HETA 2003-0206
Evaluation of Radiation Exposures to U.S. Baggage Screeners

Peer Review Comments

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List of Abbreviations (not all are used in this document)

ACGIH®	American Conference of Governmental Industrial Hygienists
ALARA	As low as reasonably achievable
BOS	Logan International
BWI	Baltimore/Washington International
CAT	Computerized Axial Tomography
CBP	Customs and Border Patrol
CFR	Code of Federal Regulations
Cs	Cesium
CV	Coefficient of Variation
CVG	Cincinnati/Northern Kentucky International
DOE	Department of Energy
EDS	Explosive Detection System
FAA	Federal Aviation Authority
FAQ	Frequently asked questions
FDA	Food and Drug Administration
HHE	Health hazard evaluation
HNL	Honolulu International
IARC	International Agency for Research on Cancer
ICRP	International Council on Radiation Protection
LAS	McCarran International
LAX	Los Angeles International
LOD	Limit of detection
MDT	Harrisburg International
MIA	Miami International
NCRP	National Council for Radiation Protection
NIOSH	National Institute for Occupational Safety and Health
NRC	National Radiation Council
OEL	Occupational exposure limit
ORD	Chicago O'Hare
OSHA	Occupational Safety and Health Administration
OSL	Optically simulated luminescence
PBI	West Palm Beach International
PEL	Permissible exposure limit
PHL	Philadelphia International
PVC	Polyvinyl chloride
PVD	T.F. Green International
REL	Recommended exposure limit
Rem	Roentengen equivalent man
SI	Système International [International System]
TRX	Threat Image Protection Ready X-ray
TSA	Transportation Security Administration
TWA	Time-weighted average
μR/h	Micro Roentengen per hour

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Reviewer 1

1. I would recommend expansion of the introduction to include more details in areas relevant to the two objectives listed at the top of page 2. Specifically, more details on the carry-on baggage screening equipment would be useful. Are there several different types of machines used for carry-on screening? Compare and contrast the potential for radiation exposures between the carry-on and checked baggage machines in terms of both work practices and radiation energies used. A few pictures in this section would be helpful.

2. Perhaps NIOSH should begin this section by describing the nature of an HHE and how it is used. For example, some readers may expect the type of design (randomization, power calculations, etc.) that is typical of a peer-reviewed research study. However, despite the limitations of a typical HHE, the results must be representative of situations that will be addressed in the recommendations. In this respect I am not entirely sure that the methods as described are adequate. A better description of how the 12 airports were selected should be added. Perhaps a table could be added that would show airport characteristics such as number of TSA screeners, types of machines used, machine locations, and existence of radiation protection training or programs. This might suggest useful comparisons that could be made between or within airports.

3. Since one of the most important aspects of this HHE was to characterize the potential for radiation exposure above background due to machine design or work practices, efforts should have been made to compare the outputs of each machine (4 EDS and how many TRX machines?) in a systematic way. Perhaps this was done but the description of "spot checks" and the personal dosimetry data collection is very sparse. It would be valuable to see a table of spot check data and dosimetry organized by each type of machine, as well as the protocol used for spot checks. For example, were measurements made at consistent locations for each machine and airport? Were they ever moved during the survey?

4. With regard to dosimetry, a better description of how 6 airports were selected, as well as number and type of screening workers measured would be valuable. Was the variation in numbers reported in Figure 3 due to airport size, proportion of volunteers, those who adhered to protocols, presence of an existing dosimetry program, or other factors?

5. The list of organizations with recommended radiation exposure limits is helpful, but no indication is provided on which limits were used in this study. The section on page 13 indicates that the FAA adopted ACGIH limits, but then says that TSA is subject to OSHA regulations. I'm not sure what this means with regard to a worker who may periodically experience a leaking machine or high exposure scenario related to a baggage jam.

6. The section on health effects will not be very useful to TSA managers or workers. The workers have essentially zero chance of an acute radiation effect. The paragraph on chronic effects just says that these effects are still being studied. It would be more helpful to cite the recent BEIR VII report where the linear no-threshold model is endorsed. Although the LNT model assumes that there is some

elevation in risk due to any exposure above background, the report could state that this excess risk of cancer is extremely small for the dose ranges measured in this study.

7. Although Table 2 provides conversions from mrem to mSv, the body of the report generally uses units in mrem. I have no problem with this, but many scientific organizations and journals require SI units whenever possible.

8. The primary handicap in statistical comparisons and reporting summary statistics was the fact that over 80% of measures were below the LOD of 1.0 mrem. Therefore, it appears that any statistical comparisons made between checked and carry-on screeners was based upon the proportion of measurements above the LOD. This should be stated in the tables.

9. While the tables reporting percentiles from the 50^{th} to 99^{th} are helpful, the real issue in question seems to be the maximum values found. It is clear that "typical" exposures are very low, but what caused the high measurements sometimes recorded? A statement on page 11 that "It was not technically feasible to determine exposure profiles for badges with doses less than 100 mrem," is confusing.

10. Other than attempts to exclude high measurements for deliberate tampering, were actual high measurements systematically linked to work practices or machine characteristics?

11. The description of walk-through surveys on page 16 hints at the potential causes of high dosimetry results, but I could not find any attempt to verify these observations using personal monitoring data. Page 18, mentions data on baggage throughput at 3 airports, but I could not find any statistical results linking throughput to high dosimetry measurements.

12. The potential for high exposure seems to be related to baggage jams. If possible, it would be very useful to report means and ranges for radiation levels from either real-time measurements or personal dosimeters when baggage jams were known to occur.

13. For personal dosimeters, it may be possible to make comparisons for airports or workers where baggage jams were common relative to workers or airports where they were rare.

14. With regard to deleting some "non-occupational" exposures, were they only deleted if the worker was undergoing nuclear medicine treatment, if tampering was found, or if exposure was "static?" If values were deleted for other reasons, this should be mentioned.

15. I would recommend that doses less than the LOD should be reported as such, not as "zero" doses.

16. The discussion seems to focus on the median or "typical" dose for baggage screeners. In my opinion, the atypical workers are of much more interest. As mentioned earlier, more effort and discussion should be focused on the reasons for periodic high measurements. Could the machines be designed better to reduce or eliminate the chance of bad work practices? Can baggage jams be cleared effectively and in a timely fashion without producing potential high dose scenarios?

17. I think the NIOSH recommendation that routine dosimetry is unwarranted is not supported by the data. It is clear that a combination of poor machine design and maintenance, together with bad work practices can result in unnecessary radiation exposures. As the report mentions, most radiation departments in large medical centers with similar exposure potentials maintain dosimetry programs. Until machine designs improve and effective ways to quickly deal with baggage jams are incorporated, a dosimetry program could be a valuable tool to identify both workers and scenarios

that have higher exposure potential. Requiring baggage screeners to wear dosimeters may also help to reinforce in their minds that the potential for over-exposure exists.

Reviewer 2

1. I am somewhat bothered by the reporting of the median doses, since in almost all cases they were zero (really, less than detectable). After reading the Summary on page v, I was a bit taken aback by the maximum doses reported in Table 6, Page 25.

2. A colleague and I investigated the results (as best we could from the summary data presented), and it appears that the individual airport and composite results are all lognormally distributed. (This can be done using censored (less-than) values.) We found that the median monthly dose is really about 0.1 mrem from Table 5s and 6 (which is below the limit of detection) and the mean monthly dose is about 0.6 mrem. (And, we also found that LAX and BOS are higher than the other airports.) The geometric standard deviation of these distributions is quite large (7 to 8). I might suggest that a brief analysis using the assumption of lognormality be added in the cumulative data analysis section around page 29 – 30. I think that this would show that the likelihood of annual doses exceeding 100 mrem is much less than 0.1%, which would strongly support the later conclusion that monitoring is not required.

3. If I understand the first bullet on page 36, line 801, you are suggesting some follow-up measurements using personal dosimeters. This is rather subtly worded, and could be interpreted as recommending that dosimeters be used – which seems to contradict the conclusion on line 772, page 35. This could also be interpreted as a call for "more science" to fund the researchers, since they've already said it isn't needed. This proposal for more research could be coupled with the discussion I've suggested above regarding determination of the lognormality of the dose distribution, which might make it both more palatable for funding agencies and less intimidating for the workers.

4. This is actually well written and understandable, except perhaps for the use of the median doses as a basis for discussions. Some might interpret the emphasis on the "zero" results to be a diversion from the maxima. The "big" doses certainly draw the reader's attention. A way of emphasizing the unlikely (and probably spurious nature) of these "big" numbers would help.

Reviewer 3

1. Table 2, page 13 – background is 0-20 μR – state over what time period.

2. The report is thoughtful and thorough. However, I am concerned about the several high doses reported to several workers (some near or over 500 mrem, including one near 1000 mrem). Based on the levels expected, and those recorded for the vast majority of handlers, I would think that routine badging of these employees would not be warranted from a radiation protection standpoint (although it might be instituted in some cases simply to communicate a culture of safety and reassure the workers, especially if requested). The report suggests further investigation of these high values, to see if they may have been due to tampering, nuclear medicine or other medical exposures, etc. and I agree. However until this is resolved, I don't think that routine badging can be categorically ruled out. If it is poor work practice, leaky devices, or other situations leading to real exposures of this level, badging may be necessary in some cases. These are not doses that are particularly worrisome, but certainly ones that should be recorded. If they are due to tampering or other non-work-related causes, this should be determined and a way to avoid this should be sought.

3. Page 13-14 – the more up to date terms 'stochastic' and 'nonstochastic' should probably be used.

4. Some of the manufacturing defects found in certain machines (page 16) could be cited in the executive summary.

5. Page 23 – the number of significant figures in the average background number is excessive.