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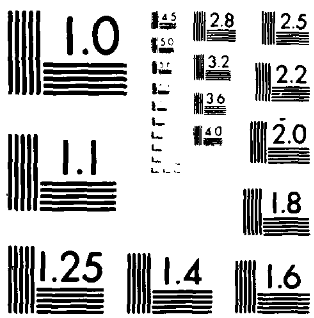

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TRANSPORT AND DIFFUSION SOLUTIONS FOR OBSCURATION USING THE XM-825 SMOKE MUNITION

AD A109739

NOVEMBER 1981

By

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Smoke	Munition expenditure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The practical problem of downwind transport and diffusion of smoke from an array of sources with an arbitrary distribution of positions and emission strengths may be dealt with by integrating the distributions from the individual point sources. Identifying the effects of a number of continuous emissions may be carried out algebraically by superimposing the alongwind concentrations from successive sources to determine the cumulative contributions at some finite distance downwind. The transport and diffusion area

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20. ABSTRACT (cont)

source characteristics of the candidate smoke projectile XM-825 have been studied, and the resultant attributes of the multipoint-source, chemically generated smoke have been modeled. Three schemes are considered and compared to experimental data with respect to the integrated line of sight concentrations and crosswind integrated concentrations downwind of the resultant area source.

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INTRODUCTION

Military requirements for more efficient smoke munitions have led to the development of the XM-825 felt wedge white phosphorus (FWWP) 155-mm projectile. The basic goals of the XM-825 were to provide a smoke munition that nearly eliminated the exothermic and the quasi-instantaneous source characteristics associated with bulk-filled white phosphorus (WP). The XM-825 projectile accomplishes this by using 92 phosphorous-impregnated felt wedges* that provide an area smoke source of a continuous nature with little or no exothermic effect when dispersed.

The continuous area source has introduced some complexities to the diffusion modeling associated with this candidate munition. However, several area source approaches to the downwind dispersion of windborne material are available. Notable among these hypotheses are a pseudopoint model advocated by Turner,[1] an infinite line solution also suggested by Turner, and the algebraic integration method suggested by Pasquill.[2]

The three approaches to area source diffusion were investigated within the framework of the KWIK smoke algorithm.[3] Results obtained during evaluation of the three methods using data from Dugway Proving Ground[4] were encouraging.

THEORETICAL CONSIDERATIONS

The XM-825 Candidate Smoke Munition

The XM-825 is a 155-mm projectile designed to disperse 92 phosphorous-saturated felt wedges* which will produce a screening smoke for 5 to 10 min. The total warhead payload is 7.48 kg, consisting of 1.13 kg of felt wedges and 6.35 kg (±0.10 kg) of white phosphorus. Preliminary estimates indicate that this configuration is 82 percent efficient by weight and produces effective obscuration in the visible portion of the electromagnetic spectrum for up to 450 s.

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*Configuration of XM-825 as of March 1980.

[1]Turner, D. B., Workbook of Atmospheric Dispersion Estimates, Public Health Service Publication No. 999-AP-26, Cincinnati, Ohio, Rev. 1969.

[2]Pasquill, F., Atmospheric Diffusion, second edition, Halsted Press Div, John Wiley and Sons, Inc., New York, 429 pp, 1974.

[3]Umstead, R. K., R. Pena, and F. V. Hansen, KWIK: An Algorithm for Calculating Munition Expenditures for Smoke Screening/Observation in Tactical Situations, ASL-TR-0030, 1979.

[4]Dugway Proving Ground, Development Test 1 of 155 mm Smoke Projectiles (XM-803 and XM-825), Defense Technical Information Center, Cameron Station, Alexandria, Virginia, 1979.

The Pseudopoint Solution

One approach to solving area source diffusion problems is to assume that the area can be represented by a pseudopoint located at some distance x_0 upwind of the center of the area. Thus, the origin of the vertical dispersion parameter σ_z is at the pseudopoint--in this case, the upwind edge of the XM-825 burst pattern. The vertical dispersion parameter (standard deviation) can then be written as:

$$\sigma_z = c(x_0 + x)^d \tag{1}$$

where x_0 is the burst radius and x the downwind distance. The coefficients and indices c and d for equation (1) are dependent upon both surface roughness and the stability of the surface boundary layer according to Pasquill.[2] The obscuration power of a screening smoke is dependent upon the crosswind integrated concentration (CWIC) of the aerosol in an optical path traversing the plume. The integrated concentration through a nonbuoyant continuous plume can be shown to be given by:

$$\chi_{cwic} = \left(\frac{2}{\pi}\right)^{1/2} \frac{\lambda \Omega Q}{\sigma_z \overline{V}} \exp\left[-1/2\left(\frac{z}{\sigma_z}\right)^{3/2}\right] \tag{2}$$

where λ is a munition efficiency, Ω a relative-humidity-dependent yield factor, Q the source strength in grams per second, $\overline{V}$ the mean windspeed in meters per second, and z the height above the surface of the optical path. Equation (2) is an empirically modified version of a Gaussian plume in that a power of 3/2 is used in place of the more conventional second power. This is done to compensate for non-Gaussian effects upon vertical dispersion, based upon experimental results obtained by Pasquill,[2] Huang,[5] and Horst.[6]

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[2]Pasquill, F., Atmospheric Diffusion, second edition, Halsted Press Div, John Wiley and Sons, Inc., New York, 429 pp, 1974.

[5]Huang, C. H., "A Theory of Dispersion in Turbulent Shear Flow," Atmospheric Environ, 13:453, 1979.

[6]Horst, T. W., "Lagrangian Similarity Modeling of Vertical Diffusion From a Ground-Level Source," J Appl Meteorol, 18:733, 1979.

The Infinite Line Source

Turner[1] suggests that area sources may be treated by considering the area as a line source by compressing all of the sources into an infinite line running through the axis of the burst pattern. Concentrations at a given distance downwind may then be calculated from:

$$\chi = \frac{2q\Lambda\Omega}{\sin\,\phi\,\sqrt{2\pi}\,\sigma_z\bar{V}}\,\exp\left[-1/2\left(\frac{z}{\sigma_z}\right)^{3/2}\right] \qquad (3)$$

where ϕ is the angle between the wind direction and the line source, and $q = Q/L$ with L being the diameter of the burst. Equation (3) is not valid when ϕ is less than 45°. The vertical standard deviation σ_z is calculated in the same fashion as in the pseudopoint model. The horizontal standard deviation σ_y is required to calculate CWIC and is determined from:

$$\sigma_y = ax^b \qquad (4)$$

where the coefficient a and index b are functions of the Pasquill Stability Category. CWIC can then be calculated from the following:

$$\chi_{cwic} = \chi(L + 4,3\ \sigma_y) \qquad (5)$$

The factor 4.3 is included to delineate the visible edge of the plume, where the concentration decreases to 10 percent of the centerline value.

A comparison was made between the infinite line source and a finite line source, which is basically the same equation with an edge effect error function. The difference in downwind concentrations at screening distances were found to be insignificant.

Algebraic Integration Method

The pseudopoint and infinite line source models are very simplistic models based on unrealistic geometrics of the burst pattern. They are only capable of predicting an average value for CWIC. A more sophisticated approach would be to model the geometry of the burst to give a more realistic answer. The algebraic integration approach of Pasquill[2] attempts to model the geometry with a circular burst pattern, as shown in figure 1. The circular pattern is

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[1]Turner, D. B., Workbook of Atmospheric Dispersion Estimates, Public Health Service Publication No. 999-AP-26, Cincinnati, Ohio, Rev. 1969.

[2]Pasquill, F., Atmospheric Diffusion, second edition, Halsted Press Div, John Wiley and Sons, Inc., New York, 429 pp, 1974.

divided into crosswind strips of equal downwind lengths Δx. The strips are of varying widths, with the submunitions of the XM-825 spread uniformly throughout the pattern. A weighting factor W is used to represent the relative importance of the separate contributions from each strip and is given by:

$$W = n^{(1-d)} - (n - 1)^{(1-d)} \tag{6}$$

where n is the number of the strip (the first strip being farthest downwind). The index d is identical with that of equation (1). A sample of the weights for six strips for a surface roughness length of 10 cm and a Pasquill Stability Categoy of "B" is as follows:

n =	1	2	3	4	5	6
weighting factor =	1.0	0.11	0.07	0.05	0.04	0.04

Eighty-five percent of the source is contained in the first two strips due to the rapid decline in the contribution of the more distant strips.

The contribution to the downwind concentration of a given strip n is:

$$\chi = W\ A\ q_n (1-d)^{-1} \left[(j^{1-d}) \right]_{(n-1)\Delta x}^{n\Delta x} \tag{7}$$

where $A = \dfrac{\lambda \Omega}{\sin \Phi\ \pi\ \sigma_z \bar{V}}$, q_n is the source strength of strip n in grams per meter per second and j is a dummy variable. Calculating the total CWIC at some downwind sampling distance requires that concentrations first be calculated for each separate strip and then be summed over the six strips, using the appropriate weighting factors. In addition, σ_z must be calculated separately for each strip, since the successive strips are farther upwind by a distance of Δx. CWIC is then evaluated from:

$$\chi_{cwic} = \chi(L_s + 4.3\ \sigma_y) \tag{8}$$

assuming that L_s is the width of the source strips.

MODEL RESULTS AND EVALUATIONS

The three area sources postulates were used to evaluate seven sets of experimental data extracted from data reports published by Dugway Proving Ground.[4] Of the seven examples, three were chosen for inclusion in this report. The remainder were eliminated because of apparent improper burning characteristics, unfavorable wind direction, or a combination of both. A summary of test conditions is listed in table 1 and the test grid is illustrated in figure 2.

The integrated concentration values of the pseudopoint, infinite line, and algebraic integration models are as follows:

Test	Pseudopoint	Infinite Line	Algebraic Integration Peak	Algebraic Integration Mean
G1-A2	0.66 g m^{-2}	1.62 g m^{-2}	2.19 g m^{-2}	1.40 g m^{-2}
G2-A1	0.50 g m^{-2}	1.24 g m^{-2}	1.99 g m^{-2}	1.34 g m^{-2}
G4-A1	0.49 g m^{-2}	1.20 g m^{-2}	2.11 g m^{-2}	1.38 g m^{-2}

The pseudopoint model generates average integrated concentrations which are consistently the lowest of the three models. It underpredicts the measured values, as shown in figures 3, 4, and 5. This is not surprising, due to the simplifying assumptions in the model.

The infinite line model does better than the pseudopoint model in giving average integrated concentrations that are closer to the measured values, as shown in figures 3, 4, and 5. However, during the final 150 s of burn time the model overpredicts. For test G4-A1, the results are slightly high for the entire burn.

The algebraic integration model (which will be called the circle model due to the shape of the modeled burst) gives the best results of the three. This model generates both a peak and a geometric mean value for CWIC. The peak value is the highest CWIC that is expected for the given meteorological conditions and the distance from the optical line of sight. The threshold value of smoke which will obscure the visible wavelengths is calculated from:

$$CL = \frac{\ln T_{smk}}{-\alpha} \tag{9}$$

[4]Dugway Proving Ground, Development Test 1 of 155 mm Smoke Projectiles (XM-803 and XM-825), Defense Technical Information Center, Cameron Station, Alexandria, Virginia, 1979.

where CL is the concentration, T_{smk} the transmittance, and α the extinction coefficient. The threshold concentration is calculated to be 0.7 g m^{-2}. This value occurs at an average burn time of 450 s. By assuming the peak value occurs at the beginning of the burn, an estimate of the emission rate curve of the XM-825 can be made. The results are labeled "circle" in figures 3, 4, and 5. The actual emission characteristics curve, as reported by Carter,[7] indicates that the emission rate of the XM-825 decreases with time after its initial buildup time. This is due to the peculiarities of the burn characteristics of the phosphorous-impregnated felt submunitions. (The geometric mean value is listed with the model results shown previously.)

The overestimation of CWIC by this model for the first 75 s of the burn--which is evident in figures 3, 4, and 5--is a function of the buildup time, the time required for the smoke plume to reach the measuring line, and the percentage of the cloud that actually drifts through the optical line of sight. As with the infinite line model there is a slight overestimation of CWIC in test G4-A1. Both of these overestimates could be caused by the failure of some of the submunitions to burn properly, thus giving lower concentrations than would normally be expected.

The preliminary center-to-center impact separations can be computed based on the weighted circular model. The equation to compute the separation is a variation of equation (7), which is as follows:

$$x = \left[\frac{\sum_{1}^{n} (W_n q_n) \Omega \lambda}{\pi \bar{V} \; c \; \chi_{cwic}} \; \Delta x^{(1-d)} \right]^{d} \tag{10}$$

For stability category C the impact separation is 132 m, and for category B the impact separation is 121 m.

CONCLUSIONS

The pseudopoint model underpredicts the average integrated concentrations in all cases investigated. Therefore, this model would overpredict the number of munitions necessary to screen and would not be an acceptable model. The infinite line model, although better than the pseudopoint model still overpredicts the final 150 s of the burn. This would cause too few munitions to be expended, risking the deterioration of the screen. The circle model appears to be the best fit to the experimental data. It gives a fairly good

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[7]Dugway Proving Ground, Basic Smoke Characterization Test, TECOM-DPG-TP-77-311, Dugway Proving Ground, Utah, 1979.

estimate of the emission curve, as shown in figures 3, 4, and 5. The overestimation of the concentrations in the model only occurs during the first 75 s of the burn, which is the buildup time of the smoke generated by this munition. This model has the promise of giving good expenditure estimates, and it deserves further investigation.

TABLE 1. SUMMARY OF TEST CONDITIONS

Test	G1-A2	G2-A1	G4-A1
Date - Time	8 Aug 78 - 1020	8 Aug 78 - 1228	8 Sep 78 - 1219
Wind direction (8 m)	339°	338°	330°
Windspeed (8 m)	3.8 m/s	3.8 m/s	3.8 m/s
Relative humidity (4 m)	16%	14%	11%
Temperature (8 m)	29.3°C	30.8°C	31.7°C
Visibility (km)	48	48	48
Cloud cover	0%	0%	10%
Stability category	C	B	B
Entry angle	15.9°	15.9°	15.9°
Burst altitude (m)	102	103	101
Time to obscuration (s)	9.5	11	13

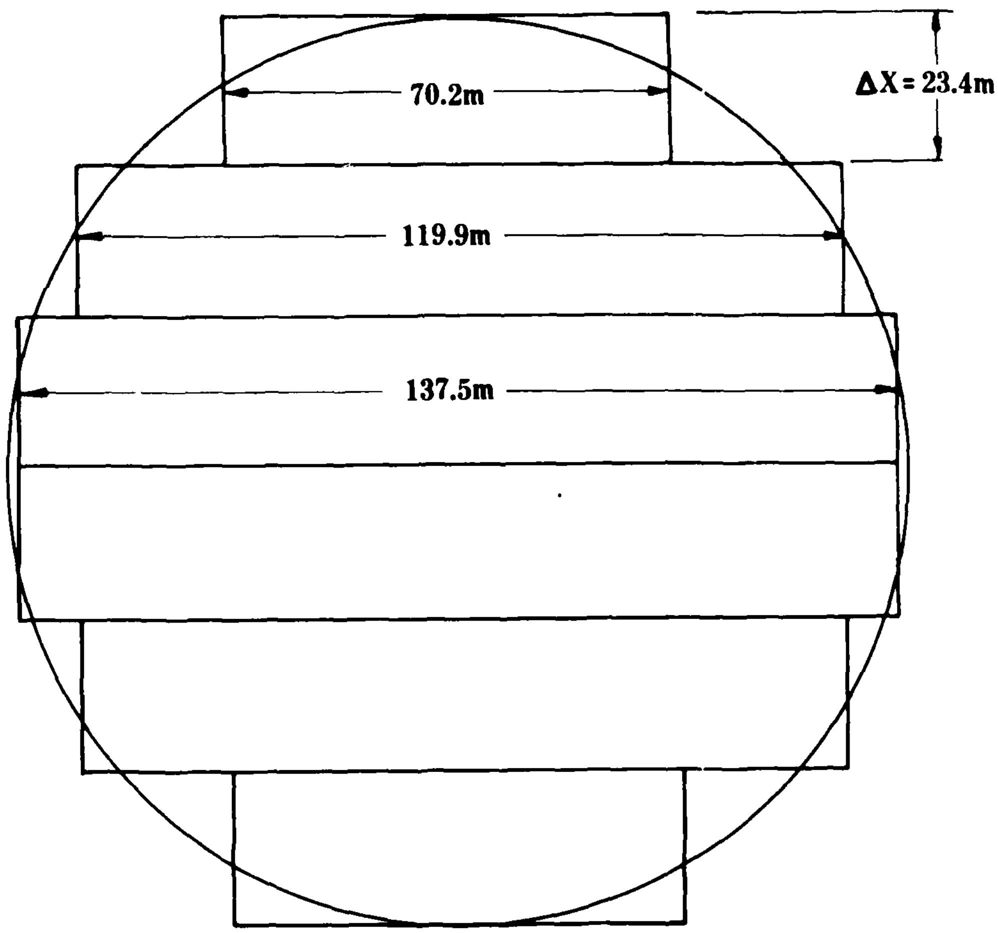
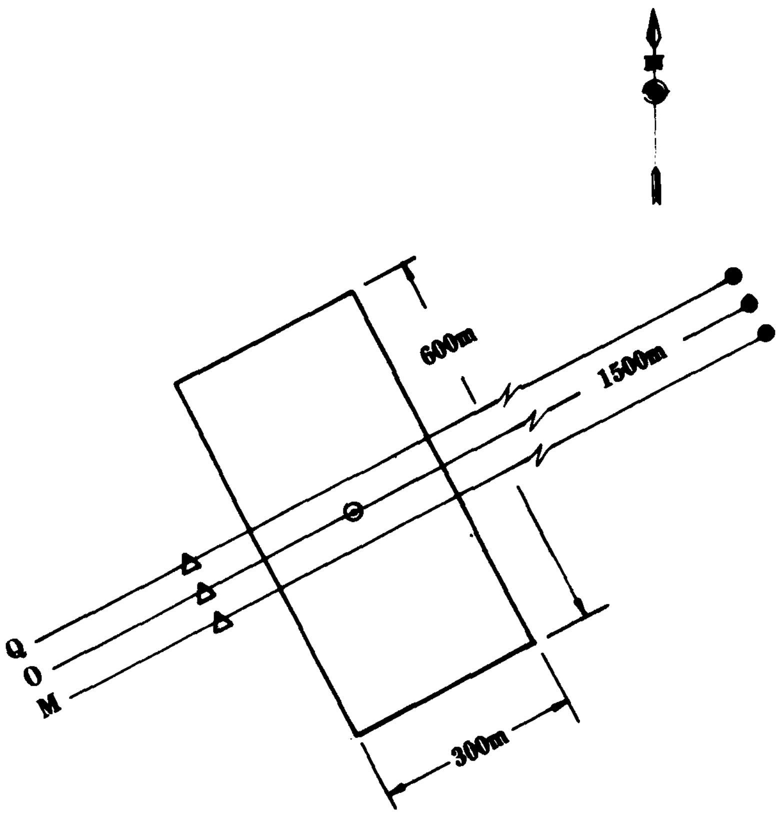


Figure 1. Circular representation of XM-825 area source and source strength strips.



△ MID IR TRANSMITTERS

● MID IR RECEIVERS

⊙ GRID CENTER

Figure 2. Test grid for XM-825 FWWP smoke munition.

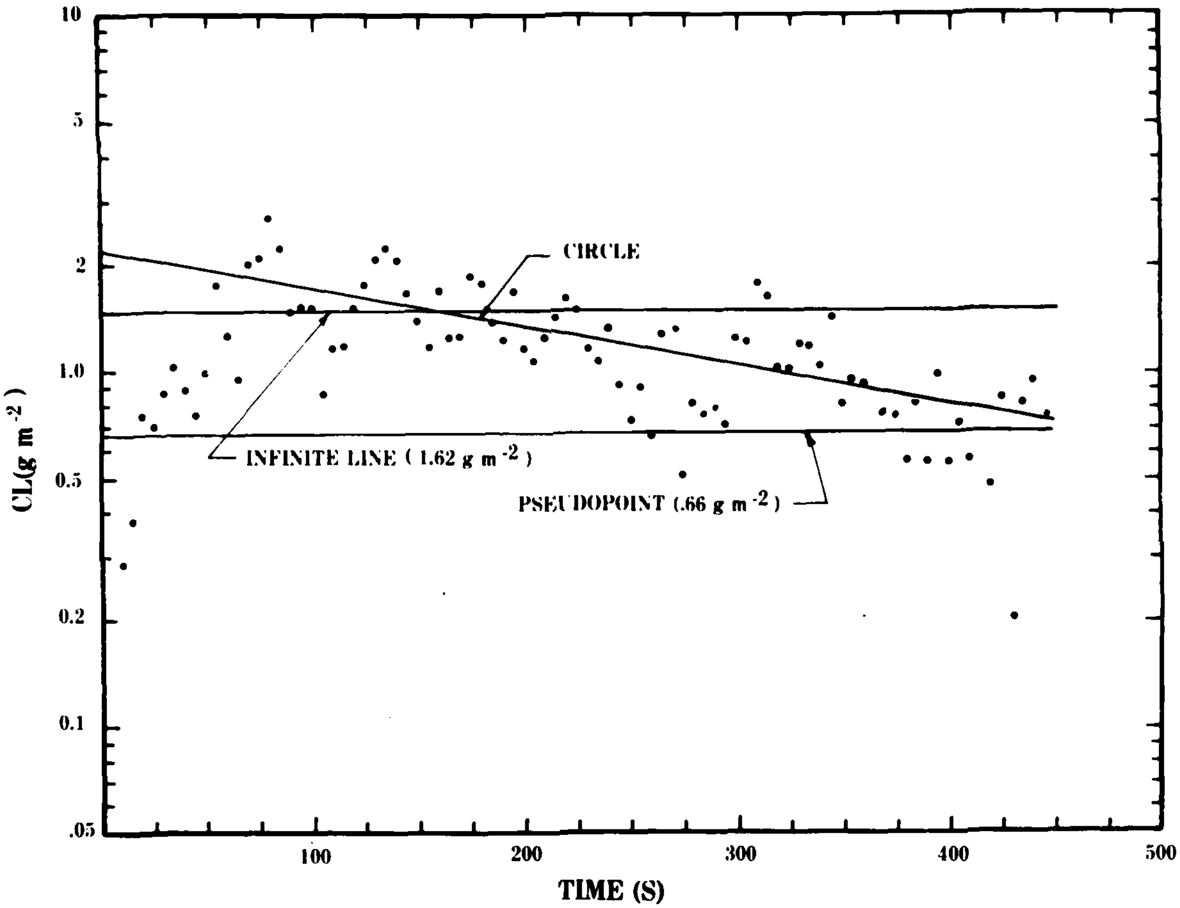


Figure 3. CWIC for XM-825 FWWP smoke munition, Test G1-A2.

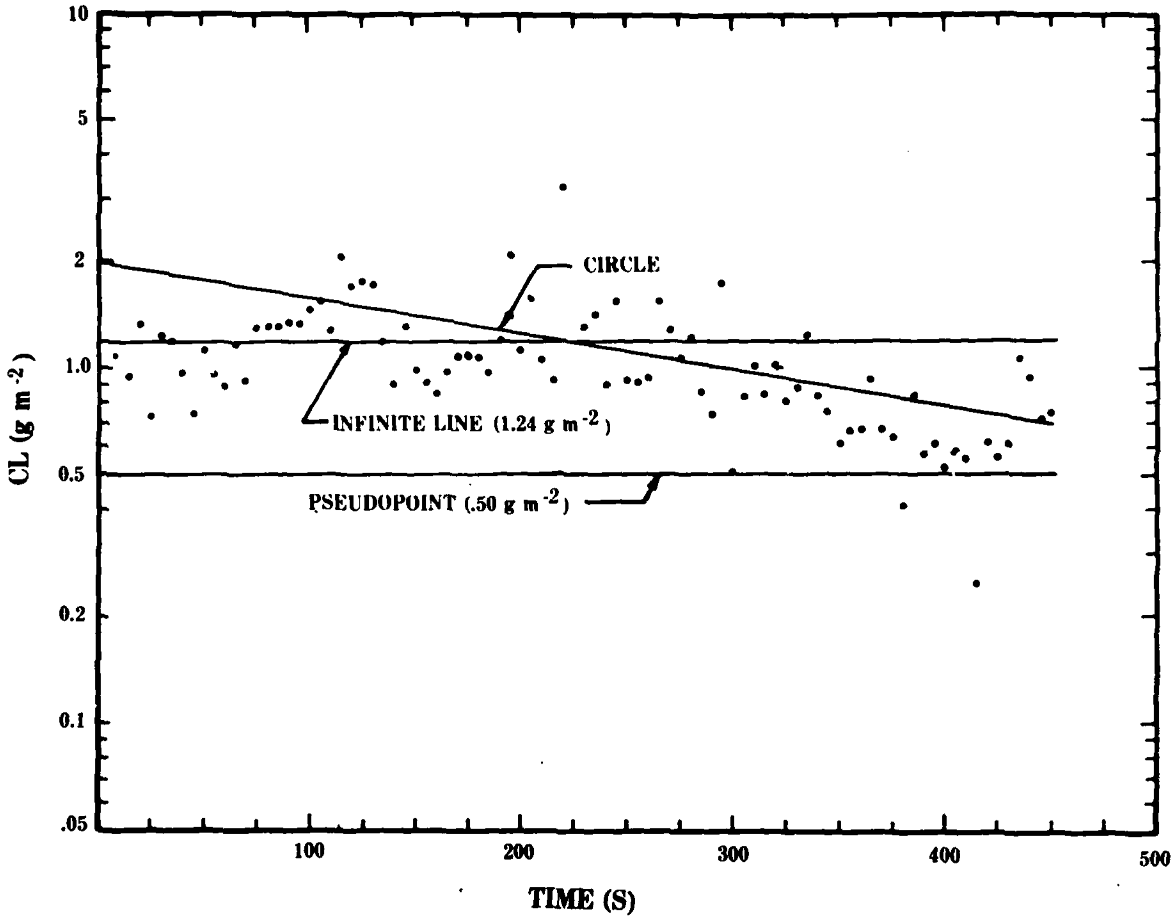


Figure 4. CWIC for XM-825 FWWP smoke munition, Test G2-A1..

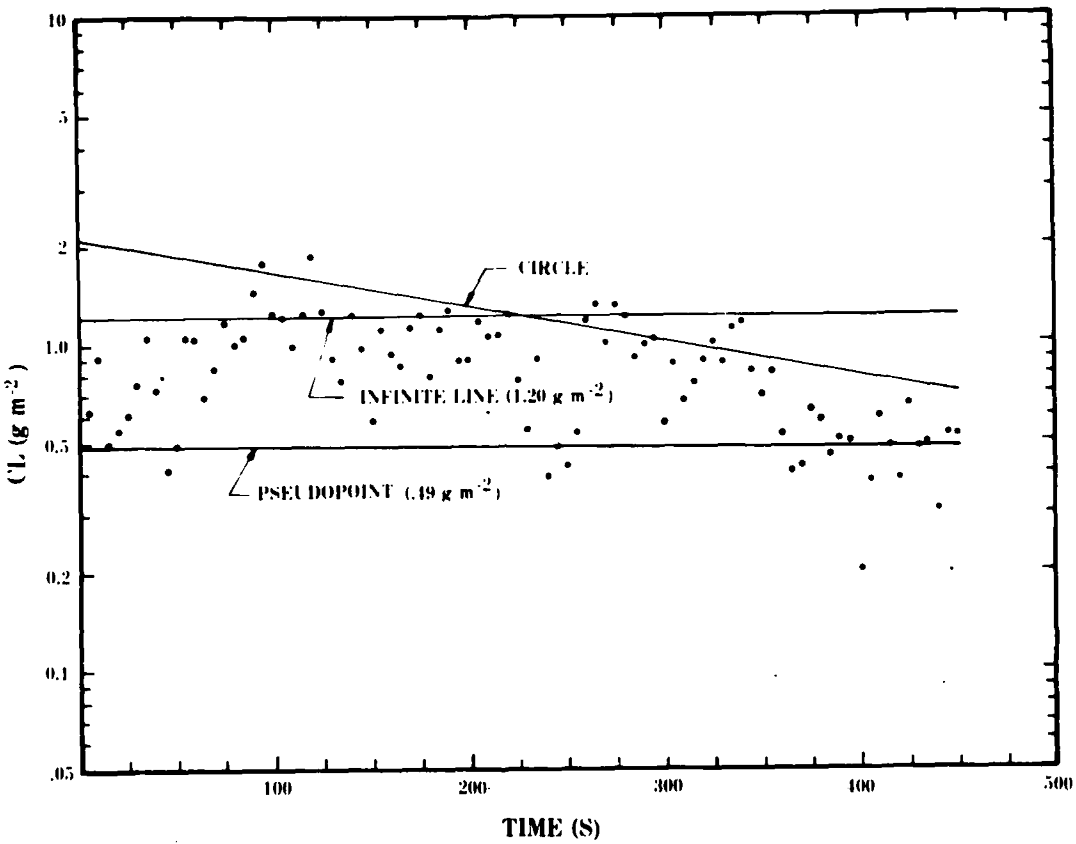


Figure 5. CWIC for XM-825 FWWP smoke munition, Test G4-A1.

REFERENCES

1. Turner, D. B., Workbook of Atmospheric Dispersion Estimates, Public Health Service Publication No. 999-AP-26, Cincinnati, Ohio, Rev. 1969.

2. Pasquill, F., Atmospheric Diffusion, second edition, Halsted Press Div, John Wiley and Sons, Inc., New York, 429 pp, 1974.

3. Umstead, R. K., R. Pena, and F. V. Hansen, KWIK; An Algorithm for Calculating Munition Expenditures for Smoke Screening/Observation in Tactical Situations, ASL-TR-0030, 1979.

4. Dugway Proving Ground, Development Test 1 of 155 mm Smoke Projectiles (XM-803 and XM-825), Defense Technical Information Center, Cameron Station, Alexandria, Virginia, 1979.

5. Huang, C. H., "A Theory of Dispersion in Turbulent Shear Flow," Atmospheric Environ, 13:453, 1979.

6. Horst, T. W., "Lagrangian Similarity Modeling of Vertical Diffusion From a Ground-Level Source," J Appl Meteorol, 18:733, 1979.

7. Dugway Proving Ground, Basic Smoke Characterization Test, TECOM-DPG-TP-77-311, Dugway Proving Ground, Utah, 1979.

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ATMOSPHERIC SCIENCES RESEARCH REPORTS

1. Lindberg, J. D. "An Improvement to a Method for Measuring the Absorption Coefficient of Atmospheric Dust and other Strongly Absorbing Powders," ECOM-5565, July 1975.

2. Avara, Elton P., "Mesoscale Wind Shears Derived from Thermal Winds," ECOM-5566, July 1975.

3. Gomez, Richard B., and Joseph H. Pierluissi, "Incomplete Gamma Function Approximation for King's Strong-Line Transmittance Model," ECOM-5567, July 1975.

4. Blanco, A. J., and B. F. Engebos, "Ballistic Wind Weighting Functions for Tank Projectiles," ECOM-5568, August 1975.

5. Taylor, Fredrick J., Jack Smith, and Thomas H. Pries, "Crosswind Measurements through Pattern Recognition Techniques," ECOM-5569, July 1975.

6. Walters, D. L., "Crosswind Weighting Functions for Direct-Fire Projectiles," ECOM-5570, August 1975.

7. Duncan, Louis D., "An Improved Algorithm for the Iterated Minimal Information Solution for Remote Sounding of Temperature," ECOM-5571, August 1975.

8. Robbiani, Raymond L., "Tactical Field Demonstration of Mobile Weather Radar Set AN/TPS-41 at Fort Rucker, Alabama," ECOM-5572, August 1975.

9. Miers, B., G. Blackman, D. Langer, and N. Lorimier, "Analysis of SMS/GOES Film Data," ECOM-5573, September 1975.

10. Manquero, Carlos, Louis Duncan, and Rufus Bruce, "An Indication from Satellite Measurements of Atmospheric CO_2 Variability," ECOM-5574, September 1975.

11. Petracca, Carmine, and James D. Lindberg, "Installation and Operation of an Atmospheric Particulate Collector," ECOM-5575, September 1975.

12. Avara, Elton P., and George Alexander, "Empirical Investigation of Three Iterative Methods for Inverting the Radiative Transfer Equation," ECOM-5576, October 1975.

13. Alexander, George D., "A Digital Data Acquisition Interface for the SMS Direct Readout Ground Station - Concept and Preliminary Design," ECOM-5577, October 1975.

14. Cantor, Israel, "Enhancement of Point Source Thermal Radiation Under Clouds in a Nonattenuating Medium," ECOM-5578, October 1975.

15. Norton, Colburn, and Glenn Hoidale, "The Diurnal Variation of Mixing Height by Month over White Sands Missile Range, NM," ECOM-5579, November 1975.

16. Avara, Elton P., "On the Spectrum Analysis of Binary Data," ECOM-5580, November 1975.

17. Taylor, Fredrick J., Thomas H. Pries, and Chao-Huan Huang, "Optimal Wind Velocity Estimation," ECOM-5581, December 1975.

18. Avara, Elton P., "Some Effects of Autocorrelated and Cross-Correlated Noise on the Analysis of Variance," ECOM-5582, December 1975.

19. Gillespie, Patti S., R. L. Armstrong, and Kenneth O. White, "The Spectral Characteristics and Atmospheric CO_2 Absorption of the Ho^{+3}:YLF Laser at 2.05μm," ECOM-5583, December 1975.

20. Novlan, David J., "An Empirical Method of Forecasting Thunderstorms for the White Sands Missile Range," ECOM-5584, February 1976.

21. Avara, Elton P., "Randomization Effects in Hypothesis Testing with Autocorrelated Noise," ECOM-5585, February 1976.

22. Watkins, Wendell R., "Improvements in Long Path Absorption Cell Measurement," ECOM-5586, March 1976.

23. Thomas, Joe, George D. Alexander, and Marvin Dubbin, "SATTEL - An Army Dedicated Meteorological Telemetry System," ECOM-5587, March 1976.

24. Kennedy, Bruce W., and Delbert Bynum, "Army User Test Program for the RDT&E-XM-75 Meteorological Rocket," ECOM-5588, April 1976.

25. Barnett, Kenneth M., "A Description of the Artillery Meteorological Comparisons at White Sands Missile Range, October 1974 - December 1974 ('PASS' - Prototype Artillery [Meteorological] Subsystem)," ECOM-5589, April 1976.

26. Miller, Walter B., "Preliminary Analysis of Fall-of-Shot From Project 'PASS'," ECOM-5590, April 1976.

27. Avara, Elton P., "Error Analysis of Minimum Information and Smith's Direct Methods for Inverting the Radiative Transfer Equation," ECOM-5591, April 1976.

28. Yee, Young P., James D. Horn, and George Alexander, "Synoptic Thermal Wind Calculations from Radiosonde Observations Over the Southwestern United States," ECOM-5592, May 1976.

29. Duncan, Louis D., and Mary Ann Seagraves, "Applications of Empirical Corrections to NOAA-4 VTPR Observations," ECOM-5593, May 1976.

30. Miers, Bruce T., and Steve Weaver, "Applications of Meteorological Satellite Data to Weather Sensitive Army Operations," ECOM-5594, May 1976.

31. Sharenow, Moses, "Redesign and Improvement of Balloon ML-566," ECOM-5595, June 1976.

32. Hansen, Frank V., "The Depth of the Surface Boundary Layer," ECOM-5596, June 1976.

33. Pinnick, R. G., and E. B. Stenmark, "Response Calculations for a Commerical Light-Scattering Aerosol Counter," ECOM-5597, July 1976.

34. Mason, J., and G. B. Hoidale, "Visibility as an Estimator of Infrared Transmittance," ECOM-5598, July 1976.

35. Bruce, Rufus E., Louis D. Duncan, and Joseph H. Pierluissi, "Experimental Study of the Relationship Between Radiosonde Temperatures and Radiometric-Area Temperatures," ECOM-5599, August 1976.

36. Duncan, Louis D., "Stratospheric Wind Shear Computed from Satellite Thermal Sounder Measurements," ECOM-5800, September 1976.

37. Taylor, F., P. Mohan, P. Joseph, and T. Pries, "An All Digital Automated Wind Measurement System," ECOM-5801, September 1976.

38. Bruce, Charles, "Development of Spectrophones for CW and Pulsed Radiation Sources," ECOM-5802, September 1976.

39. Duncan, Louis D., and Mary Ann Seagraves, "Another Method for Estimating Clear Column Radiances," ECOM-5803, October 1976.

40. Blanco, Abel J., and Larry E. Taylor, "Artillery Meteorological Analysis of Project Pass," ECOM-5804, October 1976.

41. Miller, Walter, and Bernard Engebos, "A Mathematical Structure for Refinement of Sound Ranging Estimates," ECOM-5805, November 1976.

42. Gillespie, James B., and James D. Lindberg, "A Method to Obtain Diffuse Reflectance Measurements from 1.0 and 3.0μm Using a Cary 17I Spectrophotometer," ECOM-5806, November 1976.

43. Rubio, Roberto, and Robert O. Olsen, "A Study of the Effects of Temperature Variations on Radio Wave Absorption," ECOM-5807, November 1976.

44. Ballard, Harold N., "Temperature Measurements in the Stratosphere from Balloon-Borne Instrument Platforms, 1968-1975," ECOM-5808, December 1976.

45. Monahan, H. H., "An Approach to the Short-Range Prediction of Early Morning Radiation Fog," ECOM-5809, January 1977.

46. Engebos, Bernard Francis, "Introduction to Multiple State Multiple Action Decision Theory and Its Relation to Mixing Structures," ECOM-5810, January 1977.

47. Low, Richard D. H., "Effects of Cloud Particles on Remote Sensing from Space in the 10-Micrometer Infrared Region," ECOM-5811, January 1977.

48. Bonner, Robert S., and R. Newton, "Application of the AN/GVS-5 Laser Rangefinder to Cloud Base Height Measurements," ECOM-5812, February 1977.

49. Rubio, Roberto, "Lidar Detection of Subvisible Reentry Vehicle Erosive Atmospheric Material," ECOM-5813, March 1977.

50. Low, Richard D. H., and J. D. Horn, "Mesoscale Determination of Cloud-Top Height: Problems and Solutions," ECOM-5814, March 1977.

51. Duncan, Louis D., and Mary Ann Seagraves, "Evaluation of the NOAA-4 VTPR Thermal Winds for Nuclear Fallout Predictions," ECOM-5815, March 1977.

52. Randhawa, Jagir S., M. Izquierdo, Carlos McDonald, and Zvi Salpeter, "Stratospheric Ozone Density as Measured by a Chemiluminescent Sensor During the Stratcom VI-A Flight," ECOM-5816, April 1977.

53. Rubio, Roberto, and Mike Izquierdo, "Measurements of Net Atmospheric Irradiance in the 0.7- to 2.8-Micrometer Infrared Region," ECOM-5817, May 1977.

54. Ballard, Harold N., Jose M. Serna, and Frank P. Hudson, Consultant for Chemical Kinetics, "Calculation of Selected Atmospheric Composition Parameters for the Mid-Latitude, September Stratosphere," ECOM-5818, May 1977.

55. Mitchell, J. D., R. S. Sagar, and R. O. Olsen, "Positive Ions in the Middle Atmosphere During Sunrise Conditions," ECOM-5819, May 1977.

56. White, Kenneth O., Wendell R. Watkins, Stuart A. Schleusener, and Ronald L. Johnson, "Solid-State Laser Wavelength Identification Using a Reference Absorber," ECOM-5820, June 1977.

57. Watkins, Wendell R., and Richard G. Dixon, "Automation of Long-Path Absorption Cell Measurements," ECOM-5821, June 1977.

58. Taylor, S. E., J. M. Davis, and J. B. Mason, "Analysis of Observed Soil Skin Moisture Effects on Reflectance," ECOM-5822, June 1977.

59. Duncan, Louis D., and Mary Ann Seagraves, "Fallout Predictions Computed from Satellite Derived Winds," ECOM-5823, June 1977.

60. Snider, D. E., D. G. Murcray, F. H. Murcray, and W. J. Williams, "Investigation of High-Altitude Enhanced Infrared Backround Emissions," (U), SECRET, ECOM-5824, June 1977.

61. Dubbin, Marvin H., and Dennis Hall, "Synchronous Meteorological Satellite Direct Readout Ground System Digital Video Electronics," ECOM-5825, June 1977.

62. Miller, W., and B. Engebos, "A Preliminary Analysis of Two Sound Ranging Algorithms," ECOM-5826, July 1977.

63. Kennedy, Bruce W., and James K. Luers, "Ballistic Sphere Techniques for Measuring Atmospheric Parameters," ECOM-5827, July 1977.

64. Duncan, Louis D., "Zenith Angle Variation of Satellite Thermal Sounder Measurements," ECOM-5828, August 1977.

65. Hansen, Frank V., "The Critical Richardson Number," ECOM-5829, September 1977.

66. Ballard, Harold N., and Frank P. Hudson (Compilers), "Stratospheric Composition Balloon-Borne Experiment," ECOM-5830, October 1977.

67. Barr, William C., and Arnold C. Peterson, "Wind Measuring Accuracy Test of Meteorological Systems," ECOM-5831, November 1977.

68. Ethridge, G. A., and F. V. Hansen, "Atmospheric Diffusion: Similarity Theory and Empirical Derivations for Use in Boundary Layer Diffusion Problems," ECOM-5832, November 1977.

69. Low, Richard D. H., "The Internal Cloud Radiation Field and a Technique for Determining Cloud Blackness," ECOM-5833, December 1977.

70. Watkins, Wendell R., Kenneth O. White, Charles W. Bruce, Donald L. Walters, and James D. Lindberg, "Measurements Required for Prediction of High Energy Laser Transmission," ECOM-5834, December 1977.

71. Rubio, Robert, "Investigation of Abrupt Decreases in Atmospherically Backscattered Laser Energy," ECOM-5835, December 1977.

72. Monahan, H. H., and R. M. Cionco, "An Interpretative Review of Existing Capabilities for Measuring and Forecasting Selected Weather Variables (Emphasizing Remote Means)," ASL-TR-0001, January 1978.

73. Heaps, Melvin G., "The 1979 Solar Eclipse and Validation of D-Region Models," ASL-TR-0002, March 1978.

74. Jennings, S. G., and J. B. Gillespie, "M.I.E. Theory Sensitivity Studies - The Effects of Aerosol Complex Refractive Index and Size Distribution Variations on Extinction and Absorption Coefficients, Part II: Analysis of the Computational Results," ASL-TR-0003, March 1978.

75. White, Kenneth O., et al, "Water Vapor Continuum Absorption in the 3.5μm to 4.0μm Region," ASL-TR-0004, March 1978.

76. Olsen, Robert O., and Bruce W. Kennedy, "ABRES Pretest Atmospheric Measurements," ASL-TR-0005, April 1978.

77. Ballard, Harold N., Jose M. Serna, and Frank P. Hudson, "Calculation of Atmospheric Composition in the High Latitude September Stratosphere," ASL-TR-0006, May 1978.

78. Watkins, Wendell R., et al, "Water Vapor Absorption Coefficients at HF Laser Wavelengths," ASL-TR-0007, May 1978.

79. Hansen, Frank V., "The Growth and Prediction of Nocturnal Inversions," ASL-TR-0008, May 1978.

80. Samuel, Christine, Charles Bruce, and Ralph Brewer, "Spectrophone Analysis of Gas Samples Obtained at Field Site," ASL-TR-0009, June 1978.

81. Pinnick, R. G., et al., "Vertical Structure in Atmospheric Fog and Haze and its Effects on IR Extinction," ASL-TR-0010, July 1978.

82. Low, Richard D. H., Louis D. Duncan, and Richard B. Gomez, "The Microphysical Basis of Fog Optical Characterization," ASL-TR-0011, August 1978.

83. Heaps, Melvin G., "The Effect of a Solar Proton Event on the Minor Neutral Constituents of the Summer Polar Mesosphere," ASL-TR-0012, August 1978.

84. Masor[illegible]mes B., "Light Attenuation in Falling Snow," ASL-TR-0013, August [illegible].

85. Blanco, Abel J., "Long-Range Artillery Sound Ranging: 'PASS' Meteorological Application," ASL-TR-0014, September 1978.

86. Heaps, M. G., and F. E. Niles, "Modeling of Ion Chemistry of the D-Region: A Case Study Based Upon the 1966 Total Solar Eclipse," ASL-TR-0015, September 1978.

87. Jennings, S. G., and R. G. Pinnick, "Effects of Particulate Complex Refractive Index and Particle Size Distribution Variations on Atmospheric Extinction and Absorption for Visible Through Middle-Infrared Wavelengths," ASL-TR-0016, September 1978.

88. Watkins, Wendell R., Kenneth O. White, Lanny R. Bower, and Brian Z. Sojka, "Pressure Dependence of the Water Vapor Continuum Absorption in the 3.5- to 4.0-Micrometer Region," ASL-TR-0017, September 1978.

89. Miller, W. B., and B. F. Engebos, "Behavior of Four Sound Ranging Techniques in an Idealized Physical Environment," ASL-TR-0018, September 1978.

90. Gomez, Richard G., "Effectiveness Studies of the CBU-88/B Bomb, Cluster, Smoke Weapon," (U), CONFIDENTIAL ASL-TR-0019, September 1978.

91. Miller, August, Richard C. Shirkey, and Mary Ann Seagraves, "Calculation of Thermal Emission from Aerosols Using the Doubling Technique," ASL-TR-0020, November 1978.

92. Lindberg, James D., et al, "Measured Effects of Battlefield Dust and Smoke on Visible, Infrared, and Millimeter Wavelengths Propagation: A Preliminary Report on Dusty Infrared Test-I (DIRT-I)," ASL-TR-0021, January 1979.

93. Kennedy, Bruce W., Arthur Kinghorn, and B. R. Hixon, "Engineering Flight Tests of Range Meteorological Sounding System Radiosonde," ASL-TR-0022, February 1979.

94. Rubio, Roberto, and Don Hoock, "Microwave Effective Earth Radius Factor Variability at Wiesbaden and Balboa," ASL-TR-0023, February 1979.

95. Low, Richard D. H., "A Theoretical Investigation of Cloud/Fog Optical Properties and Their Spectral Correlations, "ASL-TR-0024, February 1979.

96. Pinnick, R. G., and H. J. Auvermann, "Response Characteristics of Knollenberg Light-Scattering Aerosol Counters," ASL-TR-0025, February 1979.

97. Heaps, Melvin G., Robert O. Olsen, and Warren W. Berning, "Solar Eclipse 1979, Atmospheric Sciences Laboratory Program Overview," ASL-TR-0026, February 1979.

98. Blanco, Abel J., "Long-Range Artillery Sound Ranging: 'PASS' GR-8 Sound Ranging Data," ASL-TR-0027, March 1979.

99. Kennedy, Bruce W., and Jose M. Serna, "Meteorological Rocket Network System Reliability," ASL-TR-0028, March 1979.

100. Swingle, Donald M., "Effects of Arrival Time Errors in Weighted Range Equation Solutions for Linear Base Sound Ranging," ASL-TR-0029, April 1979.

101. Umstead, Robert K., Ricardo Pena, and Frank V. Hansen, "KWIK: An Algorithm for Calculating Munition Expenditures for Smoke Screening/Obscuration in Tactical Situations," ASL-TR-0030, April 1979.

102. D'Arcy, Edward M., "Accuracy Validation of the Modified Nike Hercules Radar," ASL-TR-0031, May 1979.

103. Rodriguez, Ruben, "Evaluation of the Passive Remote Crosswind Sensor," ASL-TR-0032, May 1979.

104. Barber, T. L., and R. Rodriguez, "Transit Time Lidar Measurement of Near-Surface Winds in the Atmosphere," ASL-TR-0033, May 1979.

105. Low, Richard D. H., Louis D. Duncan, and Y. Y. Roger R. Hsiao, "Microphysical and Optical Properties of California Coastal Fogs at Fort Ord," ASL-TR-0034, June 1979.

106. Rodriguez, Ruben, and William J. Vechione, "Evaluation of the Saturation Resistant Crosswind Sensor," ASL-TR-0035, July 1979.

107. Ohmstede, William D., "The Dynamics of Material Layers," ASL-TR-0036, July 1979.

108. Pinnick, R. G., S. G. Jennings, Petr Chylek, and H. J. Auvermann, "Relationships between IR Extinction Absorption, and Liquid Water Content of Fogs," ASL-TR-0037, August 1979.

109. Rodriguez, Ruben, and William J. Vechione, "Performance Evaluation of the Optical Crosswind Profiler," ASL-TR-0038, August 1979.

110. Miers, Bruce T., "Precipitation Estimation Using Satellite Data," ASL-TR-0039, September 1979.

111. Dickson, David H., and Charles M. Sonnenschein, "Helicopter Remote Wind Sensor System Description," ASL-TR-0040, September 1979.

112. Heaps, Melvin G., and Joseph M. Heimerl, "Validation of the Dairchem Code, I: Quiet Midlatitude Conditions," ASL-TR-0041, September 1979.

113. Bonner, Robert S., and William J. Lentz, "The Visioceilometer: A Portable Cloud Height and Visibility Indicator," ASL-TR-0042, October 1979.

114. Cohn, Stephen L., "The Role of Atmospheric Sulfates in Battlefield Obscurations," ASL-TR-0043, October 1979.

115. Fawbush, E. J., et al, "Characterization of Atmospheric Conditions at the High Energy Laser System Test Facility (HELSTF), White Sands Missile Range, New Mexico, Part I, 24 March to 8 April 1977," ASL-TR-0044, November 1979.

116. Barber, Ted L., "Short-Time Mass Variation in Natural Atmospheric Dust," ASL-TR-0045, November 1979.

117. Low, Richard D. H., "Fog Evolution in the Visible and Infrared Spectral Regions and its Meaning in Optical Modeling," ASL-TR-0046, December 1979.

118. Duncan, Louis D., et al, "The Electro-Optical Systems Atmospheric Effects Library, Volume I: Technical Documentation," ASL-TR-0047, December 1979.

119. Shirkey, R. C., et al, "Interim E-O SAEL, Volume II, Users Manual," ASL-TR-0048, December 1979.

120. Kobayashi, H. K., "Atmospheric Effects on Millimeter Radio Waves," ASL-TR-0049, January 1980.

121. Seagraves, Mary Ann, and Louis D. Duncan, "An Analysis of Transmittances Measured Through Battlefield Dust Clouds," ASL-TR-0050, February 1980.

122. Dickson, David H., and Jon E. Ottesen, "Helicopter Remote Wind Sensor Flight Test," ASL-TR-0051, February 1980.

123. Pinnick, R. G., and S. G. Jennings, "Relationships Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, and Sulfuric Acid Military Smokes," ASL-TR-0052, April 1980.

124. Hinds, B. D., and J. B. Gillespie, "Optical Characterization of Atmospheric Particulates on San Nicolas Island, California," ASL-TR-0053, April 1980.

125. Miers, Bruce T., "Precipitation Estimation for Military Hydrology," ASL-TR-0054, April 1980.

126. Stenmark, Ernest B., "Objective Quality Control of Artillery Computer Meteorological Messages," ASL-TR-0055, April 1980.

127. Duncan, Louis D., and Richard D. H. Low, "Bimodal Size Distribution Models for Fogs at Meppen, Germany," ASL-TR-0056, April 1980.

128. Olsen, Robert O., and Jagir S. Randhawa, "The Influence of Atmospheric Dynamics on Ozone and Temperature Structure," ASL-TR-0057, May 1980.

129. Kennedy, Bruce W., et al, "Dusty Infrared Test-II (DIRT-II) Program," ASL-TR-0058, May 1980.

130. Heaps, Melvin G., Robert O. Olsen, Warren Berning, John Cross, and Arthur Gilcrease, "1979 Solar Eclipse, Part I - Atmospheric Sciences Laboratory Field Program Summary," ASL-TR-0059, May 1980

131. Miller, Walter B., "User's Guide for Passive Target Acquisition Program Two (PTAP-2)," ASL-TR-0060, June 1980.

132. Holt, E. H., editor, "Atmospheric Data Requirements for Battlefield Obscuration Applications," ASL-TR-0061, June 1980.

133. Shirkey, Richard C., August Miller, George H. Goedecke, and Yugal Behl, "Single Scattering Code AGAUSX: Theory, Applications, Comparisons, and Listing," ASL-TR-0062, July 1980.

134. Sojka, Brian Z., and Kenneth O. White, "Evaluation of Specialized Photoacoustic Absorption Chambers for Near-Millimeter Wave (NMMW) Propagation Measurements," ASL-TR-0063, August 1980.

135. Bruce, Charles W., Young Paul Yee, and S. G. Jennings, "In Situ Measurement of the Ratio of Aerosol Absorption to Extinction Coefficient," ASL-TR-0064, August 1980.

136. Yee, Young Paul, Charles W. Bruce, and Ralph J. Brewer, "Gaseous/Particulate Absorption Studies at WSMR using Laser Sourced Spectrophones," ASL-TR-0065, June 1980.

137. Lindberg, James D., Radon B. Loveland, Melvin Heaps, James B. Gillespie, and Andrew F. Lewis, "Battlefield Dust and Atmospheric Characterization Measurements During West German Summertime Conditions in Support of Grafenwohr Tests," ASL-TR-0066, September 1980.

138. Vechione, W. J., "Evaluation of the Environmental Instruments, Incorporated Series 200 Dual Component Wind Set," ASL-TR-0067, September 1980.

139. Bruce, C. W., Y. P. Yee, B. D. Hinds, R. G. Pinnick, R. J. Brewer, and J. Minjares, "Initial Field Measurements of Atmospheric Absorption at 9μm to 11μm Wavelengths," ASL-TR-0068, October 1980.

140. Heaps, M. G., R. O. Olsen, K. D. Baker, D. A. Burt, L. C. Howlett, L. L. Jensen, E. F. Pound, and G. D. Allred, "1979 Solar Eclipse: Part II Initial Results for Ionization Sources, Electron Density, and Minor Neutral Constituents," ASL-TR-0069, October 1980.

141. Low, Richard D. H., "One-Dimensional Cloud Microphysical Models for Central Europe and their Optical Properties," ASL-TR-0070, October 1980.

142. Duncan, Louis D., James D. Lindberg, and Radon B. Loveland, "An Empirical Model of the Vertical Structure of German Fogs," ASL-TR-0071, November 1980.

143. Duncan, Louis D., 1981, "EOSAEL 80, Volume I, Technical Documentation," ASL-TR-0072, January 1981.

144. Shirkey, R. C., and S. G. O'Brien, "EOSAEL 80, Volume II, Users Manual," ASL-TR-0073, January 1981.

145. Bruce, C. W., "Characterization of Aerosol Nonlinear Effects on a High-Power CO_2 Laser Beam," ASL-TR-0074, February 1981.

146. Duncan, Louis D., and James D. Lindberg, "Air Mass Considerations in Fog Optical Modeling," ASL-TR-0075, February 1981.

147. Kunkel, Kenneth E., "Evaluation of a Tethered Kite Anemometer," ASL-TR-0076, February 1981.

148. Kunkel, K. E., et al, "Characterization of Atmospheric Conditions at the High Energy Laser System Test Facility (HELSTF) White Sands Missile Range, New Mexico, August 1977 to October 1978, Part II, Optical Turbulence, Wind, Water Vapor Pressure, Temperature," ASL-TR-0077, February 1981.

149. Miers, Bruce T., "Weather Scenarios for Central Germany," ASL-TR-0078, February 1981.

150. Cogan, James L., "Sensitivity Analysis of a Mesoscale Moisture Model," ASL-TR-0079, March 1981.

151. Brewer, R. J., C. W. Bruce, and J. L. Mater, "Optoacoustic Spectroscopy of C_2H_4 at the 9μm and 10μm $C^{12}O_2^{16}$ Laser Wavelengths," ASL-TR-0080, March 1981.

152. Swingle, Donald M., "Reducible Errors in the Artillery Sound Ranging Solution, Part I: The Curvature Correction" (U), SECRET, ASL-TR-0081, April 1981.

153. Miller, Walter B., "The Existence and Implications of a Fundamental System of Linear Equations in Sound Ranging" (U), SECRET, ASL-TR-0082, April 1981.

154. Bruce, Dorothy, Charles W. Bruce, and Young Paul Yee, "Experimentally Determined Relationship Between Extinction and Liquid Water Content," ASL-TR-0083, April 1981.

155. Seagraves, Mary Ann, "Visible and Infrared Obscuration Effects of Ice Fog," ASL-TR-0084, May 1981.

156. Watkins, Wendell R., and Kenneth O. White, "Wedge Absorption Remote Sensor," ASL-TR-0085, May 1981.

157. Watkins, Wendell R., Kenneth O. White, and Laura J. Crow, "Turbulence Effects on Open Air Multipaths," ASL-TR-0086, May 1981.

158. Blanco, Abel J., "Extending Application of the Artillery Computer Meteorological Message," ASL-TR-0087, May 1981.

159. Heaps, M. G., D. W. Hoock, R. O. Olsen, B. F. Engebos, and R. Rubio, "High Frequency Position Location: An Assessment of Limitations and Potential Improvements," ASL-TR-0088, May 1981.

160. Watkins, Wendell R., and Kenneth O. White, "Laboratory Facility for Measurement of Hot Gaseous Plume Radiative Transfer," ASL-TR-0089, June 1981.

161. Heaps, M. G., "Dust Cloud Models: Sensitivity of Calculated Transmittances to Variations in Input Parameters," ASL-TR-0090, June 1981.

162. Seagraves, Mary Ann, "Some Optical Properties of Blowing Snow," ASL-TR-0091, June 1981.

163. Kobayashi, Herbert K., "Effect of Hail, Snow, and Melting Hydrometeors on Millimeter Radio Waves," ASL-TR-0092, July 1981.

164. Cogan, James L., "Techniques for the Computation of Wind, Ceiling, and Extinction Coefficient Using Currently Acquired RPV Data," ASL-TR-0093, July 1981.

165. Miller, Walter B., and Bernard F. Engebos, "On the Possibility of Improved Estimates for Effective Wind and Temperature," (U), SECRET, ASL-TR-0094, August 1981.

166. Heaps, Melvin G., "The Effect of Ionospheric Variability on the Accuracy of High Frequency Position Location," ASL-TR-0095, August 1981.

167. Sutherland, Robert A., Donald W. Hoock, and Richard B. Gomez, "An Objective Summary of US Army Electro-Optical Modeling and Field Testing in an Obscuring Environment," ASL-TR-0096, October 1981.

168. Pinnick, R. G., et al, "Backscatter and Extinction in Water Clouds," ASL-TR-0097, October 1981.

169. Cole, Henry P., and Melvin G. Heaps, "Properties of Dust as an Electron and Ion Attachment Site for Use in D Region Ion Chemistry," ASL-TR-0098, October 1981.

170. Spellicy, Robert L., Laura J. Crow, and Kenneth O. White, "Water Vapor Absorption Coefficients at HF Laser Wavelengths Part II: Development of the Measurement System and Measurements at Simulated Altitudes to 10 KM," ASL-TR-0099, November 1981.

171. Cohn, Stephen L., "Transport and Diffusion Solutions for Obscuration Using the XM-825 Smoke Munition," ASL-TR-0100, November 1981.

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2-8