

**A Simple Quality Control System for Evaluation of Interlaboratory Differences in Fiber Counting in Accordance with NIOSH 7400 Method**

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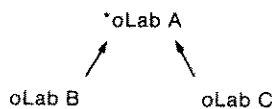
A simple statistical test is provided to evaluate the compatibility of interlaboratory data, specifically regarding asbestos analysis. A work sheet is provided and a protocol outlined for a round-robin exchange of airborne fibers analyzed using phase contrast microscopy.

**Introduction**

The Occupational Safety and Health Administration "OSHA standard on Asbestos" (OSHA 29 CFR parts 1910 and 1926) requires that any laboratory or company involved in the analysis of asbestos shall implement an interlaboratory quality assurance (QA) program to monitor and check variability between laboratories doing asbestos analysis. No protocol has been established for such a pro-

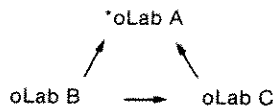
**TABLE I**  
**Sequence of Events and Schedule**

January 1



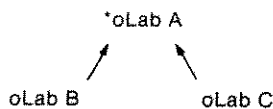
Each participating lab will send three slides, which have been taken from their regular work load and sealed with clear nail polish, to the coordinating lab. These slides will be labeled clearly and shipped in a polyethylene slide holder to avoid damage.

February 1



The coordinating lab will relabel these slides with quality control (QC) numbers and analyze them. They then will be sent to the participating labs. A total of nine slides will be analyzed each round. The coordinating lab will be responsible for assuring the cyclic delivery of slides, and will retain all slides for a recount analysis by the outlier lab should this be necessary.

April 1



The coordinating lab will receive results from participating labs. Only the coordinating lab will see the results of each participating lab prior to the final report of performance.

\* = coordinator

o = participating labs

**TABLE II**  
**Test for Significant Difference between Laboratories**

Sample Number	Lab A	Lab B	Lab C
QC #135	81.33 F/mm <sup>2</sup>	90.0 F/mm <sup>2</sup>	23.5 F/mm <sup>2</sup>
QC #136	108.0	153.0	47.0
QC #137	8.6	14.0	4.6
QC #138	32.6	39.0	5.6
QC #139	52.0	74.0	33.1
QC #140	388.5	202.84	439.6
QC #141	27.3	28.66	18.7
QC #142	13.3	22.29	14.8
QC #143	4.6	39.49	5.4
Sum	716.2	663.3	592.30
Range	393.9	188.8	435.00

$$383.9 + 188.8 + 435.0 = 1007.7 \quad (\text{Sum of Ranges})$$

$$716.2 - 592.30 = 123.90 \quad (\text{Range of Sums})$$

$$1007.7 \times 0.98 = 987.54 \quad (\text{Sum of ranges} \times \text{critical factor})$$

**Procedure:**

- (1) Compute the sum and range of each column of data.
- (2) Compute the range of sums.
- (3) Compute the sum of ranges.
- (4) Multiply the sum of ranges by a critical value of 0.98. This value is obtained from Table I of J.W. Tukey's paper.<sup>(1)</sup>
- (5) If the range of sums (2) is greater than the product found in item (4), then there is a significant difference at the stated level<sup>A</sup> associated with the critical value. Otherwise, the differences are not significant.

$$\text{Range of sums} = 123.90$$

$$\text{Sum of ranges} = 1007.7$$

$$1007.7 \times 0.98 = 987.54$$

The range of sums, 123.90, is less than 987.54; therefore, no significant difference is found in these data. An outlier test is applied at this point to check for specific differences between labs. Please see Table III.

<sup>A</sup>stated level = gap with 5% risk. This value is only for the situation of three labs and nine samples. For other situations please refer to Table I of J.W. Tukey's paper.<sup>(1)</sup>

**TABLE III**  
**Test for Identifying Outliers**

	Sample #									Rank Sum
	135	136	137	138	139	140	141	142	143	
Lab A	81.33	108.0	8.6	32.6	52.0	388.5	27.3	13.3	4.6	16
Lab B	90.0	153.0	14.0	39.0	74.0	202.8	28.6	22.3	39.	25
Lab C	23.5	47.0	4.6	5.6	33.1	439.6	18.7	14.8	5.4	13

5% two-tail limits for ranking scores = 12-24.<sup>(2)</sup> Therefore, Lab B is the outlier.

**Procedure:**

- (1) Arrange the data as seen in this Table.
- (2) Rank the values in ascending order for each slide read. Ties can be broken by flipping a coin.
- (3) Sum up the ranks for each laboratory.
- (4) Compare the ranks with the appropriate limits. In this example, the approximate 5% two-tail limits are 12 and 24 for the case of three laboratories and nine slides.
- (5) With this example it is clear that Lab B is an outlier. Lab B would be notified immediately, and an investigation into why they are out would take place. Then Lab B would be asked to reanalyze the slides to assure that the problem has been solved.

ing month. All results will be kept on a permanent laboratory record. Should a recount analysis be necessary, the coordinating lab will be responsible for assuring that this is done.

### Selection of Slides

The selection of slides is the responsibility of each participating lab. These slides are to be taken from the regular work load of samples. Each lab should follow the guidelines established in this proposal when choosing slides to be submitted for the round robin.

- (1) Slides should be free of finger prints.
- (2) Slides should be prepared so that they are dispersed evenly across the surface (e.g., minimal air bubbles).
- (3) Slides with a minimal amount of background particulates should be chosen.
- (4) Slides containing 40 to 100 fibers per 100 fields are ideal from an accuracy standpoint and, when possible, should be selected for this round robin.
- (5) Slides should be prepared with the acetone, triacetin method and sealed with clear nail polish.

- (6) A blank slide is not necessary since interferences or contamination are not a concern. The concern is strictly with the consistency of the count between laboratories.

### Data Submission

After each individual participating lab has read the nine slides, the results should be sent to the coordinating lab in units of fibers/mm<sup>2</sup>. All labs must use National Institute for Occupational Safety and Health (NIOSH) method 7400, counting rules A. Once all results have been received by the coordinating lab, the results will be calculated, and any significant differences between the laboratories will be noted. The results then will be sent to each participating lab to be kept on permanent record by each laboratory. If there is an outlier among the participating labs, the reason for the outlier will be investigated. The outlying lab will be notified and asked to reanalyze all slides.

### Conclusion

There are more sophisticated means avail-

able for the statistical evaluation by use of computers. This procedure, however, will provide a method for small laboratories engaged in asbestos fiber counting and obliged to have an interlaboratory testing program. The purpose of a round robin with alternating coordinators is to share the work involved and to eliminate all responsibility from falling on one laboratory.

### References

1. **Tukey, J.W.:** "Quick and Dirty Methods in Statistics. II. Simple Analyses for Standard Designs." Quality Control Conference Papers, Fifth Annual Convention, American Society for Quality Control, May 23 and 24, 1951. Cited in *Industrial Hygiene Laboratory Quality Control Manual 587* by the United States Department of Health and Human Services, Public Health Service. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1983. p. 194.
2. **Association of Official Analytical Chemists:** *Statistical Manual of the Association of Official Analytical Chemists* by W.J. Youden and E.H. Steiner. Washington, D.C.: Association of Official Analytical Chemists, 1975.