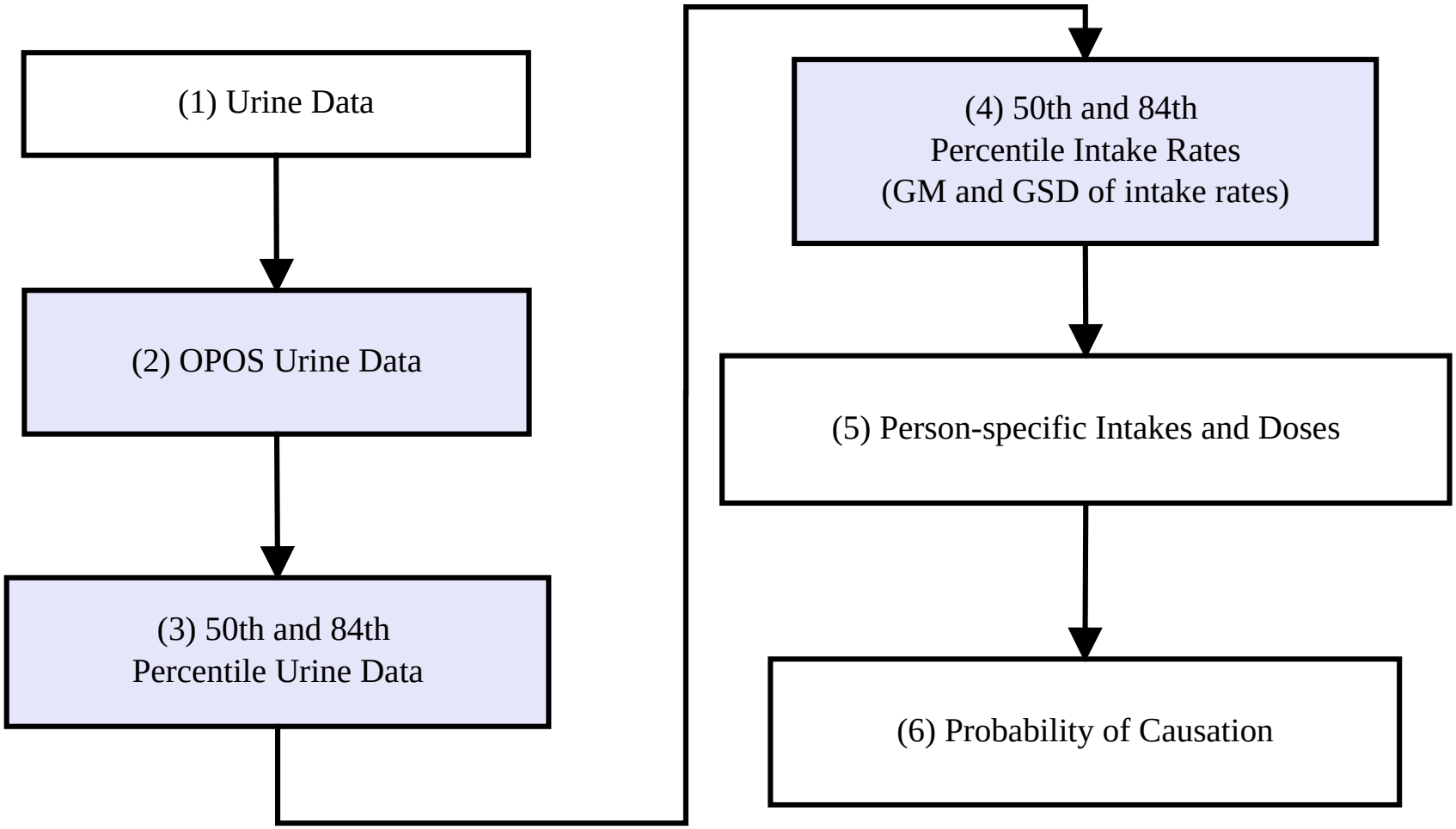
Use of Bioassay Sample Data in Co-Worker Models

Summary for SEG WG Meeting

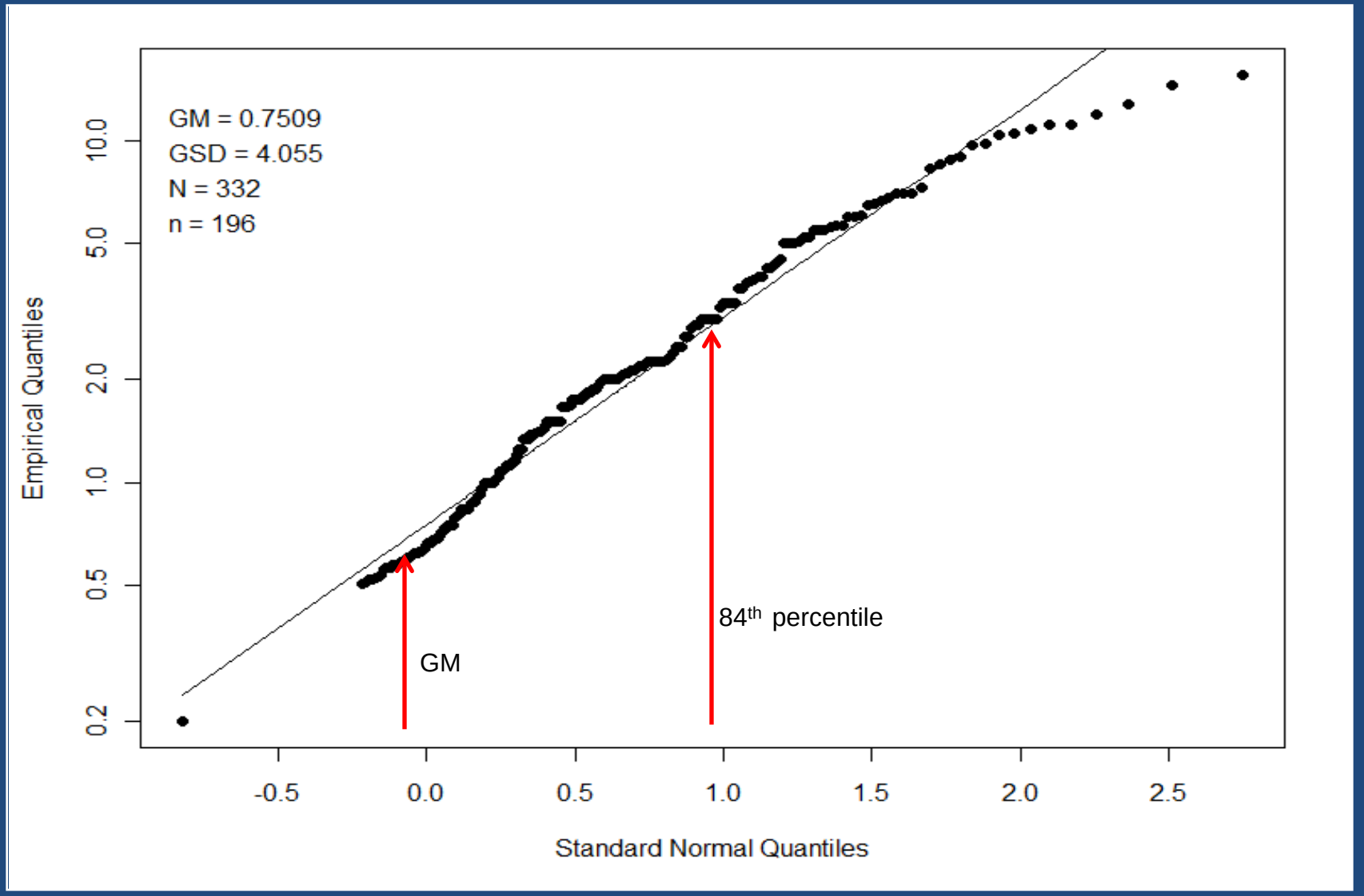
James W. Neton, PhD, CHP
Associate Director for Science
Division of Compensation Analysis and Support
National Institute for Occupational Safety and Health

September 26, 2013

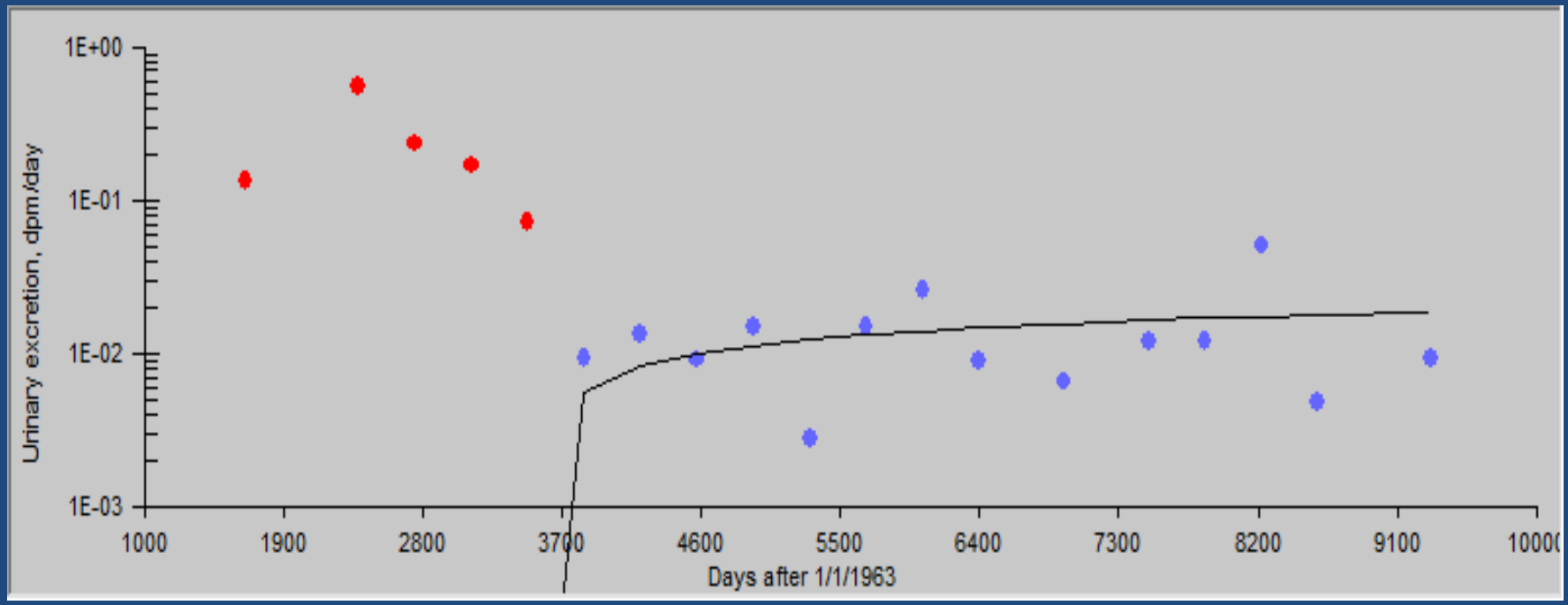
Summary of Internal Co-worker Model Calculations



Example Bioassay Distribution for a Single Year



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



IR1	9.861E-01	dpm/d
+/-	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 dpm = 0.05 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

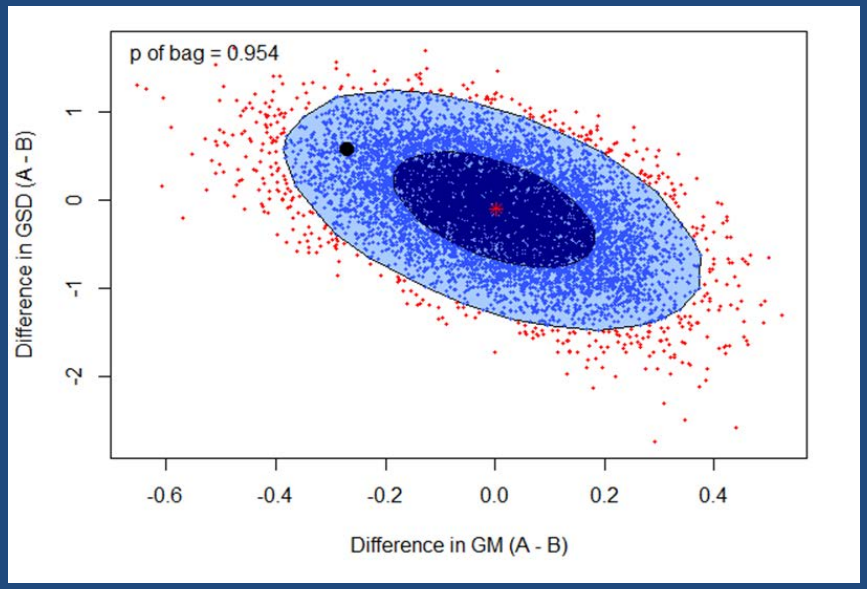
- *Assumptions:*
  - Data can be described by a lognormal distribution
  - Data is not heavily censored
- Stratify data using an *a priori* criterion
  - Construction workers vs. non-Construction workers
  - Area 100 workers vs. Area 200 workers
- For each strata calculate the Geometric mean (GM) and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

Monte Carlo Permutation Test—cont.

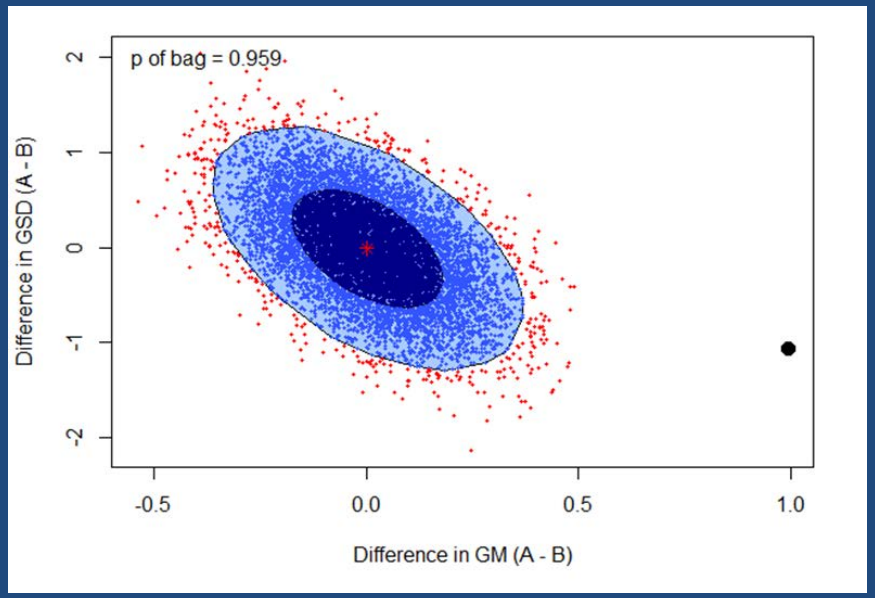
- Calculate the difference in the GM and GSD between strata
  - These differences comprise one data point with (x,y) coordinates

- 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.

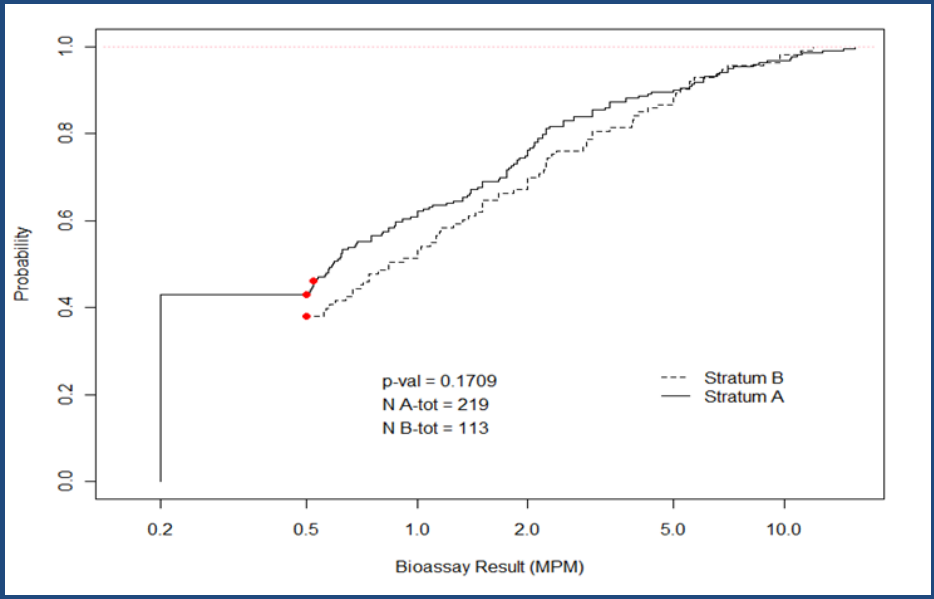
- **Benefits**
  - Can easily compare whether different size strata are significantly different
- **Limitations**
  - Requires some *a priori* decision on distribution
  - Doesn't work if data set is heavily censored
    - Too many random pulls of zero
    - Peto-Prentice Test is more appropriate

Peto-Prentice Test

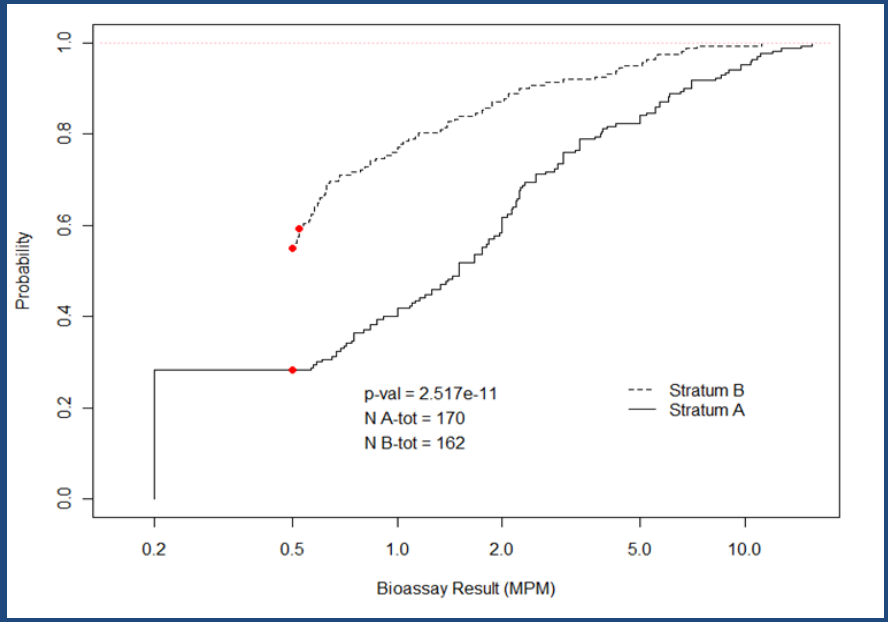
- Advantages
  - Non-parametric – i.e. no *a priori* distribution assumption
  - Can handle censored data sets
  - Can compare whether different size strata are significantly different (p-value)

- 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