concrete pad on which the shields rested also had a small incline.

The shield had to be jacked up and place high pressure pillow underneath. The shield started to slide backwards. It took four days to get the shield into the facility. Holes had to be cut into the side of the building to get the shields inside.

The shields are now in the building and the detector systems are being assembled. Routine counting for Fernald was expected to commence in December (as they are shutting down their *In Vivo* facility). Henry was asked to commence in June, but this is impossible.

The crane operator asked if he was going to get a radiation exposure. Henry estimated if this was done with planning etc the cost would have been $250,000 US. This move was done with an available workforce and all kinds of regulations were "overlooked". For example, one man was hit in the groin when a cable snapped on one of the "come-alongs".

The doors on the shields do not move freely anymore. Henry hope that he does not have to repeat this experience. The move was driven by the fact that the company that operated the parking lot was going to lose 26 parking spaces.

Discussion on ^{125}I in lung. Govind Rao.

The is a long term transuranic worker who was monitored for a termination count. The spectrum was shown and showed a signature for ^{125}I. The thyroid scan was a lot lower. The left lung showed an order of magnitude higher response of the detectors over the right lung. Govind then showed a chest X-ray of the subject in 1999 and 2001. The man had prostate cancer and had ^{125}I seeds implanted (total activity 26 mCi, 108 seeds, July 2000). One seed was found in the left lung. The doctor told the subject that these seeds can migrate through the body. The activity was 311 nCi in the seed, the software estimated 60 nCi based on a homogeneous calibration. The difference between measured and calculated is a factor 5. A lateral X-ray was shown and the needle was seen to be in the middle of the lung (front to back).

Particle size study at SRS. Ed Kvartek

Ed is an industrial hygienist. An Anderson Impactor was demonstrated. It is necessary to measure particle size to refine the dose estimate. Shape, physical size, density, and physical forces define the aerodynamic diameter (MMA D). >10 um not respirable, 5 um 25%, 3.5 um 50%, 2.5 um 75%, <2.5 um 90%. Anderson samples at 1 cfm. There are 8 stages and collects in small bins >9 um, 9 - 5.8, 4.7 - 5.8, 5.8

- 3.3, 3.3 - 4.7, 2.1 - 3.3, 1.1 - 2.1, 0.7 - 1.1, 0.4 - 0.7, and everything <0.4 um. The Anderson is supposed to be the best impactor and the bin ranges are quite accurate. After sampling, the filters showed darkening by the mass of material collected. Less than a third of the samples had quantifiable activity on the filters.
Many samples were taken in workplace areas and a plot of Pu AMAD was shown. Some of the particles collected were large and not respirable. Radon progeny are fixed to very small particles (1 um and smaller). The two plots were almost mirror images of each other. Radon progeny can be a problem if alpha on air filters is assumed to be Pu.

Results: significant percentage of Pu not respirable, SRS impactors effective at collecting Pu, Radon progeny exclusions does not affect Pu collection.

How does this change for particles released from a glove box operation? There is no way to tell. Tests on exhausts from glove boxes showed a mixture of Si, Fe, and Pu. Would it be worthwhile to measure the interior of a glove box/hot cell to characterise the material? Yes, it would be worthwhile.

A brief history of SRS whole body systems. Kelly Crandall.

A copy of this presentation is on the CD issued by the meeting committee.

Tour of SRS including the In Vivo counting facility.

Security at SRS has been greatly enhanced and procedures are still being upgraded (7 months after the World Trade Centre disaster). For example, SRS now has helicopter gun ships that patrol the area. The SRS site is large and has a land area approximately 1% of the state of South Carolina. Originally about 6,000 people were moved of the framing land that is now forested. The old town of Ellemton was physically moved off the site and renamed as New Ellenton.

The *In Vivo* facility was impressive, especially seeing all the digital technology and many spare detectors. The bioassay laboratory is now housed in a new facility. One can only be envious of the 168 alpha detectors that are housed in one of the counting rooms. The routine fecal monitoring program uses a method that seemed cumbersome compared to a fusion digestion; however, it is giving good results.