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Subject RESPIRATORY PROTECTION FOR ASBESTOS

F —

The enclosed information concerning respiratory protection for asbestos was developed by Du Pont and recently circulated to members of Organization Resources Counselors (ORC). You may find this information significant for operations involving asbestos removal. During the public hearings on the OSHA asbestos standard this past summer, there was considerable controversy about the effectiveness of disposable respirators in providing protection against asbestos fibers.

In a limited study, Du Pont found that disposable respirators provide protection equivalent to that provided by re-usable, elastomeric facepiece respirators.

Richard G. Hanlon

Richard G. Hanlon

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RGH:jmc
Enclosure

FORM LG-4878

DU PONT

ESTABLISHED 1802

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE 19898

LEGAL DEPARTMENT

OCT 23 1984

October 16, 1984

Docket Officer
Docket No. H-033C
Room S-6212
U.S. Department of Labor
Third Street and Constitution Ave., N.W.
Washington, D.C. 20210

Re: Occupational Safety and Health Administration Proposal to Revise 29 CFR §1910.1000 - Asbestos Post-Hearing Brief of <u>E. I. du Pont de Nemours and Company</u>

Dear Sir:

In the pre-hearing comments of E. I. du Pont de Nemours and Company (Du Pont) re the above-referenced proposal, the company requested to submit for the record a study it was conducting on workplace protection factors for elastomeric half-mask and single use respirators. The study was begun in 1983 and was not completed in time to present at the public hearings in June and July. The study is now finalized and is attached as exhibit A to these comments.

The authors of the study are Stephen W. Dixon, Supervisor, Industrial Hygiene, Haskell Laboratory for Toxicology and Industrial Medicine, and Thomas J. Nelson, Coordinator, Industrial Hygiene, Finishes and Fabricated Products Department. Because the authors are considering publication, we would appreciate limited distribution of the study.

<u>The Du Pont Respirator Study</u>

In the Du Pont respirator study, workplace protection factors for elastomeric and single use half-mask respirators

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were measured during asbestos removal operations. In addition, two workplace protection factor measurements were made for a self-contained breathing apparatus operated in the pressure-demand mode. The operations consisted of asbestos removal from a ceiling (fire proofing) and removal of pipe insulation.

Results of the study showed that all respirators tested reliably provided workplace protection factors of ten or greater except the American Optical (AO) R1050 which reliably provided a protection factor of five or greater (based on the best estimates of the 5th percentile of workplace protection factors). Results for the self-contained breathing apparatus suggest that it may not provide appreciably better protection than the disposable and elastomeric facepiece respirators, though it created a significantly greater safety hazard (i.e., falling due to difficulty balancing the heavy tanks when climbing scaffolding, etc.).

Much of the hearing testimony regarding adequacy of respiratory protection, particularly for disposable respirators, was conjecture. The Du Pont study provides the only data which measures the protection provided by elastomeric and single use half-mask respirators for asbestos exposures in asbestos removal operations. Based on this information, the OSHA standard should permit use of these respirators.

OSHA should adopt a performance-based work practices standard for insulation removal and permit use of elastomeric half-mask and disposable respirators in these operations.

As stated in Du Pont's pre-hearing comments, the company urges OSHA to adopt a flexible, performance based standard which permits the use of respiratory protection to achieve compliance where engineering controls are not feasible, such as in the removal of old asbestos insulation. Even witnesses generally opposed to the use of respirators in workplaces where there is potential for exposure to asbestos agree that there are instances where respirators are the only feasible control measure. At the OSHA hearings on the asbestos proposal the National Institute of Occupational Safety & Health (NIOSH) stated:

> "However, prior to the installation of or during the malfunction or maintenance of these engineering controls, for short-term intermittent exposures and

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for certain operations that are performed at constantly changing locations, a need for respirators does exist."(1)

The final standard should acknowledge that respirator use will be the only adequate control for some activities and it should allow employers the flexibility to select protective equipment based on an assessment of the potential for exposure and the individual performance capability of the respirator.

Infeasibility of supplied air respirators in insulation removal

Air line respirators or self-contained breathing apparatus (SCBA) create safety hazards in a complicated removal operation where workers are constantly climbing and descending ladders or scaffolding because of the increased risk of tripping or falling. In addition, the limited data available in the Du Pont study suggest that contrary to the general assumption, supplied air respirators may not provide appreciably better protection than air purifying respirators. In view of the documented effectiveness of elastomeric half-mask and disposable respirators, Du Pont urges OSHA to permit use of these protective devices in insulation removal operations where expected concentrations will not exceed the use limits applicable for a particular type of respiratory protection equipment.

OSHA should provide additional opportunity to comment on the proposed standard

The preamble to the proposed standard discusses many regulatory possibilities which are not contained in the actual proposed standard. It is, therefore, difficult to identify precisely what the Agency is proposing and provide meaningful input. Consequently, Du Pont requests that OSHA not proceed from this comment period directly to a final standard; instead, the Agency should reissue a revised proposal reflecting the information received in this proceeding and solicit additional comments on this revised version.

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(1) See testimony of the NIOSH transcript of the OSHA asbestos hearings on June 21, 1984, page 73.

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In summary, Du Pont supports OSHA's decision to reduce exposures to asbestos. For the specific activity of removal of old asbestos insulation, engineering controls are not effective in controlling exposures to less than 0.5 fibers/cc; consequently, respiratory protection should be permitted. The use of respirators will effectively control exposures as demonstrated by Du Pont's field study for negative pressure respirators.

If you have questions regarding any Du Pont materials submitted to the asbestos rulemaking record, I may be reached at 302-774-8284.

Very truly yours,

Julia L. Phillips

Julia L. Phillips
Attorney
Environment, Materials &
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JLP/cde
Att.

RESPIRATOR WORKPLACE PROTECTION FACTORS FOR ASBESTOS

SUMMARY AND BACKGROUND

Workplace protection factors for elastomeric and single use half-mask respirators were measured during asbestos removal operations. The operations consisted of asbestos removal from a ceiling (fire proofing) and removal of pipe insulation. The use of water/surfactant solutions to spray fire proofing and insulation resulted in conditions of high humidity for in-doors operations. Out-of-doors operations were also under high humidity conditions since light rain occurred on two of four days of out-of-doors sampling. Temperatures for both operations were in the 65-85°F range.

The respirators were used in the context of a respirator program that followed the guidance in 29 CFR 1910.134 and ANSI Z88.2 (1980) including proper respirator selection and fit testing. A total of seventeen volunteers participated in the study. One or two workplace protection factors were determined for each respirator for which the fit test had been passed.

The respirators tested were:

- One successfully fitted elastomeric facepiece respirator chosen for comfort from six respirators (MSA Comfo II and Survivair 2000 brands - small, medium or large sizes). These respirators were tested using a dust, fume and mist type filter and a high efficiency filter.

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- Each of three disposable respirators successfully fitted (3M 9910, 3M 8710 and American Optical R1050).
- A successfully fitted North 7700 elastomeric facepiece respirator, chosen from the small, medium or large size facepieces.

In addition two workplace protection factor measurements were made for a self-contained breathing apparatus operated in the pressure-demand mode.

Results showed that, with the exception of the American Optical (AO) R1050, all respirators tested reliably provided workplace protection factors of ten or greater based on estimates of the lower 5th percentile. The AO R1050 reliably provided a protection factor of five or greater. These results are consistent with information supplied to the record by Los Alamos National Laboratory which reported on the penetration of asbestos through respirator filter media.(1)

Results for the self-contained breathing apparatus suggest that it may not provide appreciably better protection than the two better disposable respirators and the elastomeric facepiece respirators, though it creates significantly greater hazard of falling because of the weight and awkwardness of the tanks. Myhre et al.(2) and Raven(3) have shown that pressure-demand type respirators do not maintain positive pressure inside the facepiece when workloads are increased from rest conditions. This may explain in part why no significant difference exists between half facepiece negative pressure and pressure-demand respirators.

PROCEDURE

Prior to testing, each person was trained in the selection and fit testing of respirators using the National Paint and Coatings Association Training Program[4]. Each was then fit tested using the saccharin fit test[4]. Respirators selected for use by participants are listed above and in Table I.

Two individuals were also trained in use of a pressure-demand self-contained breathing apparatus. Fit testing was not done, as it is not required for pressure-demand equipment in the ANSI Z88.2 (1980) standard.

During sample collection, each participant was observed continually to ensure that the sample train remained intact and did not interfere with the respirator seal on the face, and to note occurances which might have affected respirator performance, such as movement of the respirator on the face. The participants were very busy with their work activities and soon ignored the presence of the researchers.

AIR SAMPLING AND ANALYSIS

To determine the workplace protection factors, concurrent samples were taken from inside the respirator (in-mask) at nose level and outside the respirator at the

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lapel (lapel). Closed-face Glasrock (#1505) cassette filter holders fitted with half inch extenders and probes developed by NIOSH[5] were used for both the in-mask and lapel samples. The sample probes are specially designed to minimize the loss of particulates. The cassettes contained 0.8 um, 25mm cellulose ester filters.

The sample trains were calibrated before and after taking each sample using a mass flow meter. The mass flow meter was calibrated against a bubble flow meter at the beginning and end of the study. A flow rate of 2 Lpm was used for in-mask samples. Lapel samples were taken at 0.5-1.0 Lpm to avoid overloading.

Samples were collected for a one to two hour period. Each sample represented a single wearing of the respirator.

Fiber counts were done per NIOSH procedure P&CAM 239[6] (phase contrast microscopy), except that the triacetin/acetone mounting method was used as described in NIOSH method 7400[7]. Counting was done according to the "A" counting rules in method 7400. Five hundred fields were counted for in-mask samples to increase analytical sensitivity. All analyses were done by one counter who participates successfully in the American Industrial Hygiene Association's Proficiency Analytical Testing quality assurance program. Concentrations were calculated from the actual number of fibers counted (even if fewer than 50 fibers were counted) per the formulas in the NIOSH method.

NIOSH method P&CAM 239 reports a coefficient of variation of 0.12 which applies to lapel samples in this study. We estimate that the coefficient of variation for the in-mask samples is 0.4 at the median in-facepiece concentration and fiber count (Table III).

SAMPLING AND ANALYSIS METHOD VERIFICATION

In-mask sampling required use of closed-face filter cassettes. The Glassrock #1505 25mm filter cassettes used have a unique tapered design for the outlet and a half inch extender which improves the deposition patterns[8]. To minimize sample loss, the NIOSH[5] probe was used to withdraw in-mask samples.

To eliminate possible bias, the same closed-face/probed cassette was used for both in-mask and lapel samples. To document whether concentrations determined from closed-face/probe cassette sampling differed from open-face sampling, twelve area samples were taken using both methods. Results are compared in Table II with Student's and Variance Ratio tests. The two sampling methods were found to give similar results with no significant bias or difference in precision.

RESULTS AND DISCUSSION

Transmission electron microscopic analyses were made on four lapel samples to document the distribution of fiber diameters and lengths. Distributions are shown in Figures 1 and 2. Fiber diameters and lengths covered a wide range.

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The overall median concentrations of fibers for in-mask and lapel samples are given in Table III. The median number of fibers counted for in-mask (500 fields counted) and lapel ($\leq$100 field counted) samples are also given in Table III.

Cumulative distributions, geometric means, geometric standard deviations, best estimates of 5th percentiles and lists of workplace protection factors are given in Figures 3 through 8 for each respirator. The distributions of workplace protection factors were found to be approximately lognormal for all respirators studied. Therefore, logs were used for the plots, geometric means are reported as the proper measure of central tendancy and geometric standard deviations are reported as the proper measure of variability. Best estimates of 5th percentiles represent the workplace protection factors that most (95%) respirator users are expected to obtain from each respirator.

Distribution plots and geometric standard deviations include variability from the sampling and analytical method as well as from the workplace protection factors. The unavoidable inclusion of the sampling and analytical variability in the plots results in best estimates of 5th percentile protection factors which are conservative (lower than actual). This should be considered in evaluating results.

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Workplace protection factors were determined for a self-contained breathing apparatus for two individuals. Results are reported in Table IV.

Table V gives geometric means and standard deviations for all respirators studied. A Bonferroni[9] test for differences ($p=0.05$) was done and results are given in Table V. Workplace protection factors for the 3M 9910 were found to be significantly higher than those for the AO R1050. No other significant differences were found.

The relatively low results for the AO R1050 are likely due to poorer filter efficiency for asbestos, reported by Dr. Ortiz of Los Alamos National Laboratory.[1] The unexpected comparability of the results from the 3M disposable respirators, and elastomeric facepiece respirators with both dust, mist and fume filters and high efficiency filters may be explained by several factors. First, the limiting factor in performance with the respirators is likely face fit, not filter efficiency (except for the AO R1050 as noted above). Since the same fit test was used to select good fitting respirators for the study, comparable results would be expected. In addition, the researchers noted a tendency for elastomeric respirators to slip around when some wearers' faces became wet with the water/surfactant spray. This did not occur with the disposable respirators because their fibrous material of construction clung to the skin.

It is particularly noteworthy that the workplace protection factors for the self-contained breathing apparatus were not superior to the better disposable and elastomeric respirators. Myhre[2] and Raven[3] have shown that at workloads exceeding approximately 35% of maximal aerobic capacity pressure inside the facepiece of pressure-demand type respirators does not remain positive with respect to the surrounding atmosphere. This would provide an opportunity for asbestos to be drawn into the facepiece.

The volunteers who wore the self-contained breathing apparatus complained of stress and discomfort due to its weight and bulk. Movement and balance were difficult and one volunteer almost fell from a step ladder as a result. Based on their observations, the researchers believe that routine use of self-contained breathing apparatus for asbestos removal in the chemical industry would likely result in injuries, in view of the large amount of climbing involved. Certainly, acceptance will be much poorer than for the other respirators studied, due to discomfort which would discourage respirator use.

Transmission electron microscopic analyses were done on in-mask and lapel samples. Resultant workplace protection factors are reported in Table VI. Results for small diameter fibers (<0.2um - the diameter below which fibers cannot be resolved with the standard optical microscopic method) do not appear to differ from those for large diameter (≥0.2um) fibers, for 5 um or longer lengths. Thus, results for fibers visible

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with the phase contrast method ($\geq$0.2um diameter) appear to be representative of those for smaller diameter fibers for the 3M 8710 and 9910, and for elastomeric respirators with a dust, fume and mist filters and high efficiency filters.

CONCLUSIONS

1. All respirators tested provided protection against asbestos. The American Optical R1050 disposable respirator reliably provided workplace protection factors of 5 or greater. The 3M 9910, 3M 8710, and elastomeric half-face respirators with both dust, fume and mist and high efficiency filters reliable provided workplace protection factors of 10 or greater.
2. Use of higher efficiency filters did not appear to improve the workplace protector factors of the elastomeric respirators.
3. Workplace protection factor measurements for a pressure demand self-contained breathing apparatus were not significantly higher than those for the better disposable and elastomeric respirators. Comments from the test volunteers and observations indicate that acceptance of the self-contained breathing apparatus will be poorer than that of the other respirators tested. In addition, they present a significant risk of tripping or falling where removal work requires climbing ladders and working from scaffolding.
4. Transmission electron microscopic analyses indicate that overall workplace penetration of small diameter (<2um) fibers (longer than 5 um) is not discernibly higher than that of larger diameter fibers for the 3M 8710 and 3M 9910 disposable respirators nor for elastomeric respirators with dust, fume and mist or high efficiency filters.

REFERENCES

1. Ortiz, L. W. et al: "Interim Report: Penetration of Respirator Filters by an Asbestos Aerosol." May 2, 1984 (Los Alamos National Laboratory).
2. Myhre, L. G., R. D. Holden, F. W. Baumgardner and D. Tucker: Physiological Limits of Firefighters. Unclassified Report #ESL-TR-79-06, AFESC, Tyndall AFB, Florida (June 1979).
3. Raven, P. B. et al.: "Physiological Response to 'Pressure-Demand' Respirator Wear", Am. Ind. Hyg. Assoc. J. 43 (10): 773-781 (1982).
4. "Guide to Respirator Fit Testing" (1981), National Paint and Coating Association, Washington, D.C.
5. Liu, B. Y. U. et al: "In-Mask Aerosol Sampling for Powered Air Purifying Respirators," Am. Ind. Hyg. Assoc. J. 45(4):278-283 (1984).
6. U.S. Department of Health, Education and Welfare; NIOSH Manual of Analytical Methods, Second Edition, Volume I (April 1977).
7. National Institute for Occupational Safety and Health, Method 7400, February 15, 1984.
8. Adams, M. J. et al, "Cassette Extenders: Effects on Chrysotile Fiber Deposition and Concentration Measurements", Presented at the American Industrial Conference, May 24, 1983.
9. Snedecor, G. W. and W. G. Cochran: Statistical Methods, 7th Ed., Iowa State University Press, Ames, Iowa (1980).

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TABLE I

Respirators Studied

Respirator Name	Type	Vendor
Survivair 2000	Elastomeric (silicone rubber) with dust, fume and mist and high efficiency filters	U.S.D. Corp.
Comfo II	Elastomer (neoprene) with dust, fume and mist and high efficiency filters	Mine Safety Appliance Co.
3M 8710	Disposable with nonadjustable straps	3M Company
3M 9910	Disposable with adjustable straps	3M Company
American Optical R1050	Disposable with nonadjustable straps	American Optical Company
North 7700	Elastomeric (silicone rubber) with high efficiency filters	North Company
Scott Air-Pak	Self-contained breathing apparatus, pressure-demand	Scott Aviation

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TABLE II

COMPARISON OF ASBESTOS SAMPLING METHODS (OPEN-FACE VERSUS CLOSED-FACE WITH PROBE)

Parameter	Value
Mean	2.2 fibers/mL - open face filter cassette 2.3 fibers/mL - closed face cassette with probe
Standard Deviation	0.264 fibers/mL - open face cassette 0.286 fibers/mL - closed face cassette with probe
T Statistic*	1.28
Variance Ratio**	1.17
Data	
Open-face cassette:	1.9, 1.9, 2.0, 2.1, 2.1, 2.1, 2.2, 2.2, 2.2, 2.2, 2.3, 2.9
Closed-face cassette:	2.0, 2.0, 2.0, 2.2, 2.3, 2.3, 2.3, 2.4, 2.4, 2.4, 2.5, 3.0

* 1.28 is less than a comparison t statistic of 1.78 ($p=0.05$). Therefore, the means do not differ significantly.

** 1.17 is less than a comparison F statistic of 2.69 ($p=0.05$). Therefore, the variances (precision) of the methods do not differ significantly.

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TABLE III

MEDIAN ASBESTOS CONCENTRATIONS AND COUNTS FOR WORKPLACE PROTECTION FACTOR STUDY FOR ALL RESPIRATORS COMBINED

Concentrations	
Inside Respirator	0.006 fibers/mL (8 HR. TWA $\simeq$ 0.003)*
Outside Respirator	2.6 fibers/mL (8 HR. TWA $\simeq$ 1.3)*
Counts	
Inside Filter	9 fibers
Outside Filter	130 fibers

* No more than four of eight work hours were spent doing asbestos removal. Therefore, a factor of 0.5 (4 HRS/8 HRS) was applied to concentrations to estimate 8 HR TWA concentrations.

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TABLE IV

WORKPLACE PROTECTION FACTORS FOR SELF-CONTAINED BREATHING APPARATUS (PRESSURE-DEMAND)

Workplace Protection Factors:	400
	880

Geometric Mean: 620

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TABLE V

COMPARISON OF WORKPLACE PROTECTION FACTORS FOR SEVEN RESPIRATORS

Respirator	Number of Measurements	Workplace Protection Factor Geometric Mean (Geom. S.D.)	Significant Differences	Lower 5th Percentile
3M 8710	18	310 (5.3)		20
3M 9910	14	580 (4.2)	Higher than R 1050	55
American Optical R1050	7	52 (4.2)	Lower than 3M 9910	5
Elastomeric/Dust, Fume and Mist Filter	17	240 (6.3)		12
Elastomeric/High Efficiency Filter	14	94 (3.0)		16
North 7700 High Efficiency Filter	14	250 (6.9)		11
Self-Contained Breathing Apparatus Pressure-Demand	2	620		

* Based on a Bonferroni test(5) at a 0.05 level of significance, only the 3M 9910 and AO R1050 differed.

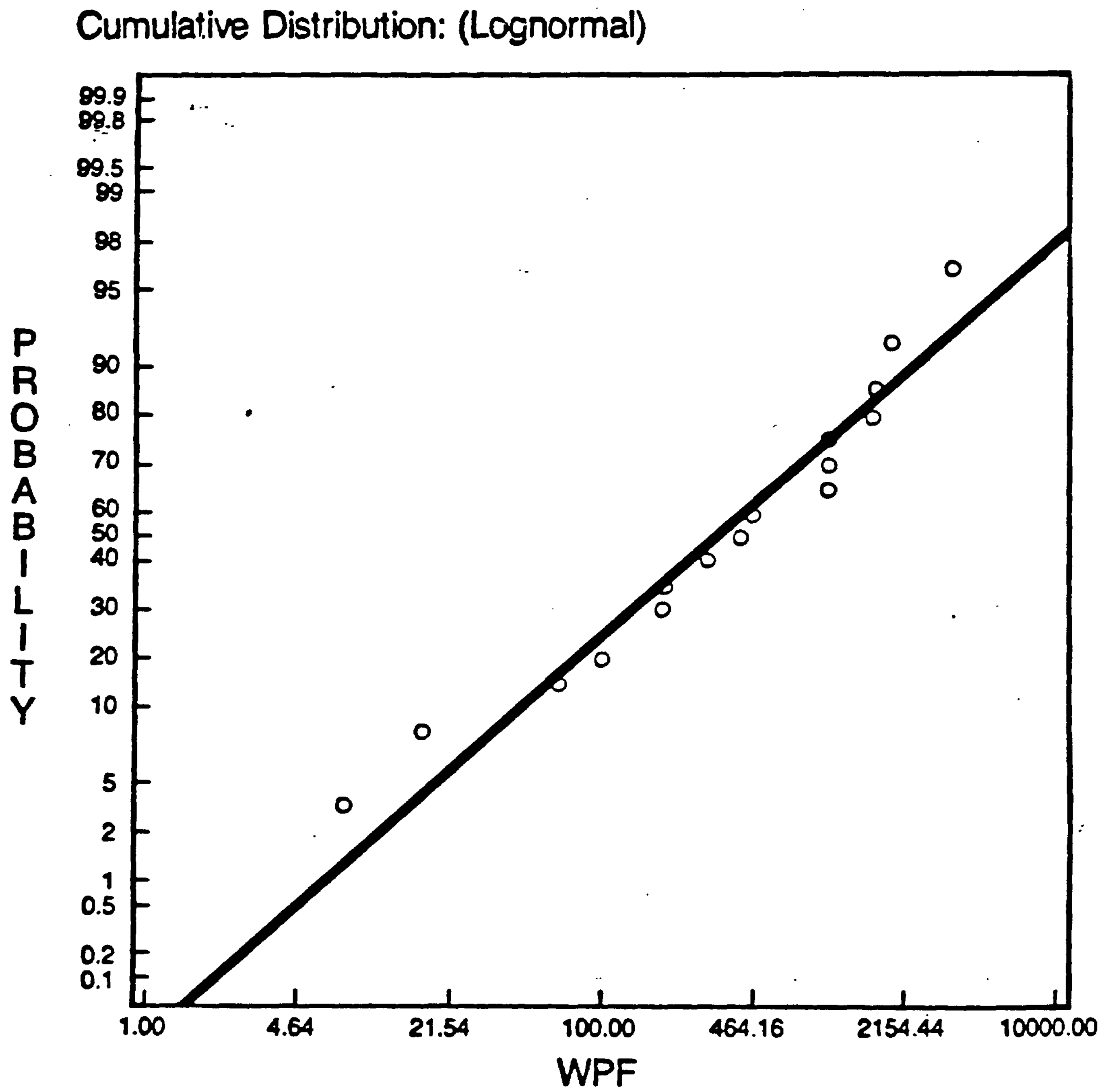
TABLE VI

WORKPLACE PROTECTION FACTORS FROM TRANSMISSION ELECTRON MICROSCOPIC ANALYSES

	Workplace Protection Factor	
Respirator	Fibers Exceeding 0.2 um Diameter and 5 um Length*	All Diameter Fibers Exceeding 5 um Length
3M 8710	330	120
3M 9910	47	41
Survivair 2000 with Dust, Mist and Fume Filter	28	29
Survivair 2000 with High Efficiency Filter	21	19

* Those which would be counted by the standard phase contrast microscopy method.

Figure 3 – Workplace Protection Factors for 3M 8710 Respirator



Geometric Mean: 310

Geometric Standard Deviation: 5.3

Best Estimate of 5th Percentile: 20

Data: 7.4, 15, 61, 110, 110, 180, 200, 310, 400, 420, 430, 1000, 1000, 1100, 1500, 1600, 1800, 3200

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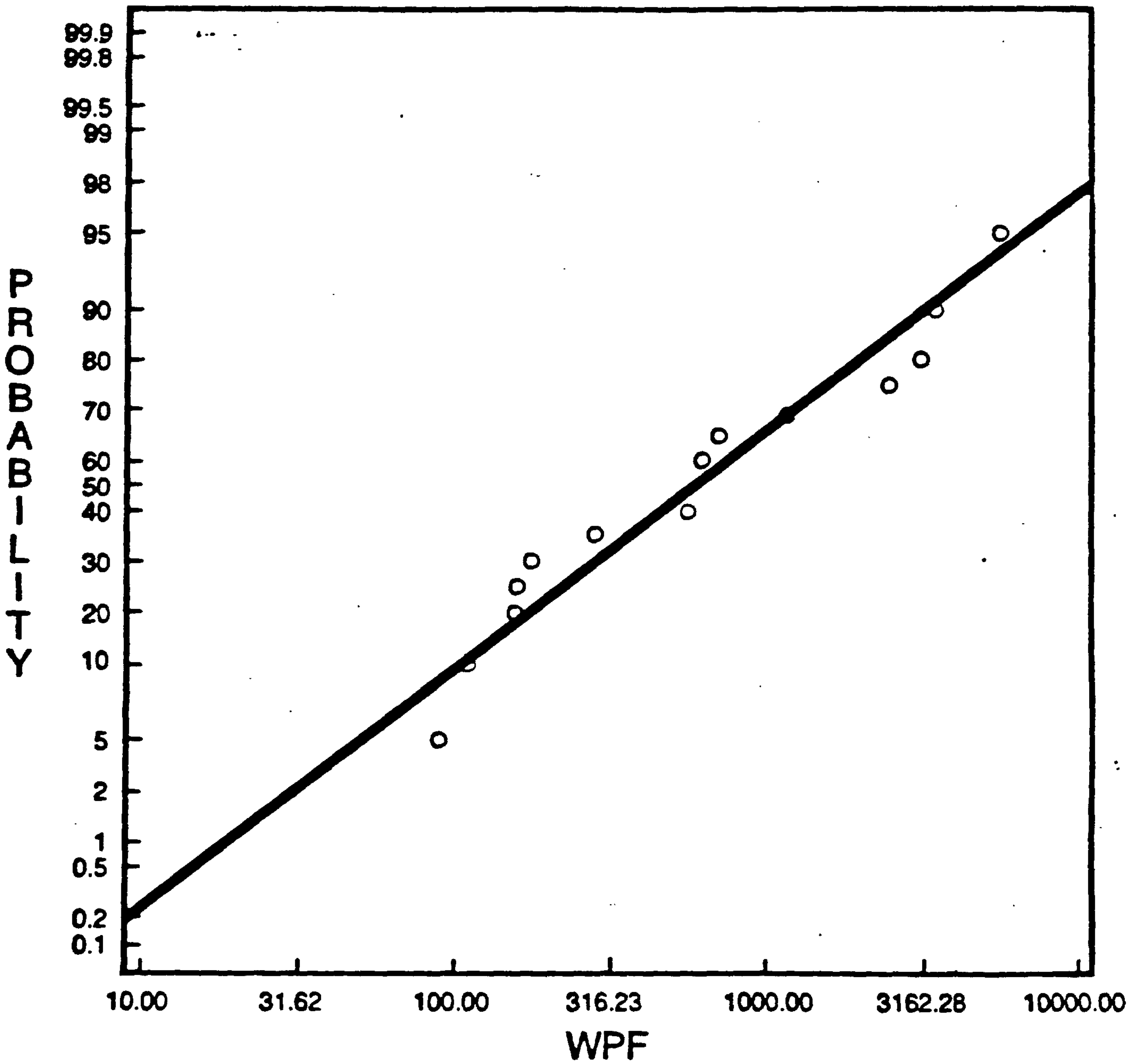
Figure 4 – Workplace Protection Factors for 3M 9910 Respirator

Cumulative Distribution: (Lognormal)



Geometric Mean: 580

Geometric Standard Deviation: 4.2

Best Estimate of 5th Percentile: 55

Data: 94, 110, 150, 150, 170, 280, 550, 630, 710, 1300, 2400, 3000, 3700. 5600

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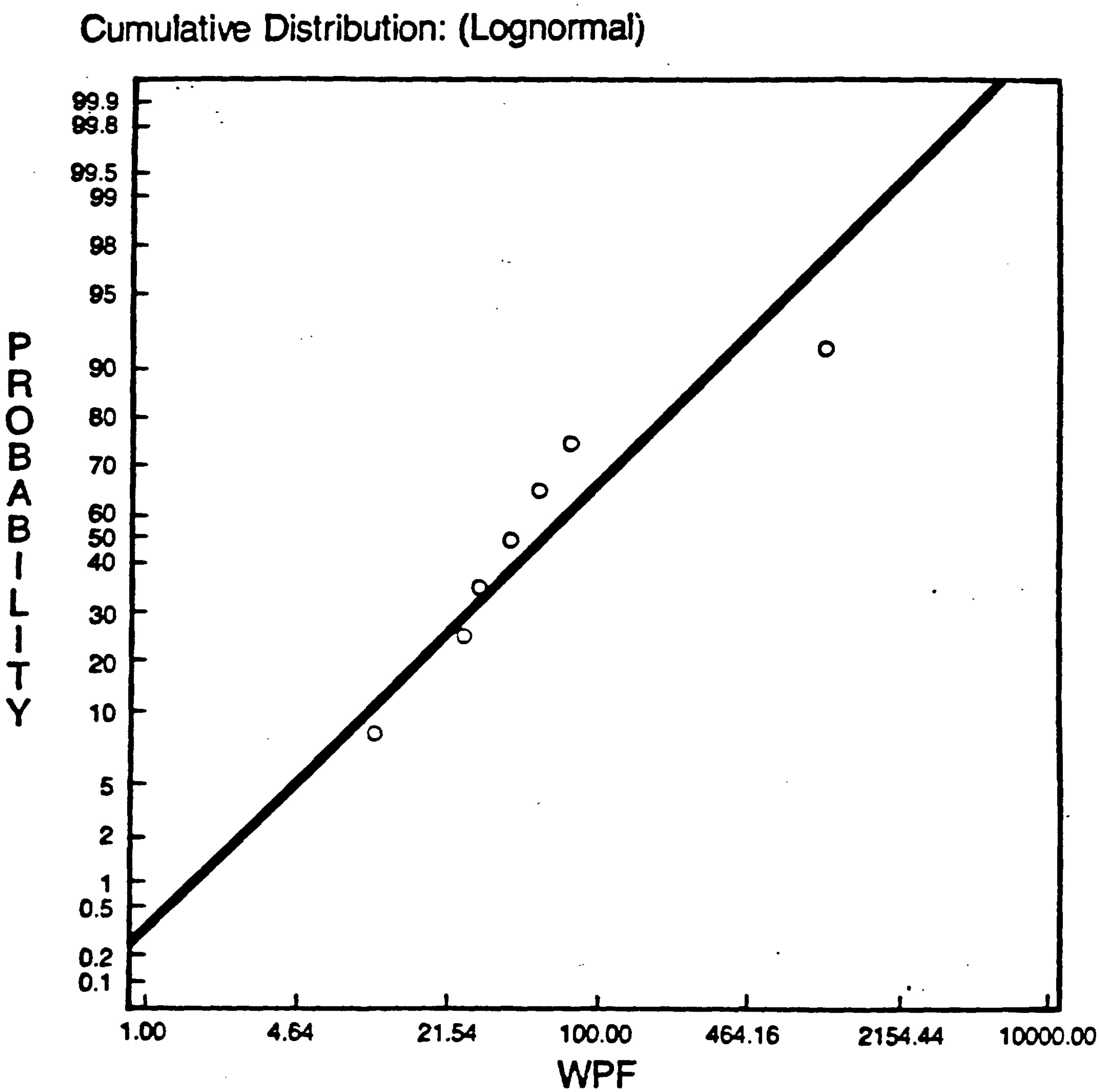
Figure 5 – Workplace Protection Factors for AO R1050 Respiratory



Geometric Mean: 52

Geometric Standard Deviation: 4.2

Best Estimate of 5th Percentile: 5

Data: 9.7, 26, 28, 38, 52, 75, 970

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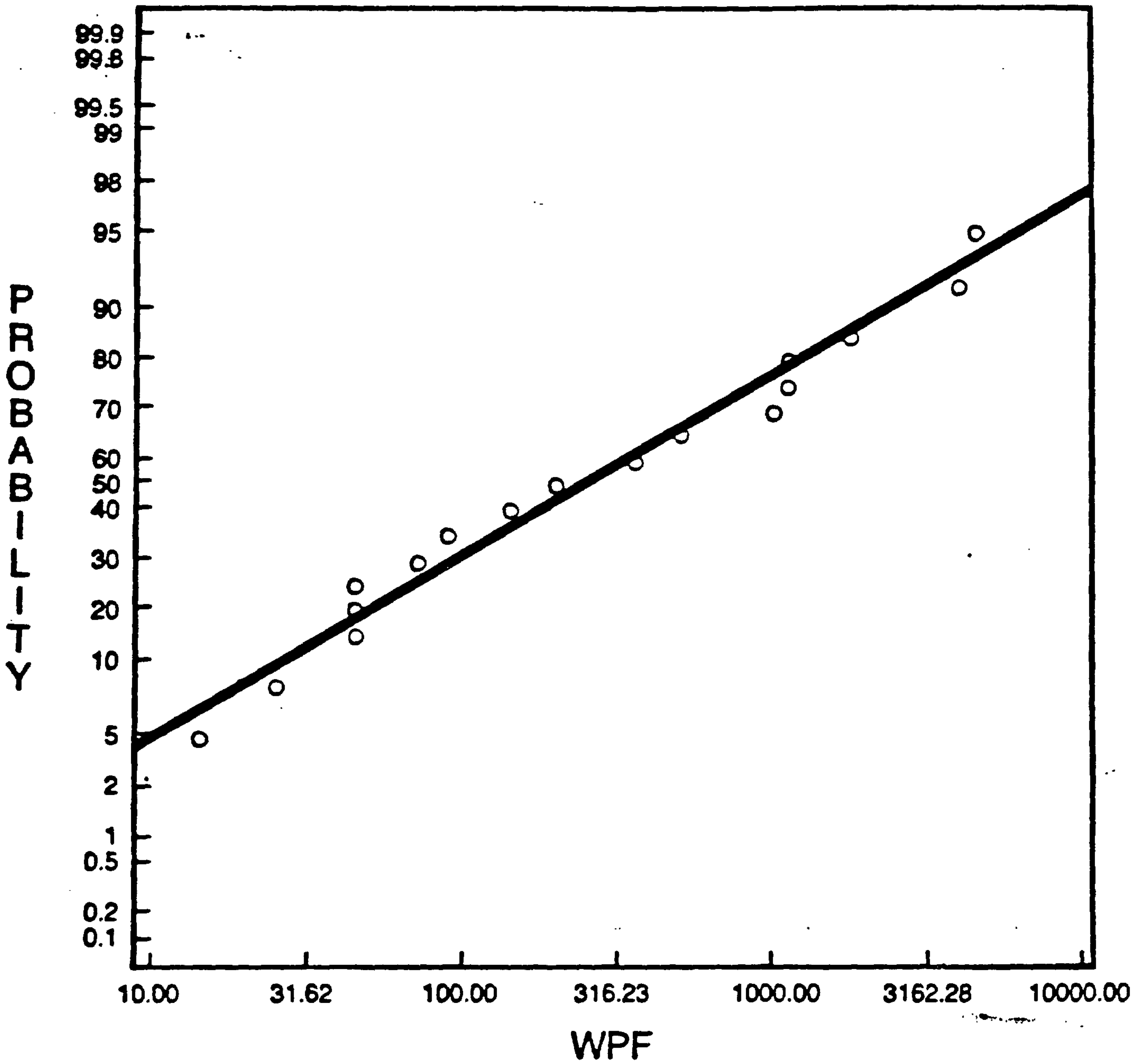
Figure 6 – Workplace Protection Factors for Survivair 2000 and MSA Comfo® Halfmask Respirators with Dust, Fume and Mist Filters

Cumulative Distribution: (Lognormal)



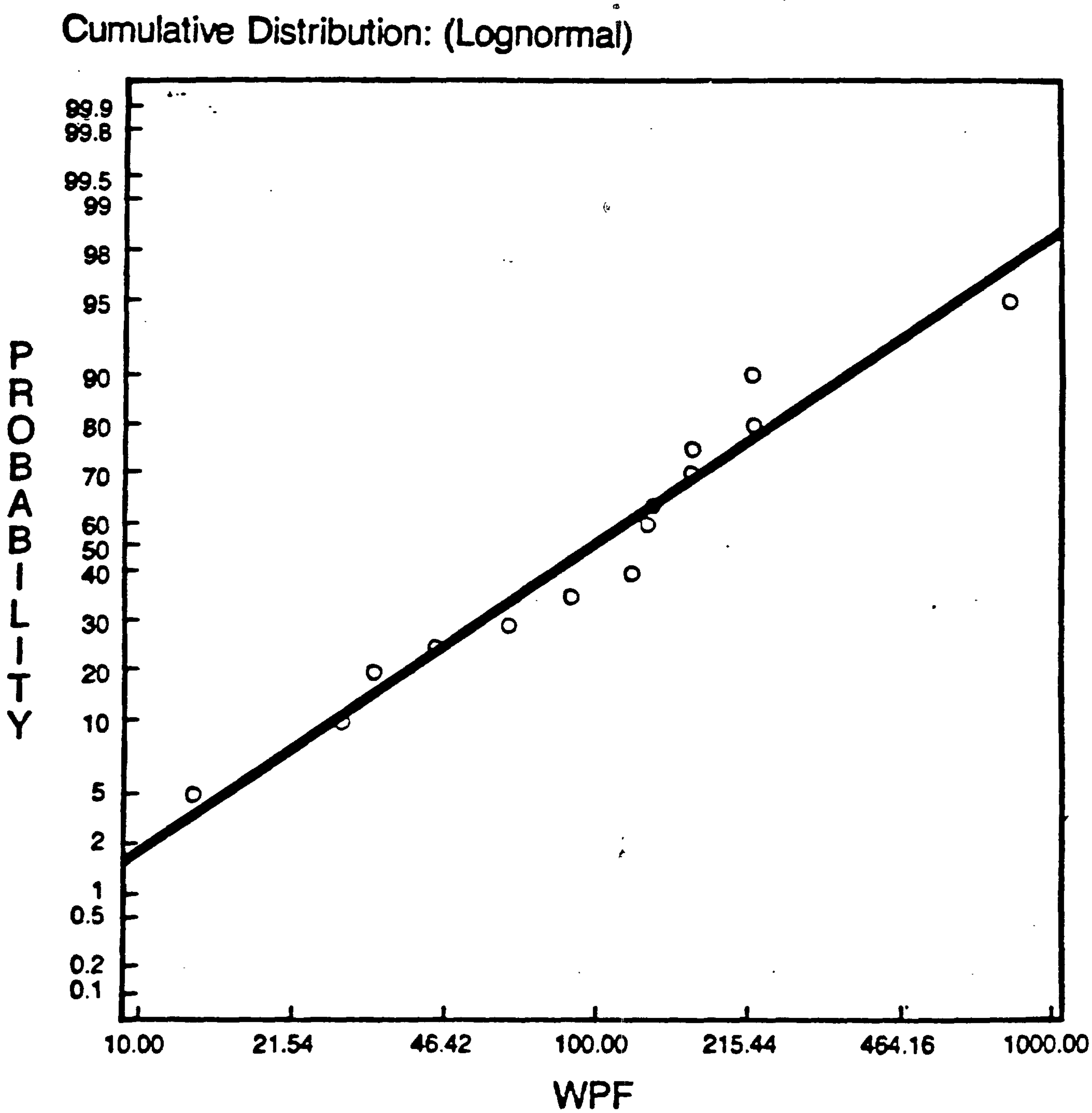
Geometric Mean: 240

Geometric Standard Deviation: 6.3

Best Estimate of 5th Percentile: 12

Data: 15, 24, 45, 46, 47, 74, 88, 140, 190, 370, 480, 1000, 1100, 1100, 1800, 4100, 4200

Figure 7 – Workplace Protection Factors for Survivair 2000 and MSA Comfo® Halfmask Respirators with High Efficiency Filters



Geometric Mean: 94

Geometric Standard Deviation: 3.0

Best Estimate of 5th Percentile: 16

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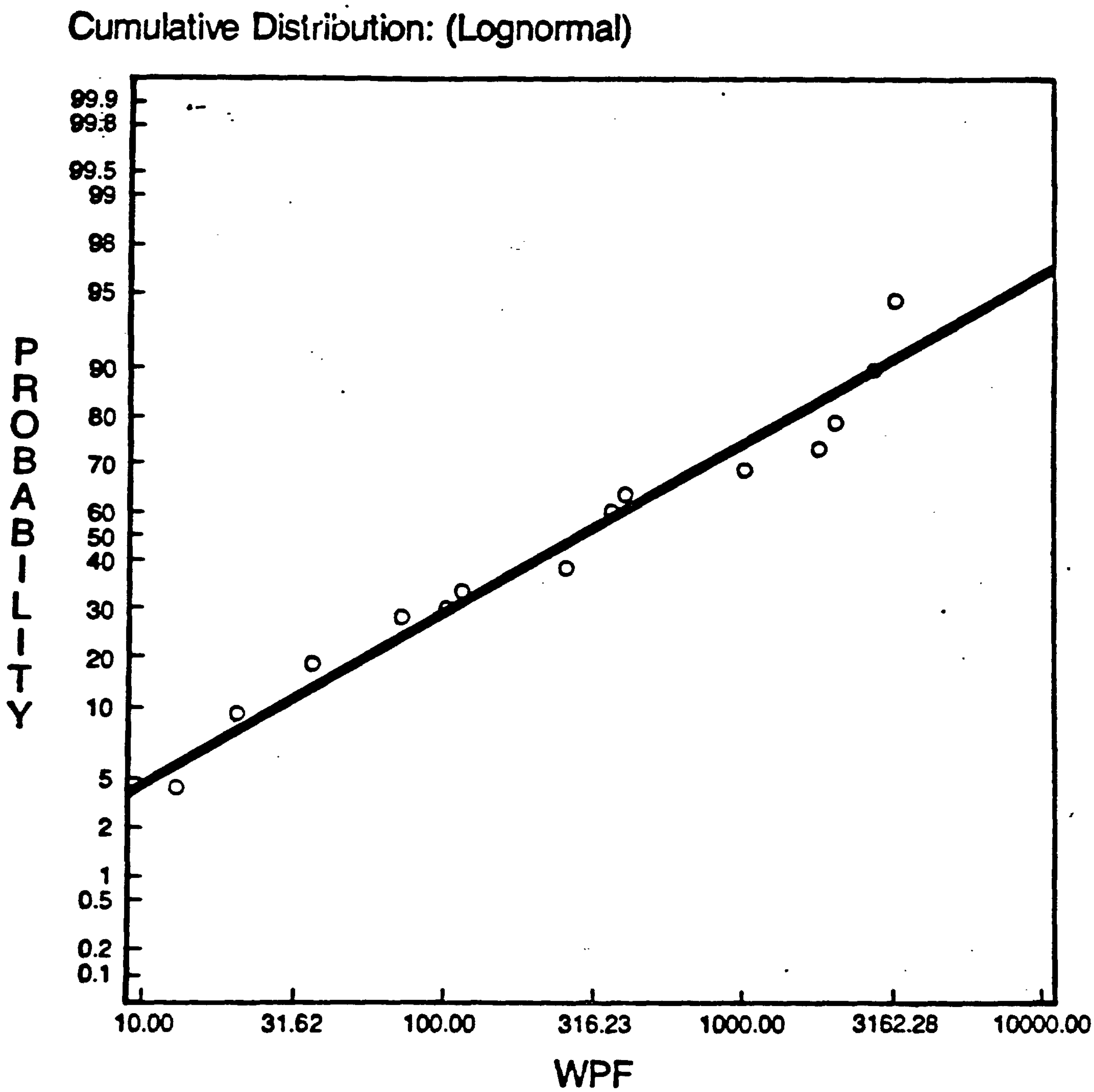
Data: 12, 28, 32, 42, 65, 85, 110, 120, 140, 160, 160, 220, 220, 780, 7900*

*Removed from plot analysis, as an outlier.

Figure 8 – Workplace Protection Factors for North 7700 Halfmask Respirators with High Efficiency Filters



Geometric Mean: 250

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Geometric Standard Deviation: 6.9

Best Estimate of 5th Percentile: 11

Data: 12, 20, 36, 60, 74, 110, 260, 350, 400, 1000, 1900, 2000, 2400, 3100

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