



RADIATION PROTECTION SERVICES



Representativeness of Air Samples

**Dennis Hadlock CHMM, RRPT, CHP
Washington Savannah River Company**

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- **Why a representative sample?**
- **Examples of what is/is not representative.**
- **Regulatory guidance on the definition of representative.**
- **Guidance to determine if your sample is representative.**
- **Use of Bioassay to verify representativeness.**
- **Selected studies on representative sampling.**
- **Savannah River Site implementation.**

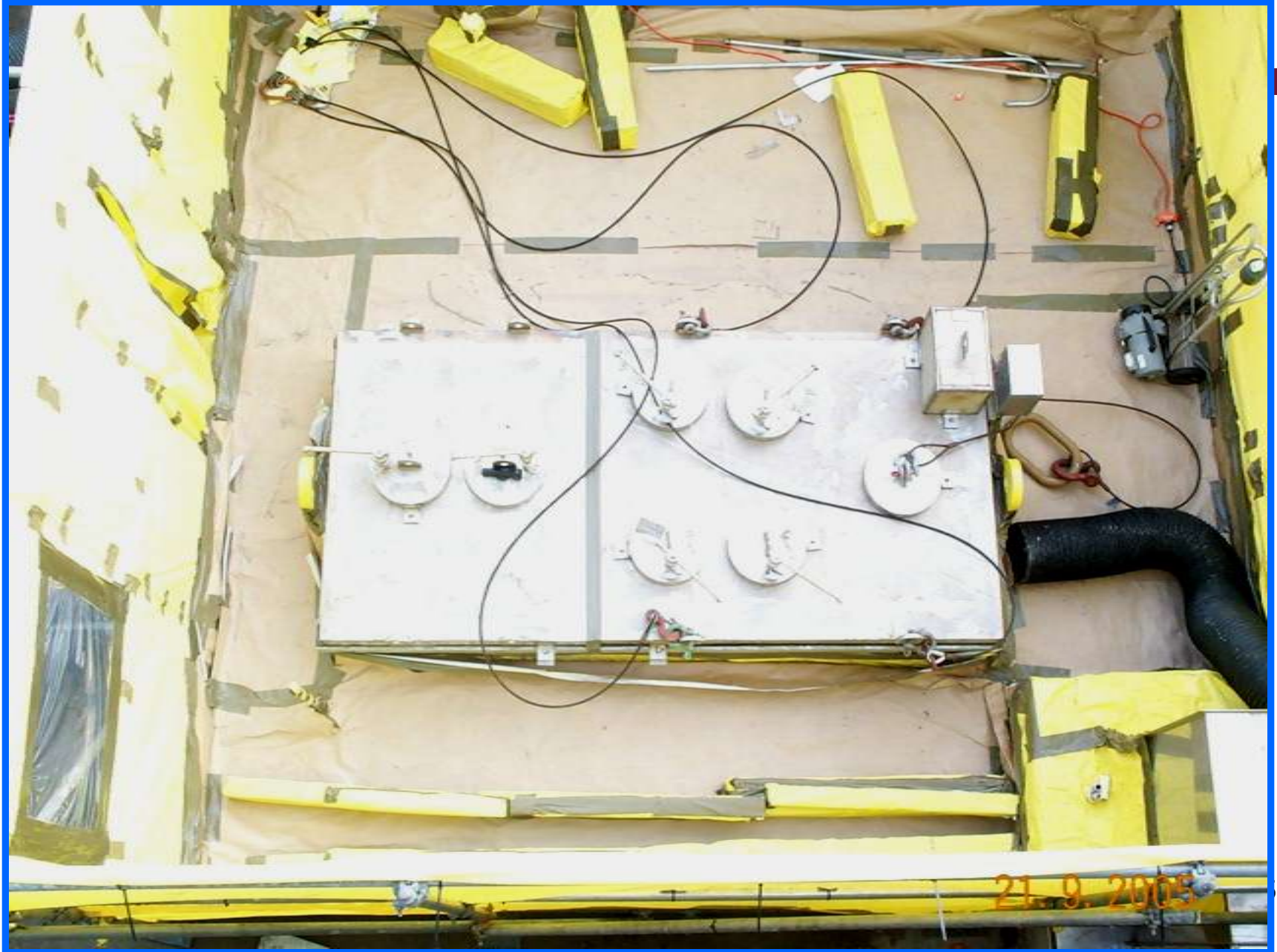
Need for a Representative Sample

- **It is imperative that you be able to obtain a good estimate of what the worker was exposed to so that you can verify that the Personal Protective Equipment (PPE) assigned was adequate.**
 - **If inadequate, then you can pursue proper follow-up actions to determine the extent of exposure (e.g., special bioassay sampling for radionuclides).**

What is a Representative Sample?



What is NOT a Representative Sample?



Definitions for Representative

- **When looking up a definition for representative, you will find definitions for both representative and breathing zone samples.**
 - Breathing zone sample is typically defined as representative.
- **Several agencies and organizations have tried to define these terms.**
 - DOE, NRC, ASTM, ANSI

Definitions for Representative

- **NRC:**
 - **Regulatory Guide 8.25**
 - *The results from lapel samples and air samplers located within about 1 foot of the worker's head may be accepted as representative without further demonstration that the results are representative.*
 - **NUREG 1400**
 - *If the sample is taken with a lapel sampler, then it is considered representative of the air breathed by the worker*

Definitions for Representative

- **DOE: DOE G 441.1-8**
 - *The sampling of airborne radioactive material in a manner such that the sample collected closely approximates both the amount and the physical and chemical properties (e.g., particle size and solubility) of the contaminant to which the individuals may be exposed.*
 - No reference to a distance or how to determine whether representative (as in the NRC guidance). This guide also defines Breathing Zone Monitoring.

Definitions for Representative

- **DOE: DOE G 441.1-8**
 - **Breathing Zone Air Monitoring:** *A form of air monitoring that is used to detect and quantify the radiological conditions of air from the general volume of air breathed by the individual, usually at a height of 1 to 2 meters. See “personal air monitoring”.*
 - You now have a height but no distance. Also have the situation where the definition sends you to another definition.

Definitions for Representative

- **DOE: DOE G 441.1-8**
 - **Personal Air Monitoring: *A form of breathing zone monitoring that involves the sampling of air in the immediate vicinity (typically within one foot) of an individual's nose and mouth, usually by a portable sampling pump and collection tube (e.g., a lapel sampler) worn on the body.***

Definitions for Representative

- **ANSI N13.1-1969**

- **Breathing Zone:** *The breathing zone is identified as that region adjacent to a worker's mouth and nostrils from which air is drawing into the lungs while he performs his assigned work. Air taken from this region will truly represent the air the worker is breathing while he works, whether standing, sitting or moving.*

Definitions for Representative

- **American Society for Testing and Materials (ASTM) D1356:**
 - breathing zone, *n* — that location in the atmosphere at which persons breathe.
- **Summary of Definitions:**
 - You need to get really, really close to the worker if you intend to take a representative sample, or you can try some other method to show that your air sample is, in fact, representative.

Determining if a Sample Other than a PAS is Representative

- **NUREG 1400 and RG 8.25 devote a good amount of text on this subject. The sampler must be in the breathing zone of the worker or use one of four suggested methods to demonstrate it is representative.**
 - **Compare fixed location [area/general sampler(s)] results with those of lapel samplers;**
 - **The ratio of intakes should be >0.7 when averaged for all workers and each individual result should be >0.5 .**

Determining if a Sample Other than a PAS is Representative

- **Compare fixed location (job specific samplers) results with those of lapel samplers.**
 - **Use multiple sample heads located in at least four locations around the workers head.**
 - **The ratio between the concentration for each sampler as compared to the average should be >0.7 .**
- **Use of quantitative airflow tests.**
 - **Release a tracer material near the release point; measure its concentration and the concentration with a sampler near the workers head location.**
 - **The ratio of the concentrations should be >0.7 .**

Determining if a Sample Other than a PAS is Representative

- Comparison of the sum of the intakes determined with air sampling to the intakes calculated from bioassay measurements.
 - The ratio of air sampling to bioassay should be >0.7 when averaged over all samples and each sample should have a ratio of >0.5 .
- Under specific conditions these methods may be useful to a Facility.
 - Let's pursue the comparison to bioassay a bit first.

Comparison to Bioassay Results

- **How many times have you heard this statement?**
 - “If my air sampling program was bad, I would see it in my routine bioassay program”.
- **Is this statement valid?**
 - All the time; Some of the time; None of the time?
- **We will use the SRS Internal Dosimetry Technical Basis Manual to see what we can see.**

Minimum Detectable Annual Dose for Routine Bioassay Program

	Urine (mrem)	WBC (mrem)	Chest (mrem)
HTO	10	-	-
<i>S</i> Co-60	-	5	-
<i>F</i> Cs-137	-	1	-
<i>S</i> Sr-90	212	-	-
<i>S</i> DU	116	-	783
<i>S</i> Pu-238	3975	-	70532

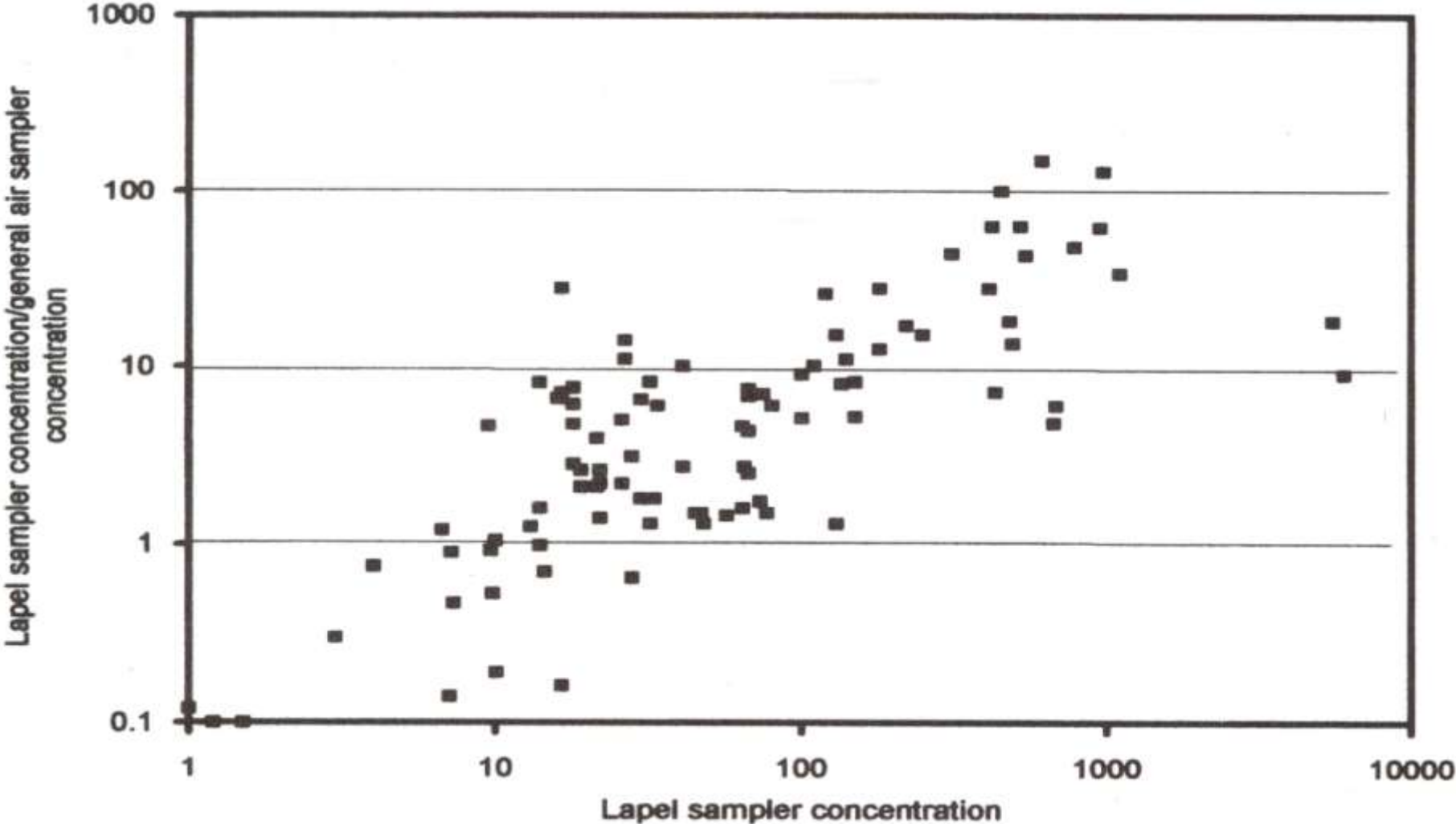
Minimum Detectable Dose for Special Bioassay Program

	Urine (mrem)	Fecal (mrem)	WBC (mrem)	Chest (mrem)
HTO	1	-	-	-
Co-60	-	-	1	-
<i>F</i> Cs-137	-	-	1	-
Sr-90	1	-	-	-
<i>S</i> DU	1	1	-	107
<i>S</i> Pu-238	260	1	-	9675

How Close is Close Enough?

- **“I don’t care what you say, that sampler over there has been good enough for 40 years and it is good enough today”.**
 - **It that is your story and your sticking to it; best of luck in defending it.**
 - **If nothing bad ever happens you can take samples that are not representative; if a tree falls in the woods...**
 - **What do some studies say about concentration gradients across a work area?**

Brunskill, RT.; Holt, FB, *Aerosol studies in plutonium and uranium plants at the Windscale and Springfields Works of United Kingdom AEA. Minutes of a symposium. Vienna: IAEA: Report No. SM-95/30' 1967:163-74-475*

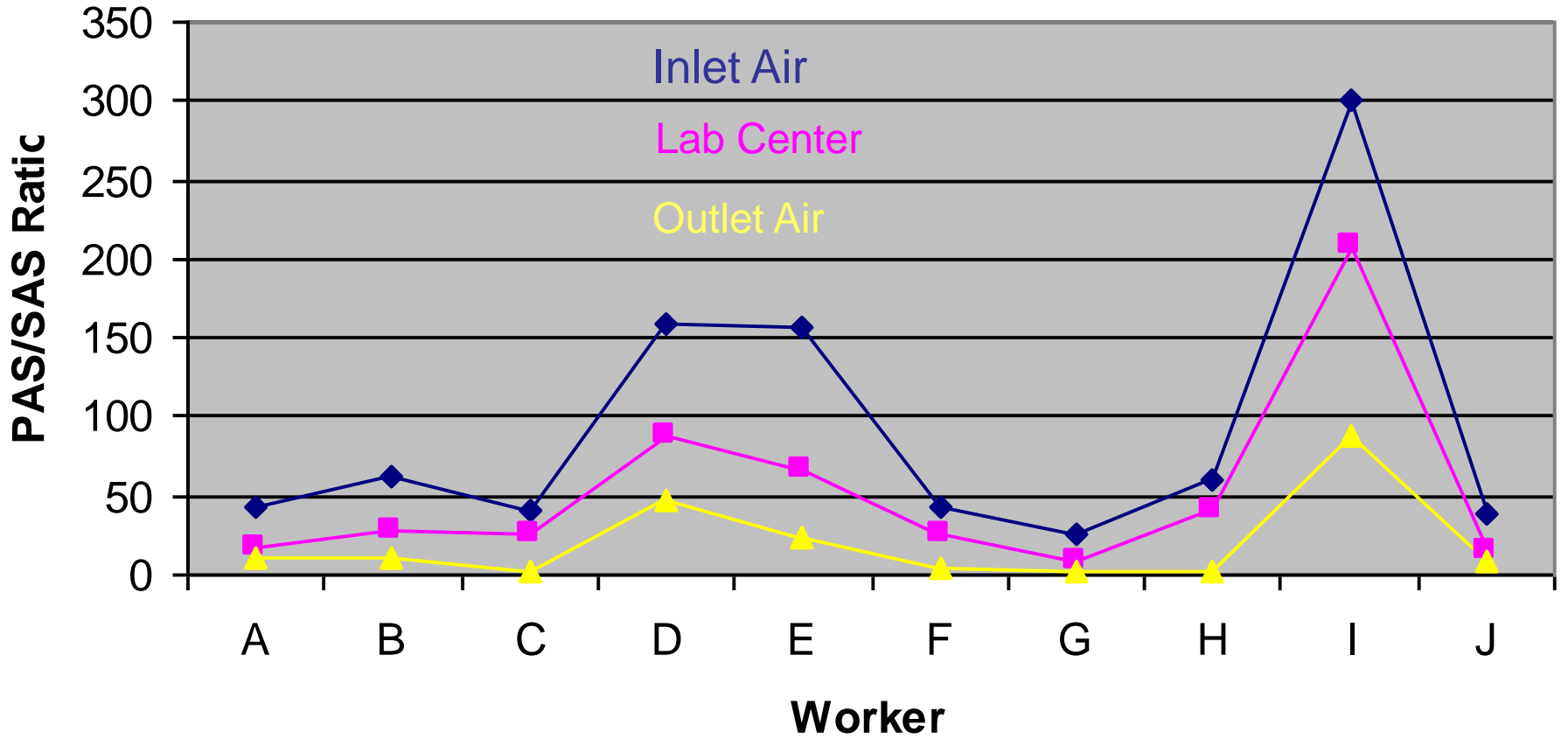


Langmead, W. A., *The Objectives of Air Monitoring and the Interpretation of Air Sampling Results*, Proceeding from Radiation Dose Measurements Symposium, June 1967

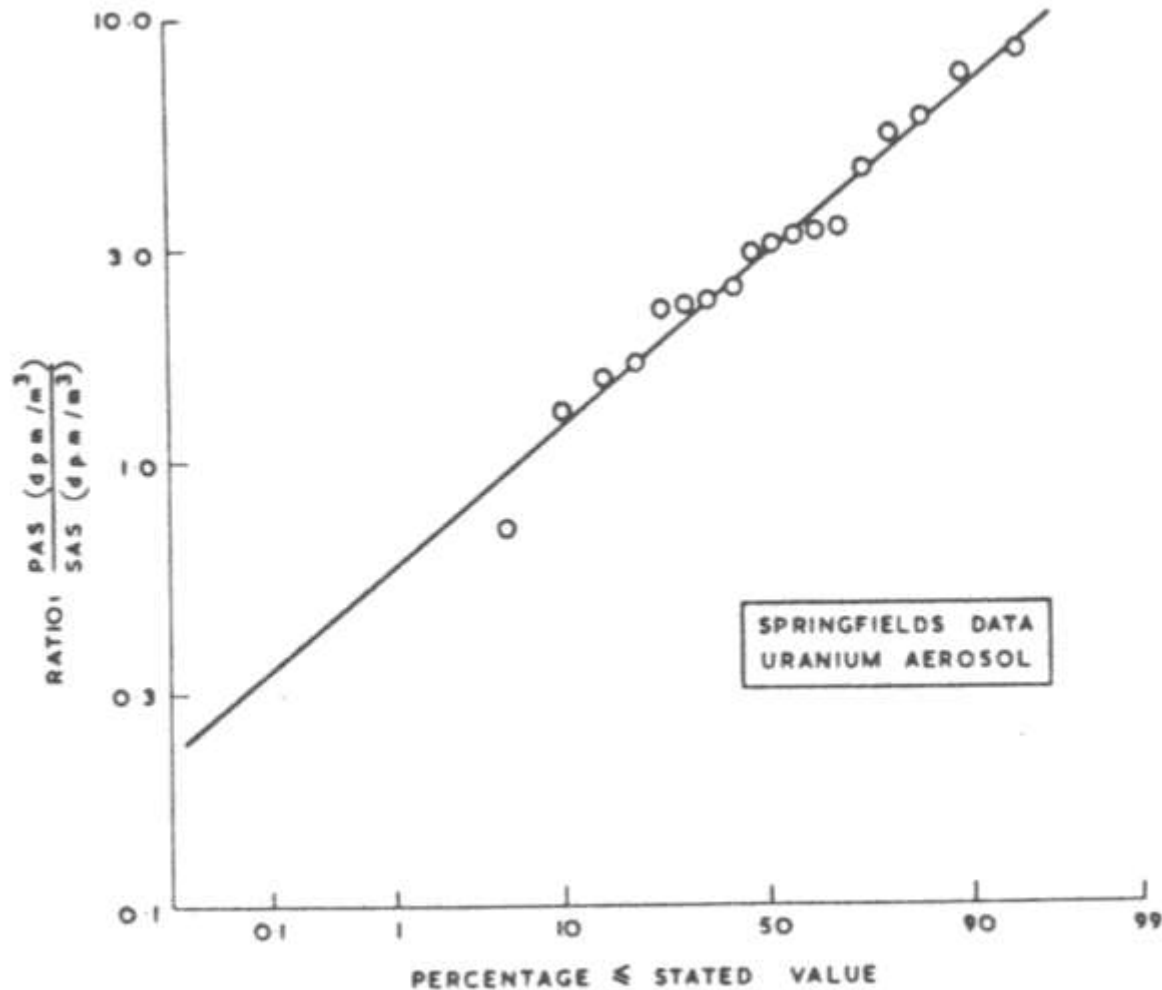
Staff	SAS Number and Position		
	Inlet Air	Lab Center	Outlet Air
A	43	17	10
B	62	28	10
C	40	26	3
D	159	89	47
E	156	67	24
F	42	26	5
G	25	8	3
H	60	40	3
I	301	209	89
J	39	15	9

$$X = \frac{C_{\text{Avg}} \text{ PAS over 9 months}}{C_{\text{Avg}} \text{ SAS over 9 months}}$$

Graphical Representation of Langmead's Data

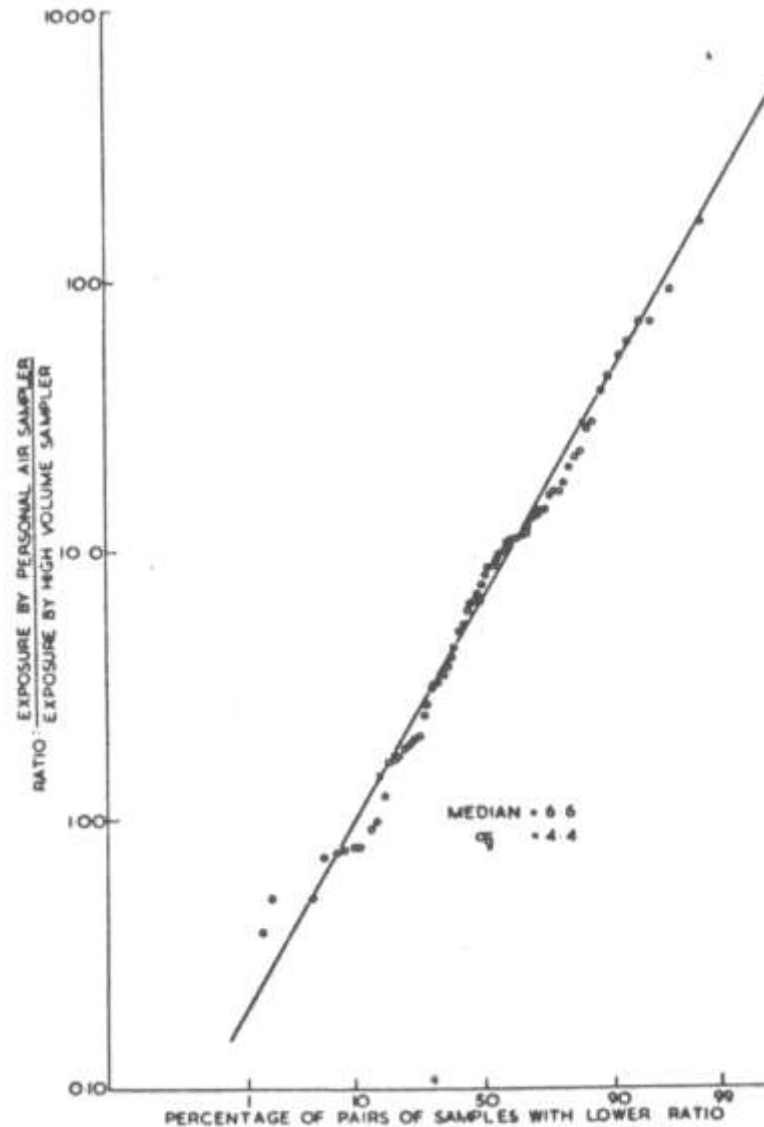


Langmead, W. A., *The Objectives of Air Monitoring and the Interpretation of Air Sampling Results*, Proceeding from Radiation Dose Measurements Symposium, June 1967

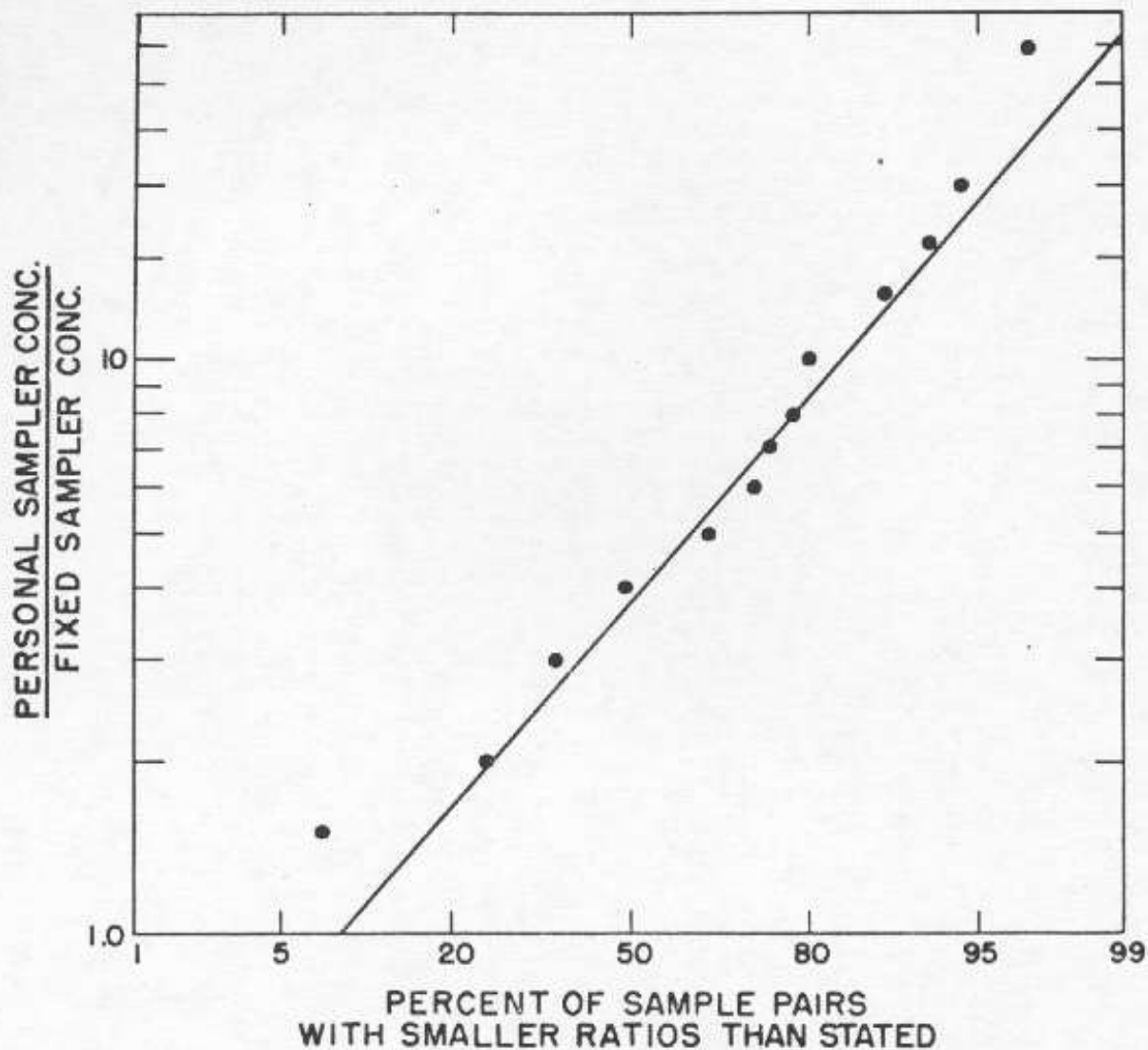


FREQUENCY DISTRIBUTION OF THE RATIO PAS/SAS

Langmead, W. A., *The Objectives of Air Monitoring and the Interpretation of Air Sampling Results*, Proceeding from Radiation Dose Measurements Symposium, June 1967



Schulte, H. F., *Personal Air Sampling and Multiple Stage Sampling; Interpretation of Results from Personal and Static Air Samplers*, Proceeding from Radiation Dose Measurements Symposium, June 1967



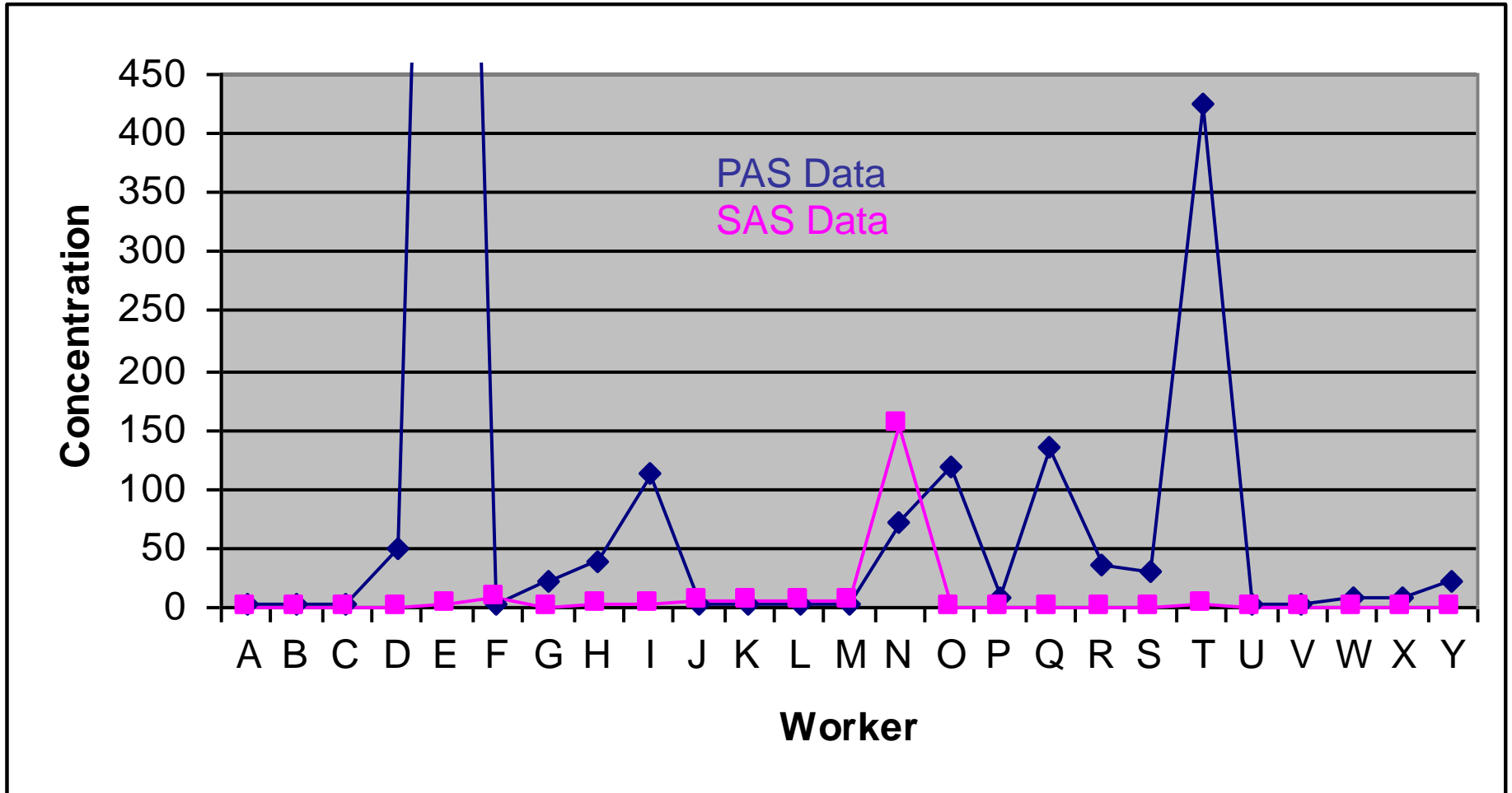
Mahathy, J. M., *Can Area Air Sampling be Used to Predict Personal Exposures?*,
 Radiation Protection Management, pgs 52-54, July 1986

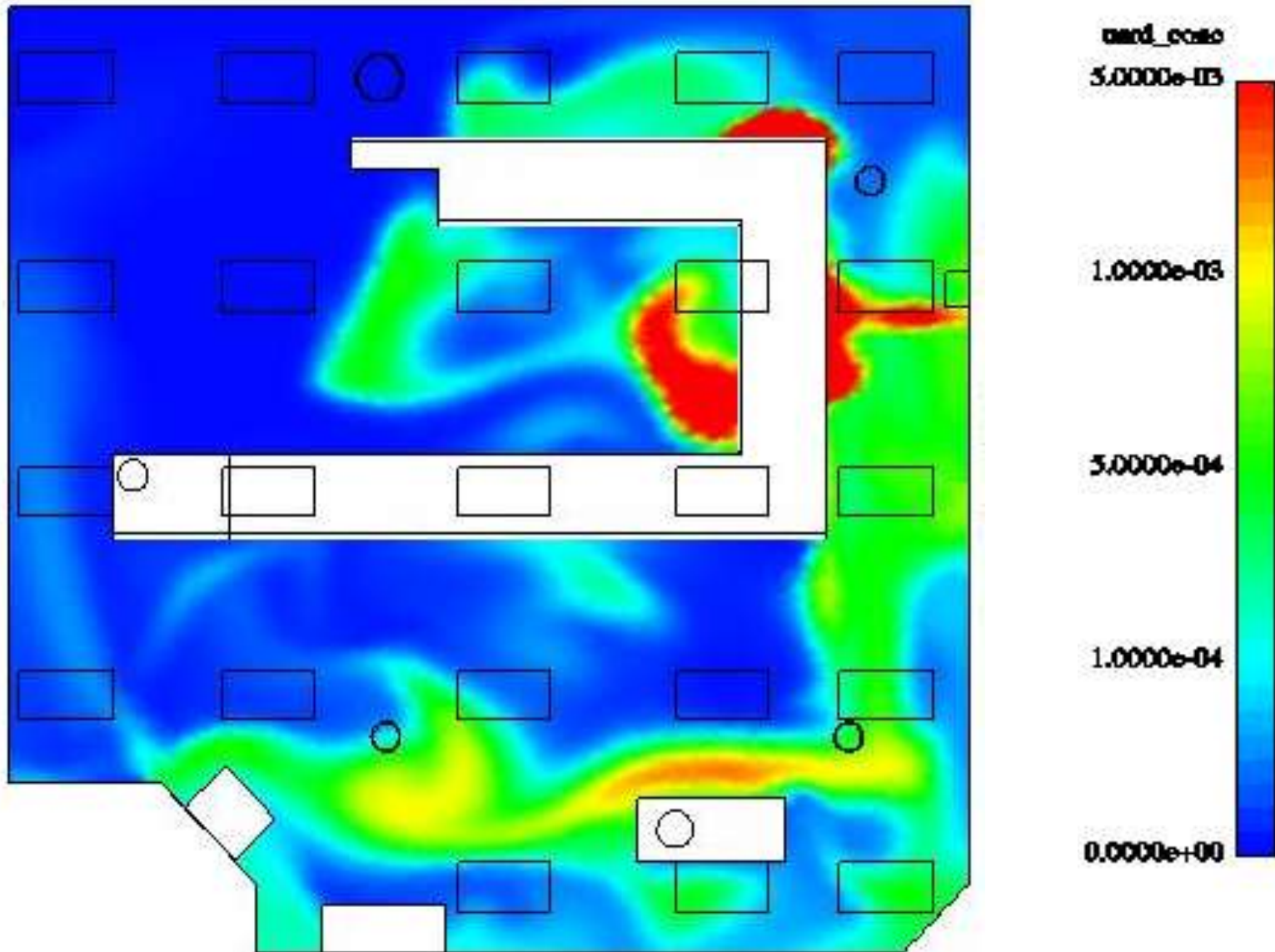
Obs	BZA	Area	Obs	BZA	Area
A	<2	1	N	71	155
B	<2	1	O	118	1
C	<2	0.3	P	7	0.1
D	51	1	Q	136	1
E	1510	3	R	37	0.1
F	<2	8	S	31	0.1
G	21	0.6	T	425	<2
H	40	3	U	<2	0.1
I	112	3	V	<2	0.1
J	<2	5	W	9	1
K	<2	6	X	9	1
L	<2	5	Y	21	1
M	<2	6			

**Results are
in dpm/m³**

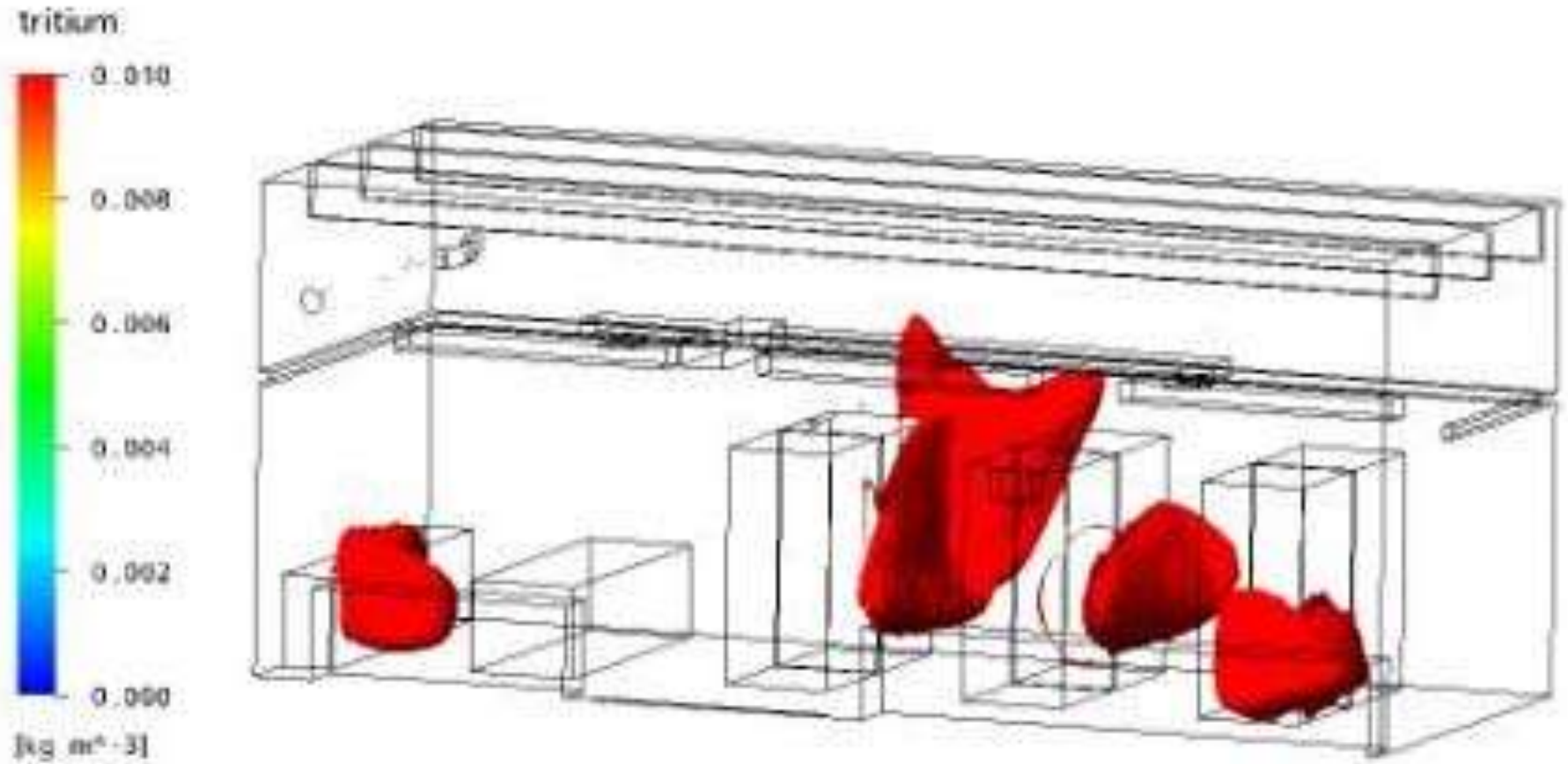
**U²³⁸ DAC
value is
44.4 dpm/m³**

Graphical Representation of Mahathy's Data

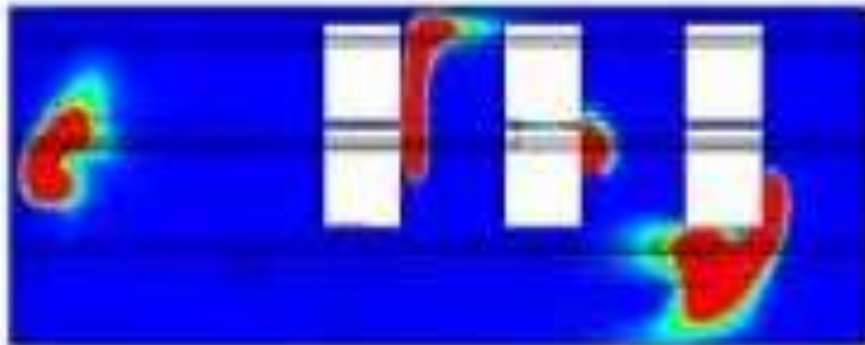




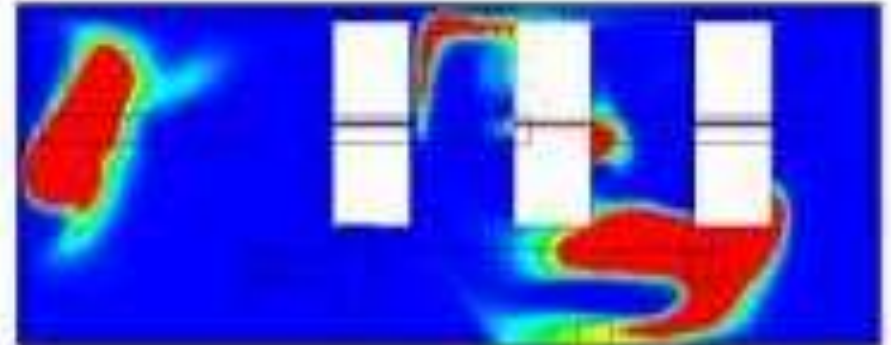
Whicker JJ, et. al., *Computational Modeling and Analysis of Airflow in a Tritium Storage Room*, LA-UR-03-0496, July 2003.



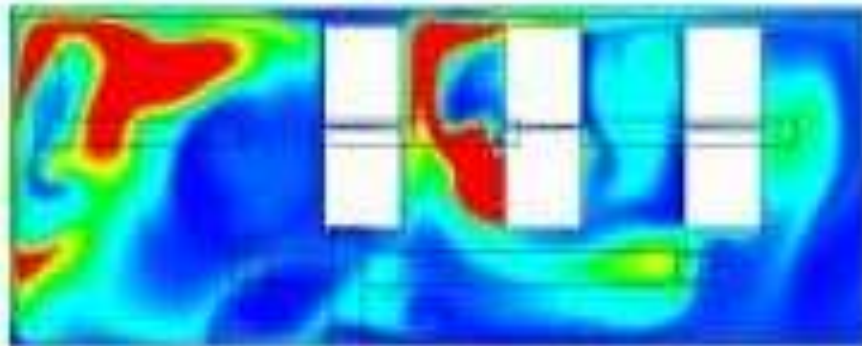
Whicker JJ, et. al., *Computational Modeling and Analysis of Airflow in a Tritium Storage Room*, LA-UR-03-0496, July 2003.



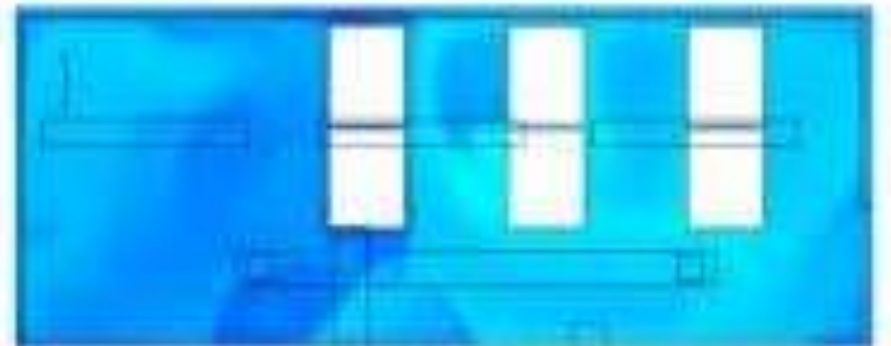
10 FRC



20 FRC



60 FRC



300 FRC

What Does This Data Mean?

- **If you really want a sample that is representative, e.g., an air sample that provides you with the best probability of sampling the same air the worker is breathing, you have to use a Personal Air Sampler placed within at least 12 inches of the workers mouth and nose.**
- **Anything else is just an approximation.**

SRS Approximation

- **At SRS a representative job specific air sample is required anytime a worker is wearing a respirator.**
- **PAS are required when:**
 - **PAS is the bioassay sample.**
 - **Validate the decision to not wear respirators for jobs where they were historically worn.**
 - **RCO assigns the PAS for the task**
 - **Large work area w/many sources of air activity**
 - **No ready power supply, etc.**

SRS Approximation

- **Representative air sampling is met when:**
 - **A PAS is used. By definition a PAS is a representative sample.**
 - **Source sampling is performed; by design this should overestimate the worker exposure.**
 - **The retrospective air sample head (filter paper) is located within 1 meter of the workers head.**

?? QUESTIONS ??

