

Use of Co-worker Data in Dose Reconstruction

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Reasons for Using Co-worker Data

- Worker was unmonitored and potentially exposed
- Worker was monitored but:
 - Data was lost or destroyed
 - Monitoring methods were not reliable
- Available data insufficient to complete a dose reconstruction

Sources of Co-worker Data

- Covered facility databases
- ORAU Center for Epidemiologic Research
- Comprehensive epidemiologic data resource (CEDR)
- Claimant data

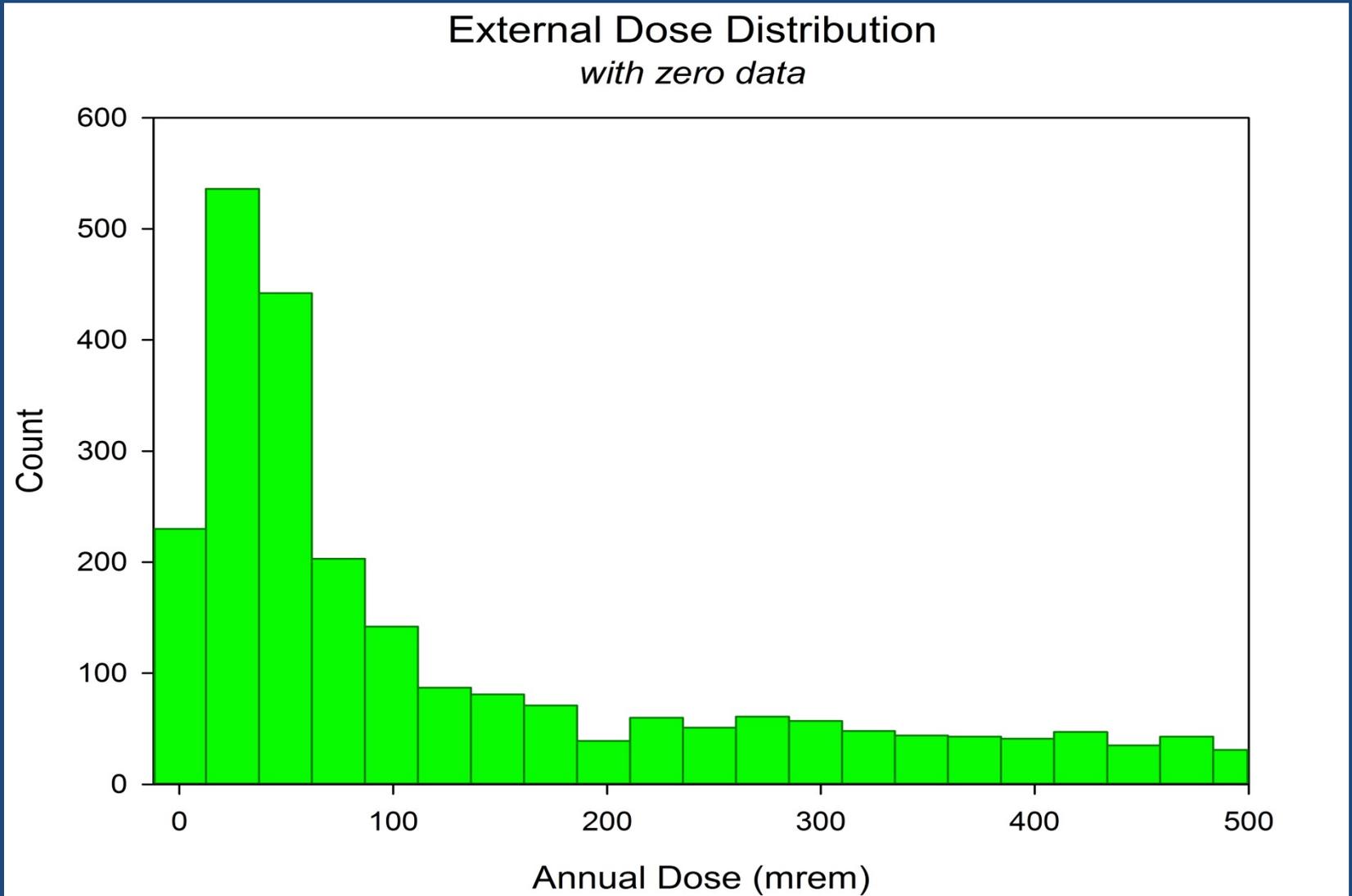
General Approach to Co-worker Evaluation

- Evaluate available data for monitored population
 - Conduct data pedigree review
 - Determine if measurement method is reliable
 - Establish that the monitored population is representative of the workforce
- Statistical approach described in ORAUT-PROC-0095

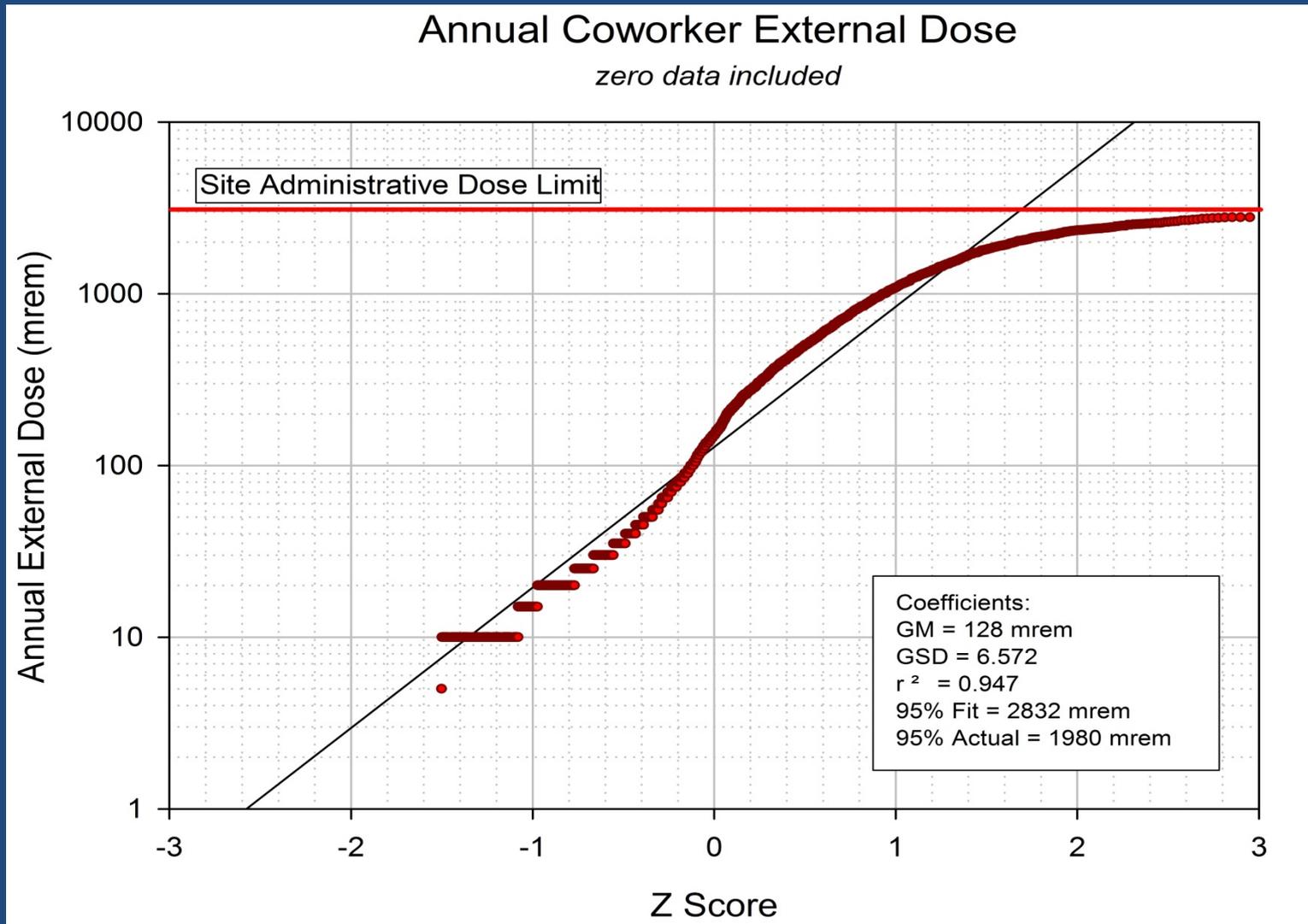
General Approach to Co-worker Evaluation—cont.

- Review data to determine if appropriate statistical distributions can be generated
 - Fit data to lognormal distributions
 - Group data as appropriate
 - Generate summary statistics and evaluate fit
- External co-worker models more straight forward than internal models

Example External Co-worker Distribution



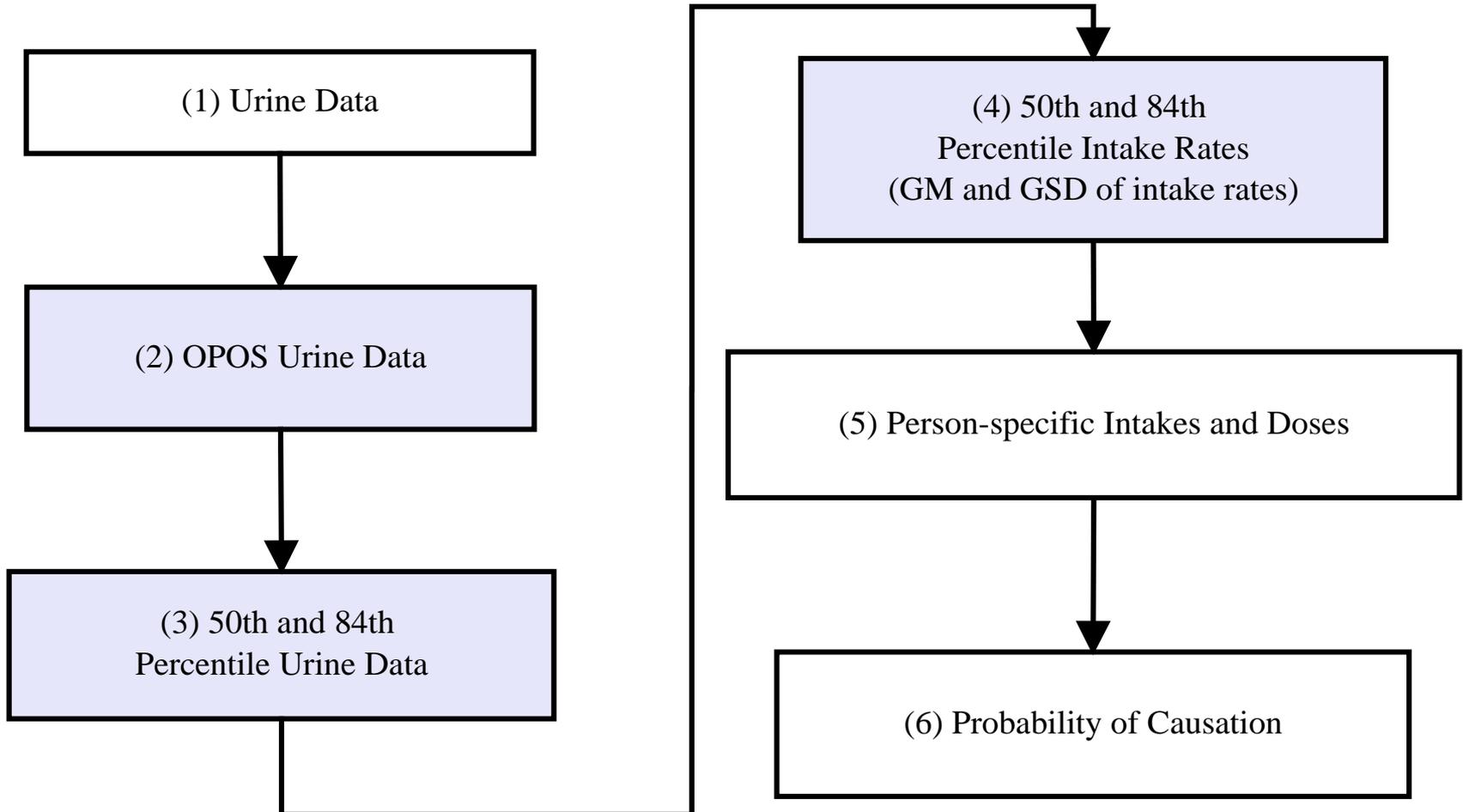
Example External Co-worker Data Plot



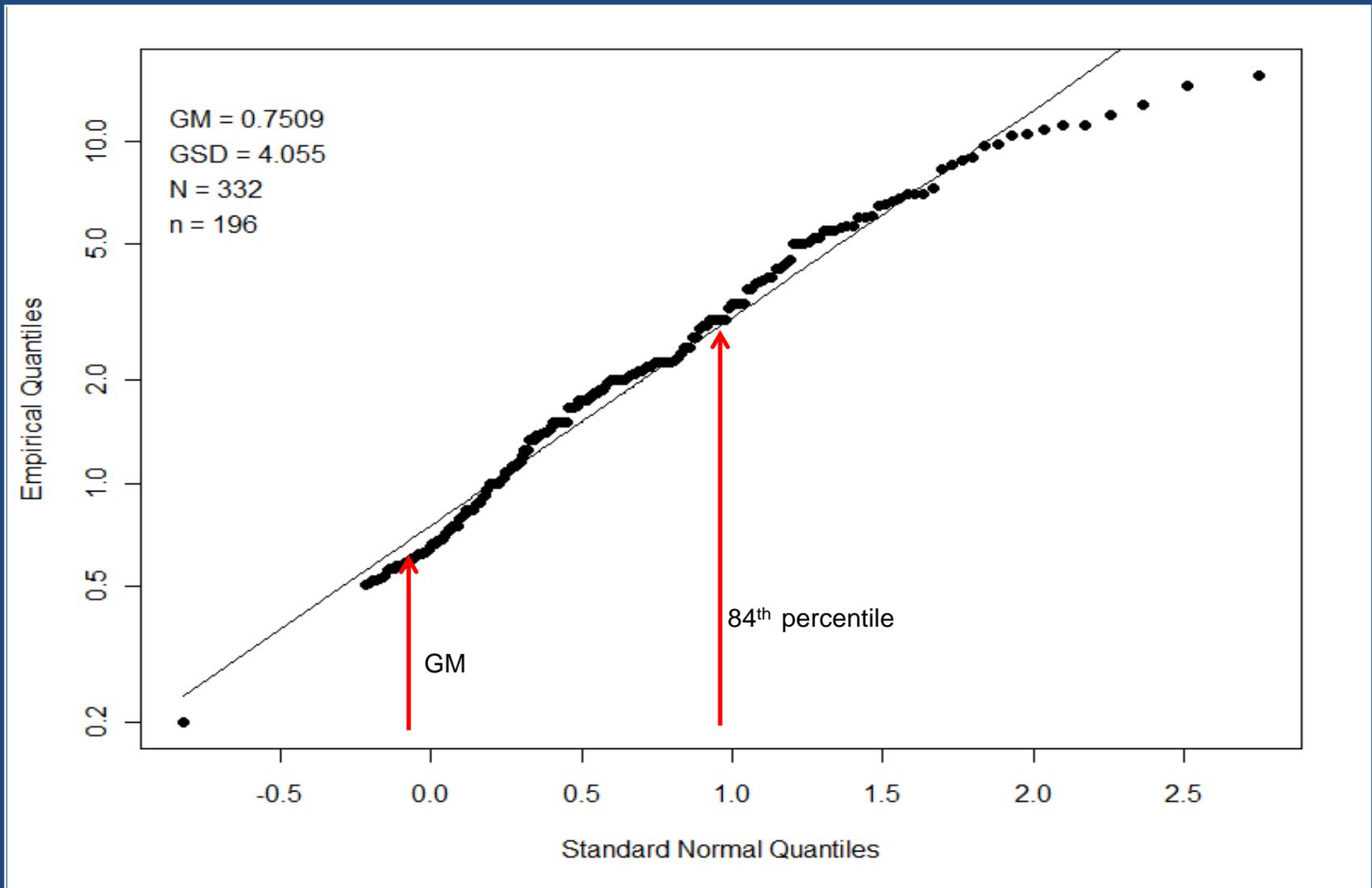
Complications of Internal Co-worker Modeling

- Often multiple bioassay results per monitoring period
 - Possible correlation of data
- Raw data must be converted to intake and dose
- Exposure pattern must be presumed
 - Accute, Chronic, mixed?

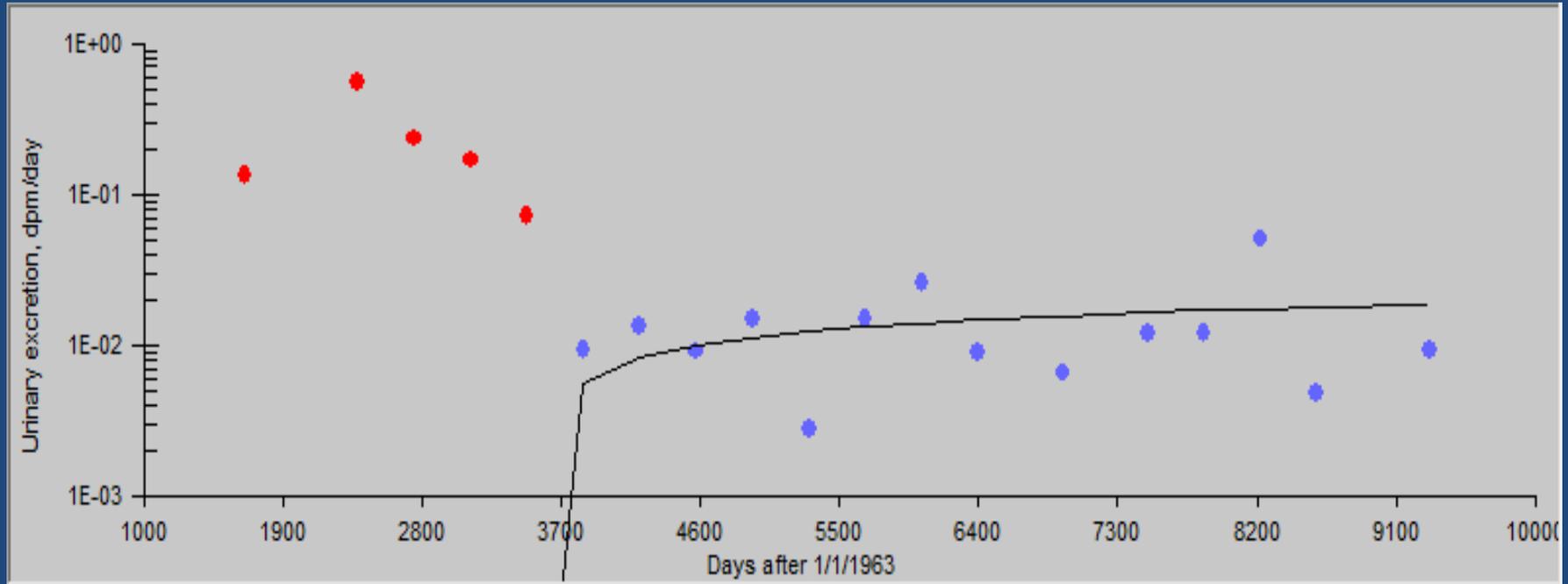
Summary of Internal Co-worker Model Calculations



Example Bioassay Distribution for a Single Year



Example Fit of Bioassay Data to Chronic Intake Scenario Over Multiple Years



IR1	<input type="text" value="9.861E-01"/>	dpm/d
+/-	<input type="text" value="2.222E-01"/>	dpm

Regression of median excretion rate on chronic Intake Retention Function

Co-worker Application

- Based on potential for exposure an unmonitored worker would receive either:
 - The full intake distribution (i.e., the 50th percentile and the Geometric Standard Deviation (GSD) as input parameters or;
 - The 95th percentile of the distribution input as a constant
- Each situation is evaluated on a site and case-specific basis
- Approach to evaluation of data stratification described in ORAUT-RPRT-0053
 - Introduces concept of one person one sample (OPOS)

One Person One Sample

- Minimizes issues related to correlated data
- Uses the Maximum Possible Mean (MPM) approach
 - Using MPM, censored data are taken to be a positive measurement, i.e., $<0.05 \text{ dpm} = 0.05 \text{ dpm}$

Example A: 10, 3, 5, 6

Mean = $24/4 = 6$ (report as 6)

Example B: 10, <3 , <5 , 6

Maximum Mean = $24/4 = 6$ (report as 6)

Example C: <10 , <3 , <5 , <6

Maximum Mean = $24/4 = 6$ (report as <6)

Data Stratification

- Monitored population is really a conglomerate of a number of subgroups
- Single distribution can be applied to unmonitored workers if:
 - Highest exposed workers were monitored or
 - Representative sampling of the exposed workers was conducted
- If stratification suspected, can be statistically evaluated
 - Monte Carlo Permutation Test
 - Peto-Prentice Test
 - Must consider the effect of multiple comparisons

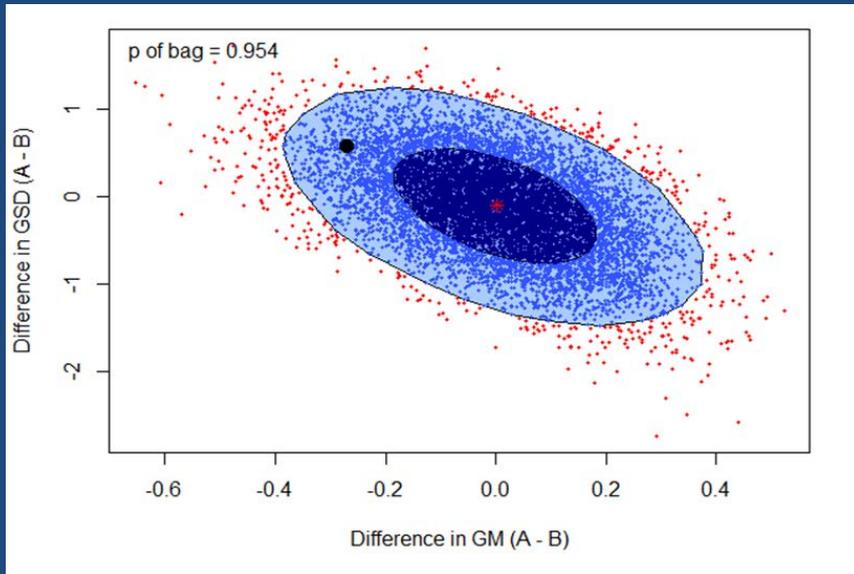
Monte Carlo Permutation Test

- ***Assumptions:***
 - Data can be described by a lognormal distribution
 - Data is not heavily censored
- **Stratify data using an *a priori* criterion**
 - Construction workers vs. non-Construction workers
 - Area 100 workers vs. Area 200 workers
- **For each strata calculate the Geometric mean (GM) and Geometric Standard Deviation (GSD)**

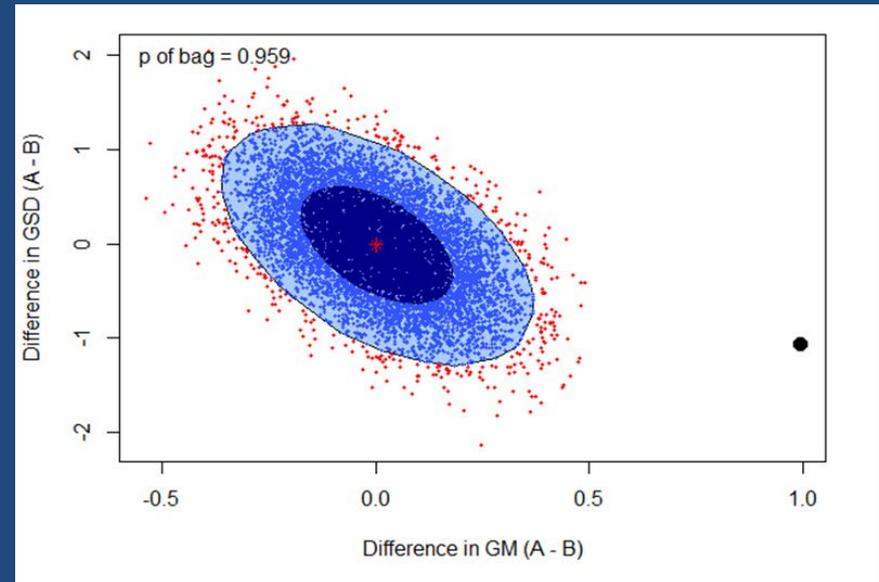
Monte Carlo Permutation Test—cont.

- Calculate the difference in the GM and GSD between strata
 - These differences comprise one data point with (x,y) coordinates
- Random Sample
 - Combine all data and randomly pull samples without replacement equal to the size of one strata
 - Calculate GM and GSD of each random strata
 - Calculate and plot the difference in GM and GSD
 - Repeat 10,000 times

Monte Carlo Permutation Test—cont.



Not significantly different



Significantly different

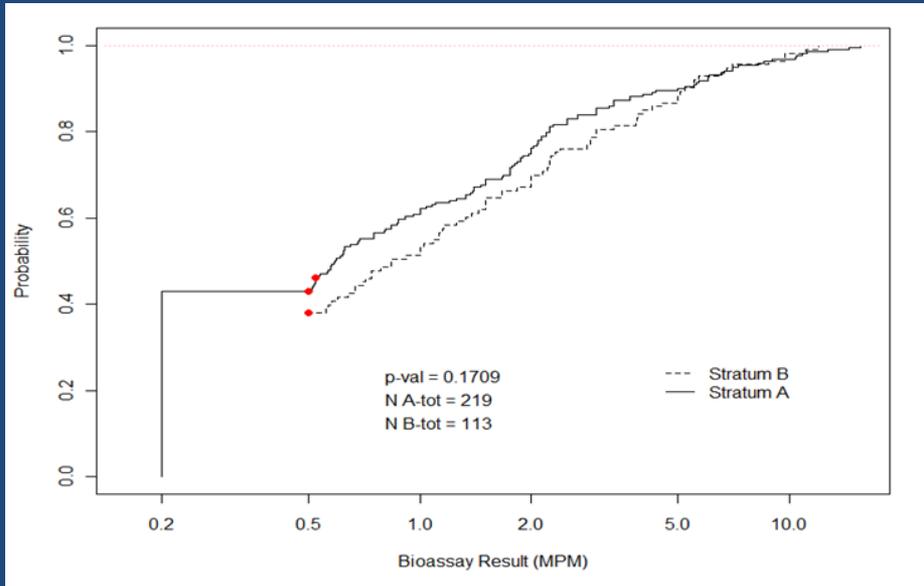
Monte Carlo Permutation Test—cont.

- **Benefits**
 - Can easily compare whether different size strata are significantly different
- **Limitations**
 - Requires some *a priori* decision on distribution
 - Doesn't work if data set is heavily censored
 - Too many random pulls of zero
 - Peto-Prentice Test is more appropriate

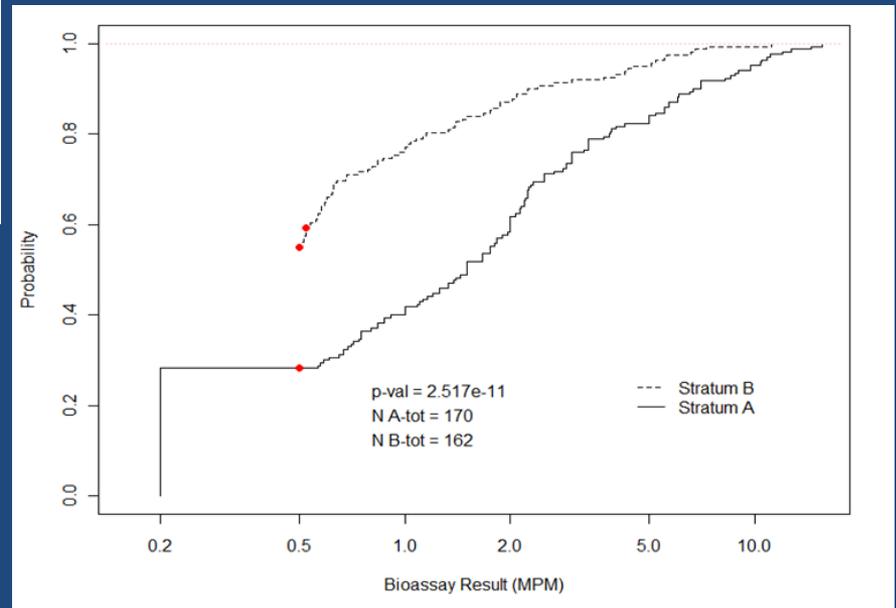
Peto-Prentice Test

- **Advantages**
 - Non-parametric – i.e. no *a priori* distribution assumption
 - Can handle censored data sets
 - Can compare whether different size strata are significantly different (p-value)
- For cases where both the Monte Carlo and Peto-Prentice are applicable, they typically lead to the same conclusion

Peto-Prentice Test—cont.



Not significantly different



Significantly different

Summary

- **Co-worker models can be used to reconstruct doses to unmonitored workers if:**
 - Highest exposed workers were monitored or;
 - Representative sampling of the exposed workers was conducted
- **Data must be carefully reviewed for applicability**
 - Data quality and representativeness
 - Potential for stratification
- **One person one sample approach is useful in normalizing data**
- **Stratification can be evaluated using standard statistical tests**