MEMO

TO: Pinellas Plant Work Group
FROM: SC&A, Inc.
DATE: March 4, 2016
SUBJECT: Stiver/Katz Notes on Pinellas Technical Call

Craig Yoder (CY), Joe Zlotnicki (JZ), John Stiver (JS), Jim Neton (JN), Pete Darnell (PD), Mutty Scharfi (MS), Bill Smith (BS), Bill Field (BF), Ted Katz (TK)

Source term – RTGs – shielding, NASA paper indicated high proportion is high energy, concern that 10 mR LOD might not be claimant favorable. Understand small doses, dose of record issue, and Landauer statements regarding their quality. May be circumstances where higher LOD should be used, such as with these RTGs.

PD: Let's talk about the NASA report as well; JN: SNAP not good surrogate for Pinellas but awaiting document clearance, let's discuss this at future meeting.

JZ to CY: If trying to measure high end of spectrum – e.g., 1 MeV… What do you say about that?

CY: My background: directed technical operations from 83 to last year, prior worked at Batelle NW testing dosimeters in anticipation of DOELAP standards. Did research relevant to question.

JN: Time period of concern is '74–'79, (provided specifics on badge type – g, monthly exchanges.

CY: So Kodak type 2 film (8 mm movie film) – g badge. Film bought in bulk, packaged by Landauer, double emulsion, less sensitive on one side (high dose), more sensitive on opposite side (low dose). Utilized plastic and aluminum filters, highly resistant to water damage, light and durable.

CY: Question is the film's ability to detect low dose under the conditions; Kodak produced in lots, 6 month shelf time, retained information on lots; each lot was characterized and controlled separately including inherent optical density (OD) (termed base fog). Gross OD upon receipt from Kodak was from .2–.23, and increased with time by about 6 millirem equivalent/month. Shipped 200–250K control badges per month.

CY: For high energy gammas (above 250 KeV), OD was converted according to a step function (not a Gaussian distribution). The minimum increment in OD on the densitometer corresponded to 6 mR. So doses would be 6, 12, 18, 24 mR. The minimum reportable dose (also referred to as the limit of detection (LOD), of 10 mR was not defined by a statistical basis; rather, Landauer adopted the convention that doses less than 10 mR were not significant – so 9 mR or less was treated as 0, 10 or more treated as 10, and so forth. In other words, doses were reported in 10 mR increments (no

intermediate doses) even though the densitometer was "calibrated" to 6 mR increments. Note that there were very few 0s and 10s. Note that for lower energy x-rays, the system was capable of detecting 3 mR (step function of 3, 6, 9, 12 mR…). Thus, actual doses of 9 mR were detectable but not reported as such. In summary, Landauer didn't have a separate detection limit for every energy – not practical at the time.

CY: DOELAP accreditation guidelines for determining the lower limit of detection (LLD) for a counting system were based on Poisson statistics, such that the Type 1 and 2 error rates (false positive and false negative, respectively) were both controlled at 5 percent. Film for high energy exposure has a LLD of 12–14 mR; thus, 95% of time will get 10 or 20 when exposed to 12. At an exposure of 9, it would look to us as 6 or 12, so 50% of time would look like 10. CY indicated that he has ever seen an LLD of 20 mR for Landauer.

CY: On customer control badges, Landauer accounted for change in base fog not accounted for in Landauer's own control badges. Would use customer controls and ours – adding or subtracting depending on the difference; but would also have in-house control as reference point, done on monthly basis. Shelf life of film long but limited use to one month; but film could sit at Landauer for 6 months and possibly an additional 6 to 7 months at Kodak; but film emulsion was pretty robust. Film unchanged all the way through early 90s (from 70s).

JS: So 95% a 10 would be a real positive? CY: Yes.

JS: So our concern was that in a high gamma field, 10 mR might not be detectable, but what you are saying is that we would still have a 95% change of detecting a true exposure at that level.

CY: Now other thing is if see lot of controls, will have variation, but always assumed negative numbers were zero, so biased high. Everything equal to the control or greater.

JZ: My concern was with x-ray… (repeated his prior argument for CY) so with high energy, it was very much at the limits of the resolution of the system; very easy to miss an 18 at some occasions.

CY: With x-ray have overresponse, have to correct for it with filtration.

BF: Age of film doesn't change the sensitivity? CY: Correct, because of accounting for increased base fog/time at Landauer and adjusting for differences between customer and Landauer control exposures.

Based on the forgoing discussions, SC&A is satisfied that the minimum reported dose of 10 mR for Landauer film, for the period of use in question at Pinellas (1974 to 1979), has a sound scientific basis, and recommends that sub issue 5 be closed.