Image Cover Sheet

CLASSIFICATION	SYSTEM NUMBER
UNCLASSIFIED	150526

TITLE

DETECTION OF BW AGENTS: DUGWAY TRINATIONAL BW FIELD TRIAL 20-30 OCTOBER 1993, DUGWAY, UTAH MOBILE AEROSOL SMAPLING UNIT DATA ANALYSIS

System Number:

Patron Number:

Requester:

Notes:

DSIS Use only:

Deliver to: FF

DRES

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD

SR 619

UNCLASSIFIED

DETECTION OF BW AGENTS: DUGWAY TRINATIONAL BW FIELD TRIAL 20-30 OCTOBER 1993, DUGWAY, UTAH MOBILE AEROSOL SAMPLING UNIT DATA ANALYSIS (U)

BY

J. HO,
M. SPENCE, AND
G.R. FISHER

JANUARY 1995

UNLIMITED DISTRIBUTION

WARNING

"The use of this information is permitted subject to recognition of proprietary and patent rights."

CRAD

National Defence Défence nationale Canada

UNCLASSIFIED

UNLIMITED DISTRIBUTION

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD

Suffield Report 619

DETECTION OF BW AGENTS: DUGWAY TRINATIONAL BW FIELD TRIAL 20-30 OCTOBER 1993, DUGWAY, UTAH
Mobile Aerosol Sampling Unit Data Analysis

by

J. Ho, M. Spence and G. Fisher

PCN No. 351SQ

Executive Summary

The capability for the CF to detect biological threat aerosol has become an important requirement. Together with the US and UK, Canada took part in a joint field trial in the fall of 1993 to determine the effectiveness of current technologies in measuring and detecting biological aerosols. The following is a report of the experimental conditions and the results obtained by the DRES team. Similar documents are prepared by the respective participants from the different countries. Emphasis in this paper is given to the Canadian approach, that is, to correlate light scatter data with live biological data while detecting the presence of a biological cloud.

The Dugway trials were hosted by the US in co-operation with CA with respect to two key technologies. First, CA supplied the hardware, software and contractors to operate the propylene tracer gas. Second, CA introduced the BG aerosol dissemination technology that employ agricultural sprayers, a system developed at DRES. In these trials, an aerosol of BW simulant (BG spores) was generated by Micronair disseminators as a point source at 800 m from sampling systems. Propylene gas was also disseminated concurrently as a tracer. Collection and measurement of aerosol were perform by the Mobile Aerosol Sampling Unit (MASU) consisting of an Aerodynamic Particle Sizer (APS) particle sizer (to measure particle light scatter) and a dichotomous sampler (DS, to measure viable organisms). Environmental data (wind speed and direction among others) were also logged to assist analysis of cloud dynamics. Information gathered by the APS served to reveal the presence of unusual aerosol as compared to background material. Samples collected by the DS provided important microbiological information like cell viability, a definitive indicator for the presence of biological aerosol.

Data from day 271, trial 3, were chosen to illustrate the capability of the MASU in defining aerosol characteristics. In this trial, the primary cloud passage was followed immediately by a second, both revealed by analysis of the data generated by the sampling system. This phenomenon was clearly shown by detection of two propylene concentration peaks within the 30 min trial period. Total particle count data from the APS also revealed two similar peaks in the same time period. Aerosol mass information was obtained by transforming particle size and number data. A time plot of these mass numbers also revealed corresponding agreement with the propylene tracer. Similarly, viable spore data also fell in line with these observations. From this experiment, it is shown that the APS was capable of detecting the presence of about 1×10^3 viable spores per litre aerosol.

A major deficiency in using particle light scatter as a means of rapid detection is that the technology is incapable of distinguishing a biological particle from a grain of sand. To overcome this problem DRES has invented a particle analyser that can measure fluorescence from excited biological particles (Fluorescence Aerodynamic Particle Sizer, FLAPS). In the next round of BW trials scheduled for fall of 1995, the FLAPS will be tested under trinational field trial conditions. Work has been started to construct BW detection module incorporating this instrument together with other generic and specific technologies.

ABSTRACT

An aerosol of BW simulant (BG spores) was generated by Micronair disseminators as a point source at 800 m from sampling systems. Propylene gas was also disseminated concurrently as a tracer. Collection and measurement of aerosol were perform by the Mobile Aerosol Sampling Unit (MASU) consisting of an Aerodynamic Particle Sizer (APS) particle sizer and a dichotomous sampler (DS). Environmental data (wind speed and direction among others) were also logged to assist analysis of cloud dynamics. Information gathered by the APS served to reveal the presence of unusual aerosol. By careful inspection of the data, it was anticipated that alarming algorithms could be developed. Samples collected by the DS provided important microbiological information like cell viability, a definitive indicator for the presence of biological aerosol.

Data from day 271, trial 3, were chosen to illustrate the capability of the MASU in defining aerosol characteristics. In this trial, the primary cloud passage was followed immediately by a second, both revealed by analysis of the data generated by the sampling system. This phenomenon was clearly shown by detection of two propylene concentration peaks within the 30 min trial period. Total particle count data from the APS also revealed two similar peaks at the same time period. Aerosol mass information was obtained by transforming particle size and number data. A time plot of these mass numbers also revealed corresponding agreement with the propylene tracer. Similarly, viable spore data also fell in line with these observations. From this experiment, it is shown that the APS was capable of detecting the presence of about 1×10^3 viable spores per litre aerosol.

Table of Contents

Acknowledgement

Thanks to Dr. J. Mohr and his crew at Dugway for hosting the field trial.

INTRODUCTION

The aim of this work was to examine the capability of the Aerodynamic Particle Sizer (APS) in detecting biological aerosols. Simulated BW aerosol produced by Micronair disseminators located 800 meters from detector systems served as realistic source material. The Canadian Mobile Aerosol Sampling Unit (MASU) consisted of an APS, Dichotomous Sampler, environmental sensors and associated controlling microcomputer system. A great deal of data was generated from these trials and to properly interprete the results, they are organised and discussed in the following order:

1. Viable spores measured by Dichotomous Sampler (DS): First to be examined will be background levels at the test grid on day 260. Emphasis will be placed on results from days 270 and 271 where significant material was detected.

2. Propylene tracer data: this information will be compared with APS measurements.

3. APS data expressed as number and mass concentrations will be compared.

4. Temporal data from APS (number concentration) and DS (viable spores) will be compared.

5. Time series aerosol particle characteristics will be examined as

   a. 3D plot of number vs. size distribution
   b. 3D plot of mass vs. size distribution

6. Transform of low concentration information by data smoothing techniques

MATERIAL AND METHODS

Aerosol Production

Aerosol dissemination was performed by the Dugway field crew using Micronair sprayers. Details are found in Table 1.

Table 1.Test Parameters for the Micronair Aerosol Generator Used for Outdoor Trials

Day Trial #	Test Date (1993)	Length of Dissem. (min:sec)	BG Dissem (L)	No. of Gener-ators	Nozzle orifice*a	Dissem. (start-stop °)*b
263 T1	20 Sep	10.00	37.5	6	3	120-160
263 T2	20 Sep	9:20	29.4	6	3	170-170
263 T3	20 Sep	10:20	48	6	3	190-190
264 T1	21 Sep	13:05	46	6	3	160-160
270 T1	27 Sep	10:59	33	6	3	120-120
270 T2	27 Sep	10:59	35	6	3	145-150
270 T3	27 Sep	8:53	27.25	6	3	145-150
270 T4	27 Sep	10:00	29	6	3	145-150
271 T1	28 Sep	10:00	29	6	3	160-162
271 T2	28 Sep	10:44	29.5	6	3	150-152
271 T3	28 Sep	13.59	22.75	6	2	160-180

*[a] Nozzle numbers 3, 2, and 1 represent large, medium, and small orifice sizes which yield approximately 1.6, 0.8, and 0.4 L/min, respectively.

*[b] Aerosol dissemination was described on an arc in degrees.

Propylene Detection System for BIDS Trials

The equipment used for detecting propylene during BIDS testing consisted of thirteen TIP- SJ2 photo-ionization chemical concentration sensors, the associated equipment

required to run the sensors, and a propylene tracer gas dissemination system (S&J Engineering, Ontario).

The TIP-SJ2 gas sensor is based on the TIP (Total Ionizables Present) detector made by Photovac. The detector consists of an ultra-violet lamp, detection cell, sample pump, and associated electronics. A continuous sample of gas is drawn into the sensor where compounds with an ionization potential less than 10.6 eV, including unsaturated hydrocarbons such as propylene, are ionized by the ultra-violet lamp. The resulting ions and electrons are drawn to the charged electrodes of the detection cell resulting in a small current. This current is amplified by an electrometer circuit resulting in an output signal proportional to the gas concentration in the detector.

All sensors were calibrated prior to the trials and re-calibrated every 5 days during the trial period using a custom made calibration system which allows up to 16 sensors to be calibrated simultaneously at various gas concentrations. The calibration results were used to generate a calibration curve for each sensor which was used to convert raw test data to propylene concentration measured in parts per million (ppm).

During trials all TIP-SJ2 sensors were set on the high gain setting which resulted in a maximum measurable concentration of about 20 parts per million (ppm). The propylene gas disseminator was mounted on a trailer which was positioned next to the BG disseminators on the 800 m arc. The propylene flowrate used during dissemination ranged from a low of about 300 litres per minute to a high of about 400 litres per minute.

Six concentration sensors were located within the test arc, these sensors were located 3 m above ground level (AGL) on towers 3, 6, 9, 10, 13, and 16. Six additional sensors were located on towers to the east and west of the arc. The three towers located west of the arc were designated A, B, and C with A being the tower located furthest west. The three towers located east of the arc were designated D, E, and F with F being the tower located furthest east. The sensors located on towers A through F were all mounted 3 m height. The final sensor was located on the gun tower approximately 15 m. This sensor designated G, was co-located with an APS operated by CA as part of the MASU system.

Following each trial the data from each sensor was corrected for baseline offset and drift, block averaged to yield 10 readings per second (data was collected at 4000 samples per second per sensor), and then converted to concentration measured in ppm. The processed data was plotted as gas concentration versus time from the start of the trial.

Aerodynamic Particle Measurement

Aerosol particles were characterized by an aerodynamic particle sizer (model PS 3300, TSI Incorp., St. Paul, MN 55164) as previously described (Agarwal et al. 1982). The instrument was calibrated using standard latex particles (Duke Scientific, Palo Alto, CA 94303) by the method of Chen et al. (1985). The instrument was connected to an IBM PC compatible microcomputer that performed data conversion and storage as number and mass concentration files. The APS measured aerodynamic diameter as well as particle numbers. Particle volume was calculated from the usual formula using APS measured diameter while mass was obtained as the product of volume and density (1 gm/cc was used as the approximate density of BG spores).

Another APS was used to measure aerosol samples at 15 m, linked to the MASU via radio modems. In addition, this instrument served as background check for the one in the MASU.

Biological Aerosol Sampling

The dichotomous sampler (DS) was operated according to standard instructions for collecting particulate aerosols (model 245, Andersen Samplers Inc., Atlanta, Ga; this model is current out of production). The inlet of the instrument was connected directly to a sampling port by a short length of tubing (3.2 cm ID, 1 meter long) through which aerosols flowed (17 L/min). The virtual impactor separated particulates aerodynamically into two size groups; greater than 2.5 μm (coarse) and less than 2.5 μm (fine), each collected on a different set of glass fiber filters. Sampling (6 min) of aerosol was initiated at zero time as broadcasted by the trial director.

Assay of Viable Cells

Glass fiber filters on which particulate aerosol samples were collected were inserted into capped glass tubes (nonsterile). Distilled water (20 mL) was added to each sample tube. The capped tubes were then shaken for 10 minutes by a wrist action shaker (model 75, Burrel Corp. , Pittsburgh, PA) which broke up the glass fiber filters, resuspending the particles. Solutions containing glass fiber slurry were strained through wire gauze disks to recover clarified filtrate containing biological particles. Viable organisms were enumerated from the filtrate by the spiral plating technique (Hedges et al. 1978). Liquid samples were applied to standard nutrient agar plates with a spiral platter (model CU, Spiral Systems Instruments Inc., Bethesda, MD). The plates were incubated over night at 30 degree C. A laser-based spiral colony counter with an integrated data processor (model 500A and model 800 respectively, Spiral Systems Instruments Inc.) was used to calculate the number of viable spores in the original sample.

RESULTS and DISCUSSION

Aerosol and propylene measurements at 15 m

Data from both measurements revealed that no significant disseminated material could be found at 15 m height. The could be interpreted to mean that under the experimental conditions there was not enough atmospheric turbulence to carry the disseminated material up to that height. This were precisely the environmental conditions that the trial directors were anticipating.

Viable spores in aerosol clouds

The background air on day 260 contained no significant BG spores as shown in figure 1. The first experiment began on day 263 and no biological aerosol was sampled by the DSs during the initial two trials. During this time, the operators of aerosol dissemination equipment gained valuable experience in coordinating wind direction variations with optimal location of the source. Only a low concentration was present on the third trial and these

failures could be attributed to low and unpredictable wind conditions which caused the aerosol cloud to drift.

A heavy cloud concentration was measured during the first trial on day 270. Significant levels were also detected in subsequent trials and these represented medium level hits. Two low level hits were registered on day 271.

Propylene as a tracer gas

The only way to track a biological aerosol cloud in real time is to use a tracer gas disseminated simultaneously with the main BG load and monitoring the gas with a sensitive sensor. It was hoped that the high level aerosol hit of day 270 (trial 1) could be used to demonstrate the dynamic relationship between the gas and biological clouds transport characteristics. If biological aerosol and propylene were disseminated simultaneously upwind from a point source, it was expected that the two clouds would arrive at the detection system about the same time with similar duration. Unfortunately, the data from figure 2 did not demonstrate this. The differences in transport characteristics of these clouds could probably be explained by improper initiation timing of the two dissemination devices. This could be a reasonable assumption as the spray operators were still in training.

The medium level aerosol hit of the fourth trial (day 270) was a better example as shown in figure 3. Clearly, the characteristics of the two clouds could be superimposed on each other suggesting that there was a temporal relationship in transport characteristics. In this case, the clouds exhibited biphasic behaviour with primary and secondary peaks, representative of the signature of two clouds. Note that particle number as well as gas concentrations were relatively lower than that of the previous example. Similarly, data from trial 2 also demonstrated these cloud characteristics (figure 4) but the time of arrival for the propylene showed a lag of about 2 minutes. Although the experimental data did not overlap in time characteristics, their respective concentration profiles were remarkably consistent, suggesting that the gas tracer behaved very much like the BG aerosol under similar environmental conditions.

Comparison of particle number and mass data

As mass data were directly derived from number data, the two sets could be shown to demonstrate similar temporal relationship (figure 5). Theoretically, mass measurement should be a more representative expression of aerosol content, especially for particles larger than 2 μm aerodynamic diameter. However, in the present version of APS software, large particle data suffer from errors in over estimation, causing problems in quantitative interpretation. Qualitative representation is acceptable, as shown in figure 5.

Comparison of viable spore and particle number concentrations

In the presence of high aerosol levels (trial 1 day 270, figure 6), the appearance of a viable spore cloud coincided with the peak of aerosol particle numbers. However, the DS was not able to resolve a secondary cloud as depicted by the APS data. This was not surprising, given the sampling time interval for the DS was 6 minutes with about 45 seconds as "dead time" due to slow sample change. This sampling time was greater than that between the APS data peaks, resulting in less than optimal resolution. A way to improve on viable count time resolution is to use the large volume aerosol sampler which concentrates ($1x10^6$

times) and collects a continuous sample at 1 mL/min. However, this instrument could not be used due to freezing problems at low outdoor temperatures.

At medium aerosol concentrations there was good evidence that DS measurements corresponded to those of APS (figure 7). Even when viable spore concentrations dropped to about 10^3/liter, APS measurement was still possible (figure 8). However, due the presence of fewer biological particles, other endogenous material imposed considerable background noise during data analysis.

Also, in figure 6, the background data point fluctuation was about 50 particles/10 seconds and this observation was fairly consistent under different experimental conditions. The presence of high biological aerosol concentration was represented by about 300 particles/10 seconds, giving a signal to noise (S/N) ratio of about 6:1. Similar estimations from medium (figure 7) and low (figure 8) biological aerosol concentrations gave S/N values of 4 and 1.5 respectively.

Time series particle size distribution

Figure 9 represents a time series plot of particle size distribution between 2 to 10 μm as a function of number concentration. This figure illustrates the passage of a cloud with high biological aerosol concentrations. As can be seen at around the 9 minute mark, significantly higher number concentration distribution could be detected and this increase is affected as a broad size spectrum. This observation is related to the total numbers plot in figure 6 where viable spores were also depicted. The duration of cloud passage, between the 9-14 minute marks as seen in figure 9 is also similar to that in figure 6. The dynamics of cloud passage can also be demonstrated by replotting the data as a contour map (figure 10). In this example, particle concentrations between 0.01-0.07 /cc were depicted as a series of contours with similar ranges. In this diagram, the time of passage can be easily seen and in addition the twin peaks observed in figure 6 could be faintly resolved.

Similarly, aerosol mass distribution can also be shown as a time series plot (figure 11). The major feature to note here is that small particles less than 2-3 μm do not contribute significantly to the overall mass distribution. During background aerosol measurement, not much particle mass was seen as compared to when the biological cloud appeared (9-14 minute span). The detection was better illustrated by the contour map in figure 12. Here particle mass concentrations between 0.002-0.01 mg/m^3 were segmented into discrete levels. The timing for presence of heavy mass concentrations coincided with that of the biological cloud shown previously (figures 5 and 6). In this illustration, the two cloud peaks, previously seen in figure 10, could not be resolved.

Low Aerosol Concentration detection and data smoothing

Using trial 3 from day 271 as an example of low cloud concentration, it can be shown that the mass contour plot (figure 13) can be used to resolve the aerosol signal from background noise. Similarly, the biological numbers could just be distinguished over the "noise" floor (figure 14). Data interpretation was enhanced by superimposing the tracer gas concentration spectrum over the same time scale. However, without using propylene data as confirmation, it was difficult to infer the presence of the aerosol cloud by inspecting the number concentration plot (figure 15, raw data plot).

However, by applying data smoothing techniques, remarkable transforms were obtained as could be seen in figure 15. Note the twin peak propylene plot was used as a visual reference. All four methods of smoothing resulted in spectra that showed two apparent peaks corresponding to the reference. Moreover, the right hand shoulder of the major peak was also resolved in all cases.

Similar smoothing treatments were applied to the mass concentration data as shown in figure 16. In this example, by observing the raw data plot, it is evident that the mass data is "noiseier" than the corresponding number data as revealed in the previous figure. Also, not all smoothing techniques showed satisfactory results, again using the propylene plot as reference. It was judged that the Savitzky-Golay method gave the best spectral fidelity. This exercise wassummarised in figure 17 where both the number and mass concentration data could be seen as having similar transport characteristics. It is recommended that data smoothing could be applied to "noisy" data derived from measuring low biological aerosol concentrations.

Interpretation of APS data from low aerosol concentratons

By inspecting APS data exclusively, it can be shown that detection of multiple clouds in an experiment was a common event (figures 2, 3 and 4). Extensive data analysis of trial 3 from day 271 has shown that two distinct biological aerosol clouds could be resolved. Environmental data revealed that wind speed and direction during this trial fluctuated only slightly, leading to the suggestion that perhaps two distinct clouds were measured. The other possibility that can easily dismissed, was that the same cloud could have being seen twice by the detection system under the rare event of 180° wind direction change.

Observations of biological aerosol transport from previous field trials with the laser cloud mapper revealed multiple discrete puffs were formed soon after dissemination from a point source. Each puff or cloud travels independently subjected to influence by terrain and other local conditions. Thus rather than a gaussian plume, a continous aerosol source generally produces a series of randomly scattered clouds that move downwind at different rates.

These observations have important implications for implementation of detection strategies using only point detectors. For example, a grid of point detection systems may be required to fully characterise and assess a biological aerosol threat. Furthermore, the results seen in these experiments suggest that the dwell time for each cloud is less than 5 minutes. Thus for a detector system to resolve its passage, a sampling interval of better 20 seconds will be needed. With the present state of technology, it has been demonstrated that the light scattering principle and mechanism of the APS is adequate for this task.

These results also demonstrate that total number particle counts with respect to time in seconds is the most promising data configuration for future alarming algorithm development. In combination with some form of data smoothing as illustrated here, it may be possible to configure alarming criteria coupled to other sensor input data or conditions. Some experiments may have to be designed to determine the number of recurrences are required to constitute an alarm situation. This approach will be further enhanced when the next generation of particle detectors can measure fluorescence characteristics that reveal biological properties of aerosols.

CONCLUSIONS

1. Aerosol disseminated at a distance of 800 meters from the detection systems was measured at widely fluctuating discrete clouds. The simulation may serve well as representative threat BW aerosols if random clouds were desirable. However, for testing of detection alarming systems, a more reliable and persistent cloud characteristic would be required.

2. Propylene served as a good tracer gas. In most cases, the transport characteristics of the gas were similar to that of biological aerosol.

3. The APS, representative of light scattering instruments, was capable of monitoring changes to aerosol particle concentrations during passage of a biological cloud. It may be able to differentiate the presence of about 10^3 viable spores/liter above background particulate material.

4. Calculated aerosol mass is a useful adjunct for detecting the presence of biological simulant aerosols. It was noted that biological aerosols produced by an agricultural sprayer such as the Micronair produced significantly larger population of particles >2 μm. The increase in numbers of particles in the 2-10 μm range is represented by a much greater increase in mass concentration, roughly proportional to the cube of the particle radii.

5. The presence of higher biological cloud concentrations (>10^4 viable spores/liter) could be measured by plotting changes in particle size distributions. Such changes could be monitored as rapidly as every 10 seconds.

6. Contour plot of particle size distributions over time may be a useful tool for pattern recognition studies, for example in computer assisted means to detect the presence of biological aerosols.

7. In cases where the biological particle concentration was not much above background noise levels, data transform techniques could be useful in obtaining meaningful information and thus may be invaluable to computer assisted detection applications.

REFERENCES

1. Agarwal, J.K., R.J. Remiarz, F.R. Quant and G.J. Sem. (1982). Real-time aerodynamic particle size analyzer. J. Aerosol. Sci. 13:222-223.

2. Chen, B.T., Y.S. Cheng and H.C. Yeh. (1985). Performance of a TSI aerodynamic particle sizer. Aerosol Sci. Tech. 4:89-97.

3. Hedges, A.J., R. Shannon and R.D. Hobbs (1978). Comparison of the precision obtained in counting viable bacteria by the Spiral Plate maker, the droplette and the Miles and Misra methods. J. Applied Bact. 45:57-75.

Figure 1

Dugway Trinational BW Field Trial

Summary of Viable Spores in Aerosol

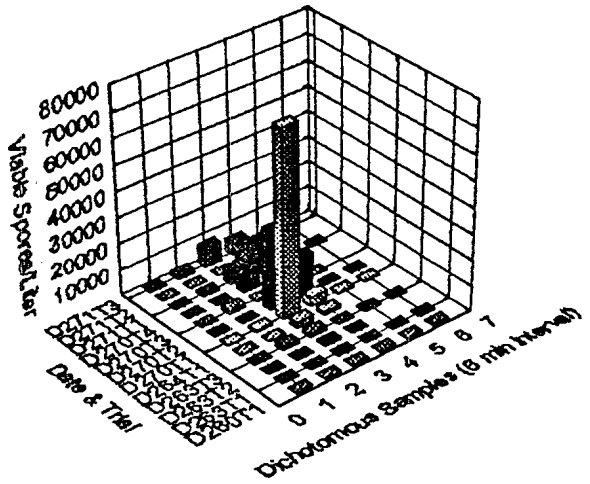


Figure 2

Dugway Trinational BW Field Trial

Day 270 Trial 1 1993

Propylene and Aerosol Number Plot

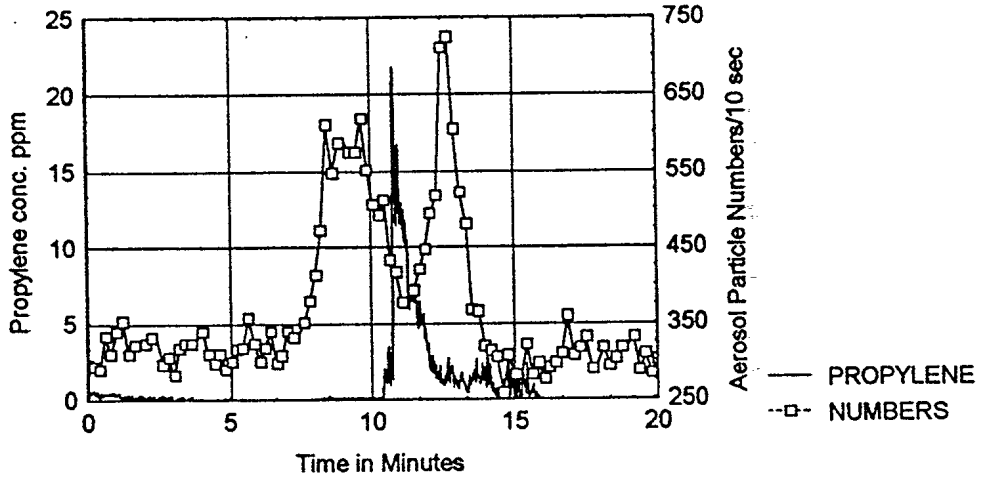


Figure 3

Dugway Trinational BW field Trial

Day 270 Trial 4 1993

Propylene and Particle Conc. Plot

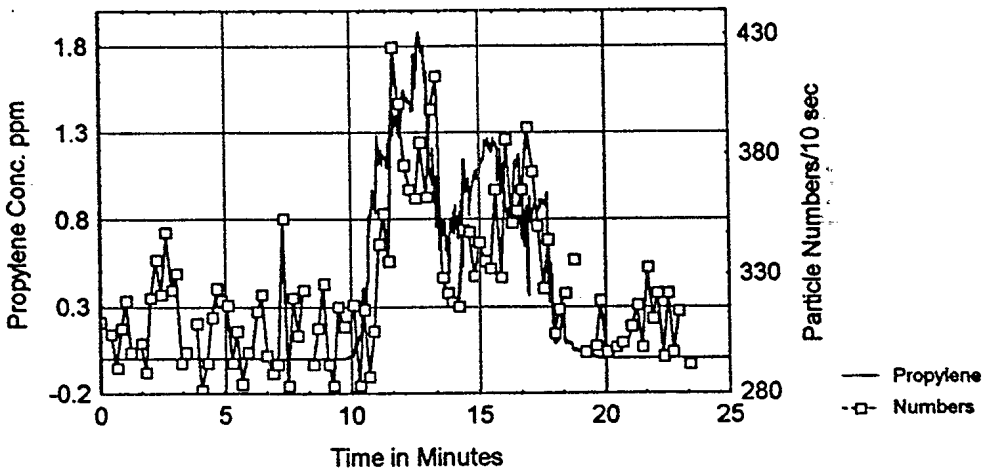


Figure 4

Dugway Trinational BW Field Trial

Day 270 Trial 2 1993

Tracer Gas and Aerosol Number Comparision

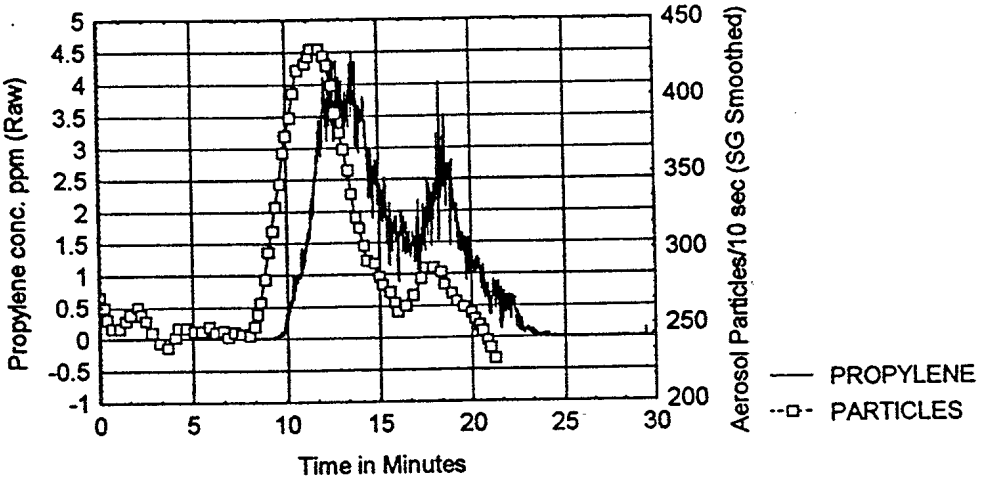


Figure 5

Dugway Trinational BW Field Trial

Day 270 Trial 1 1993

Aerosol Mass and Numbers Plot

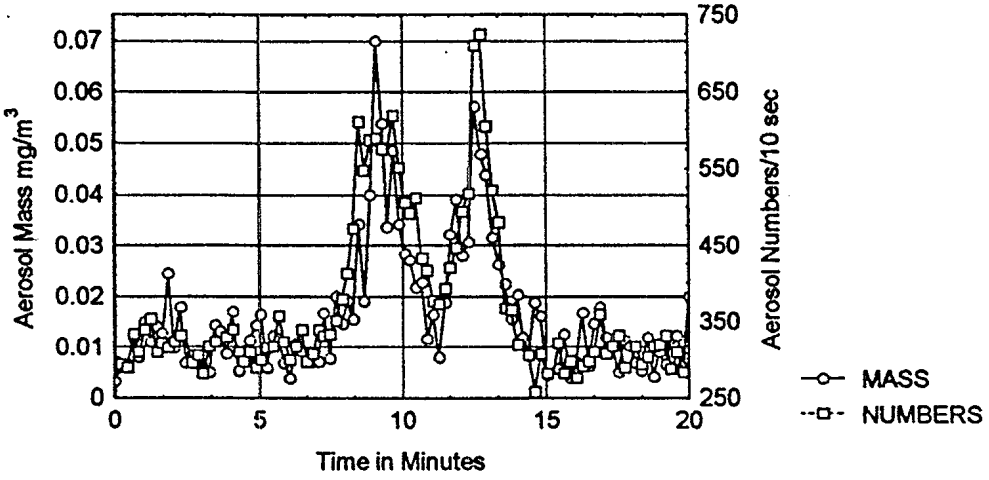


Figure 6

Dugway Trinational BW Field Trial

Day 270 Trial 1 1993

Aerosol Number and Viable Spore Plot

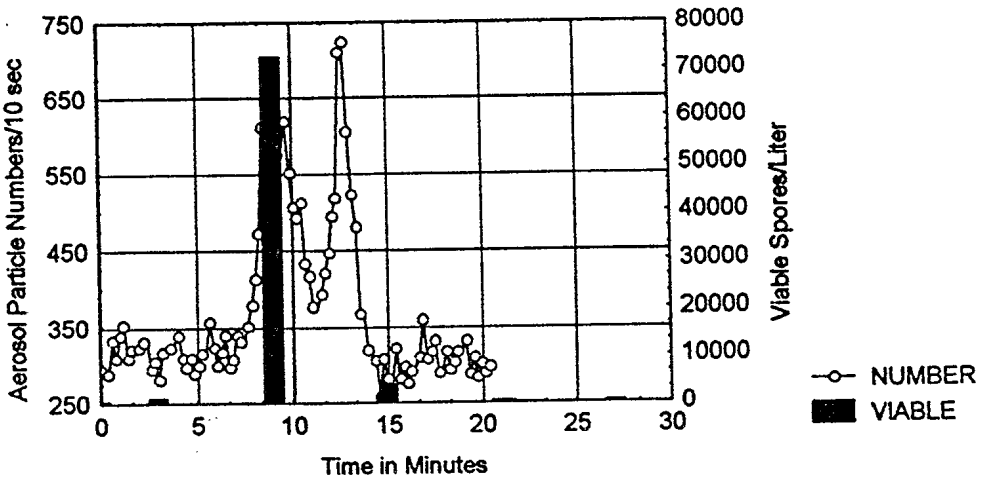


Figure 7

Dugway Trinational BW Field Trial

Day 270 Trial 2 1993

Aerosol Number and Viable Spore Plot

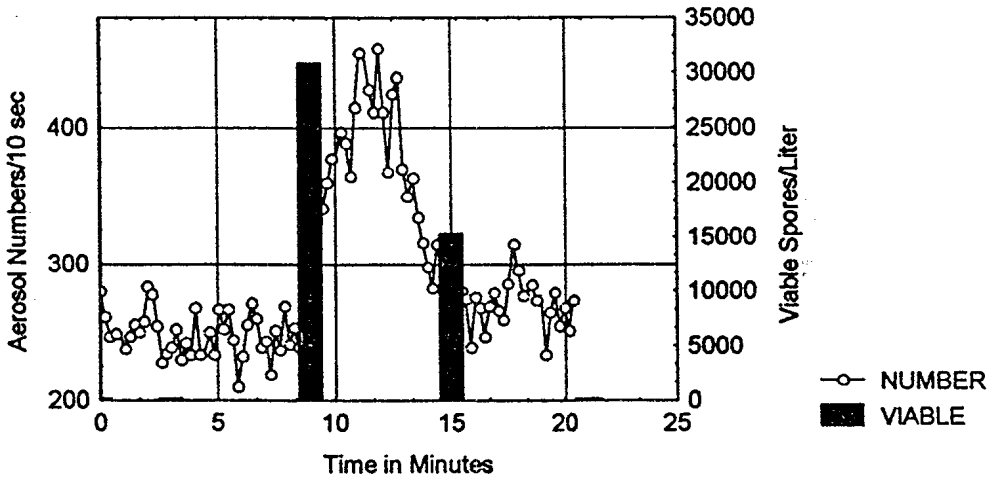


Figure 8

Dugway Trinational BW Field Trial

Day 271 Trial 3 1993

Aerosol Number and Viable Spore Plot

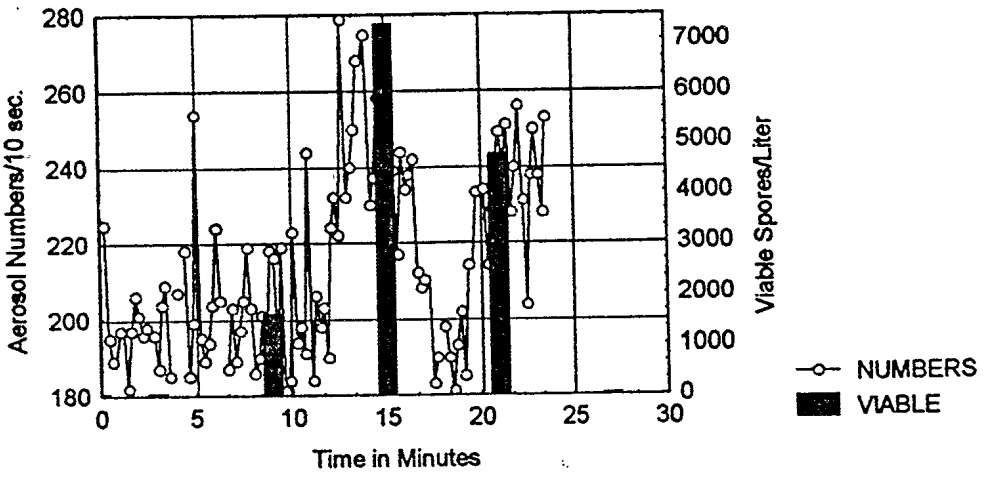


Figure 9 Dugway Trinational Field Trial Day 270 Trial 1 1993 Modified Particle Distribution Plot

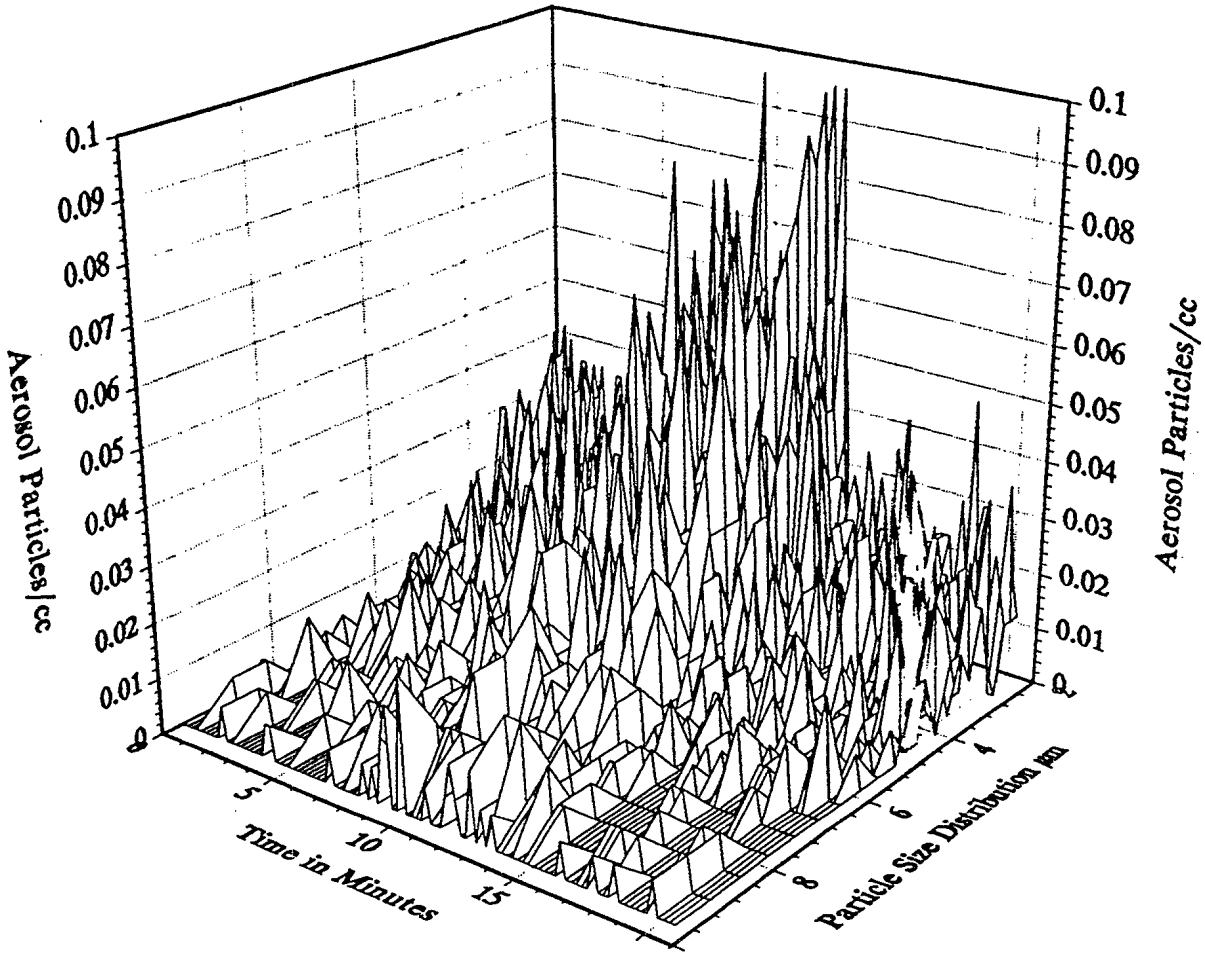


Figure 10 Dugway Trinational Field Trial Day 270 Trial 1 1993 Contour Plot 0.01-0.07 Particle/cc

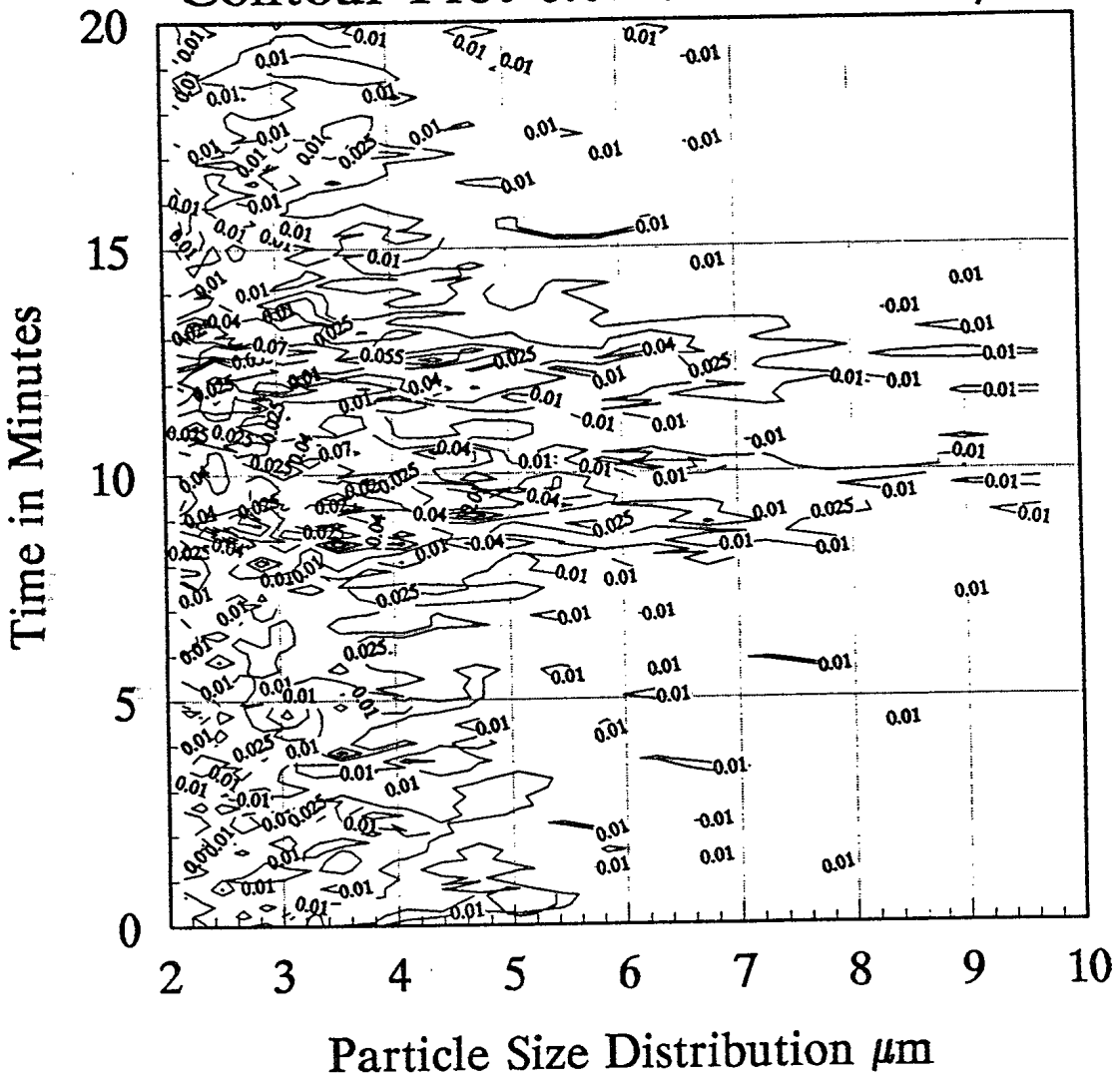


Figure 11 Dugway Trinational Field Trial Day 270 Trial 1 1993 Aerosol Mass Plot

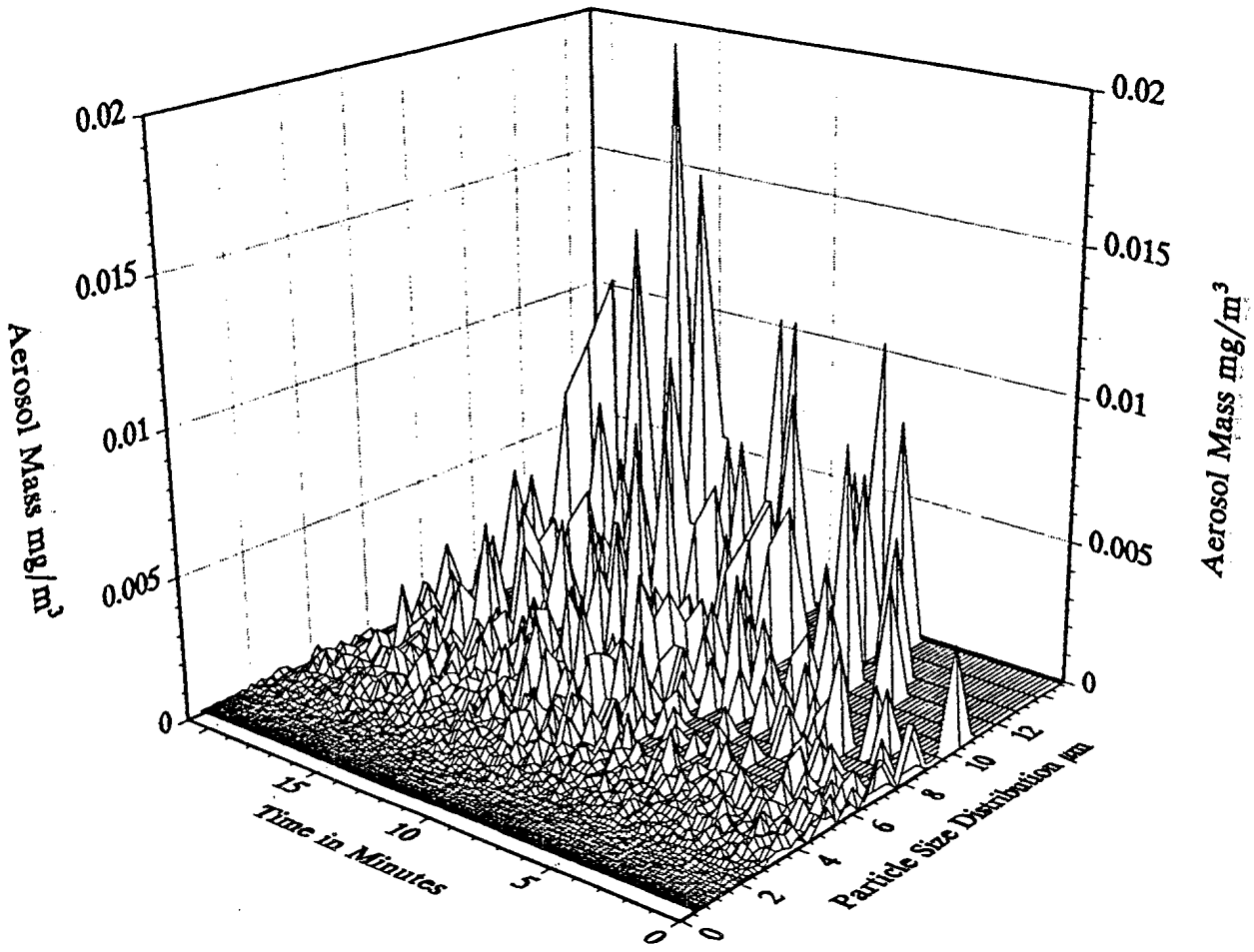


Figure 12 Dugway Trinational
Field Trial Day 270 Trial 1 1993
Contour Plot 0.002-0.01 mg/m^3

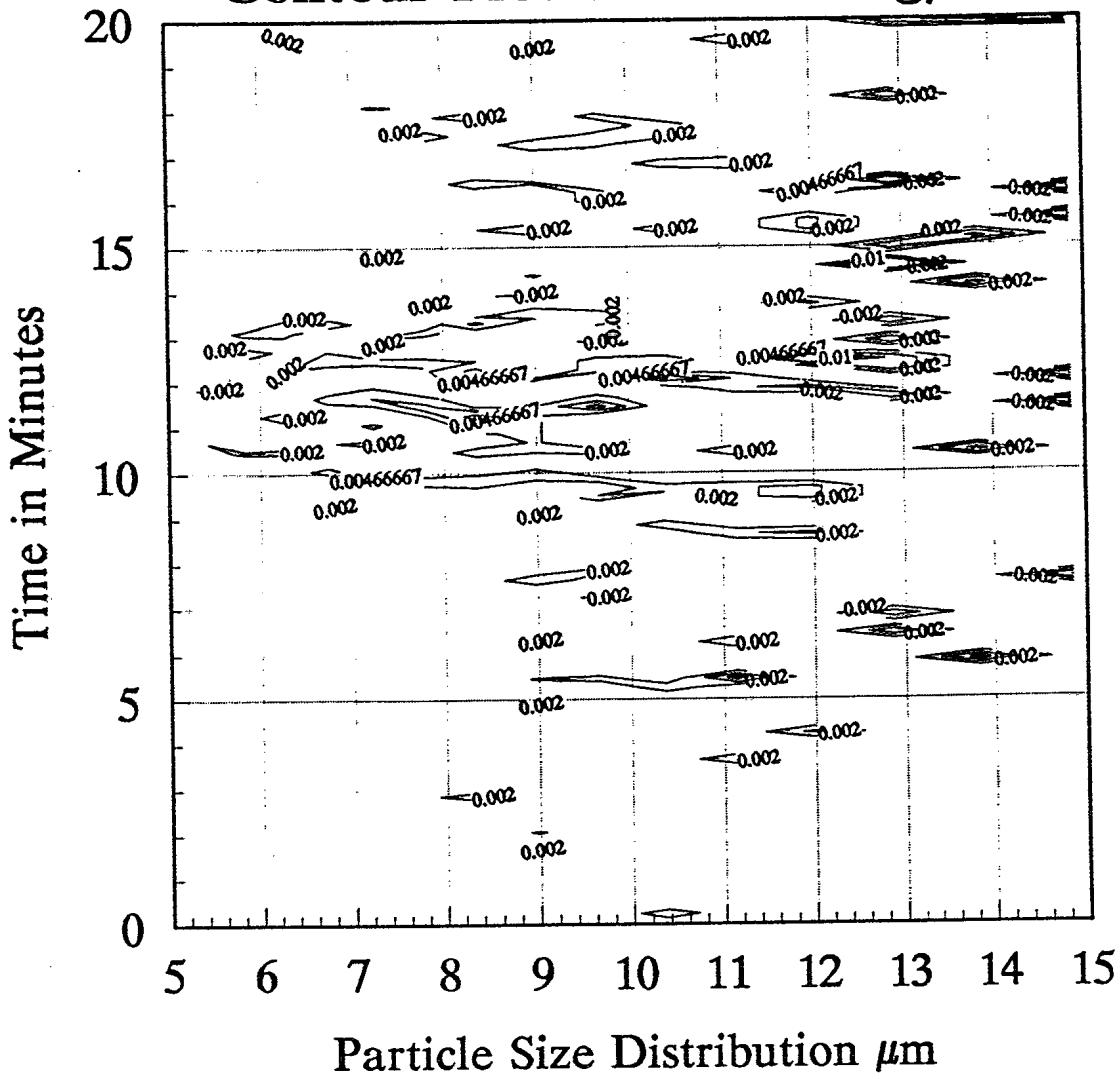


Figure 13 Dugway Trinational Field Trial Day 271 Trial 3 1993 Contour Plot of Aerosol Mass

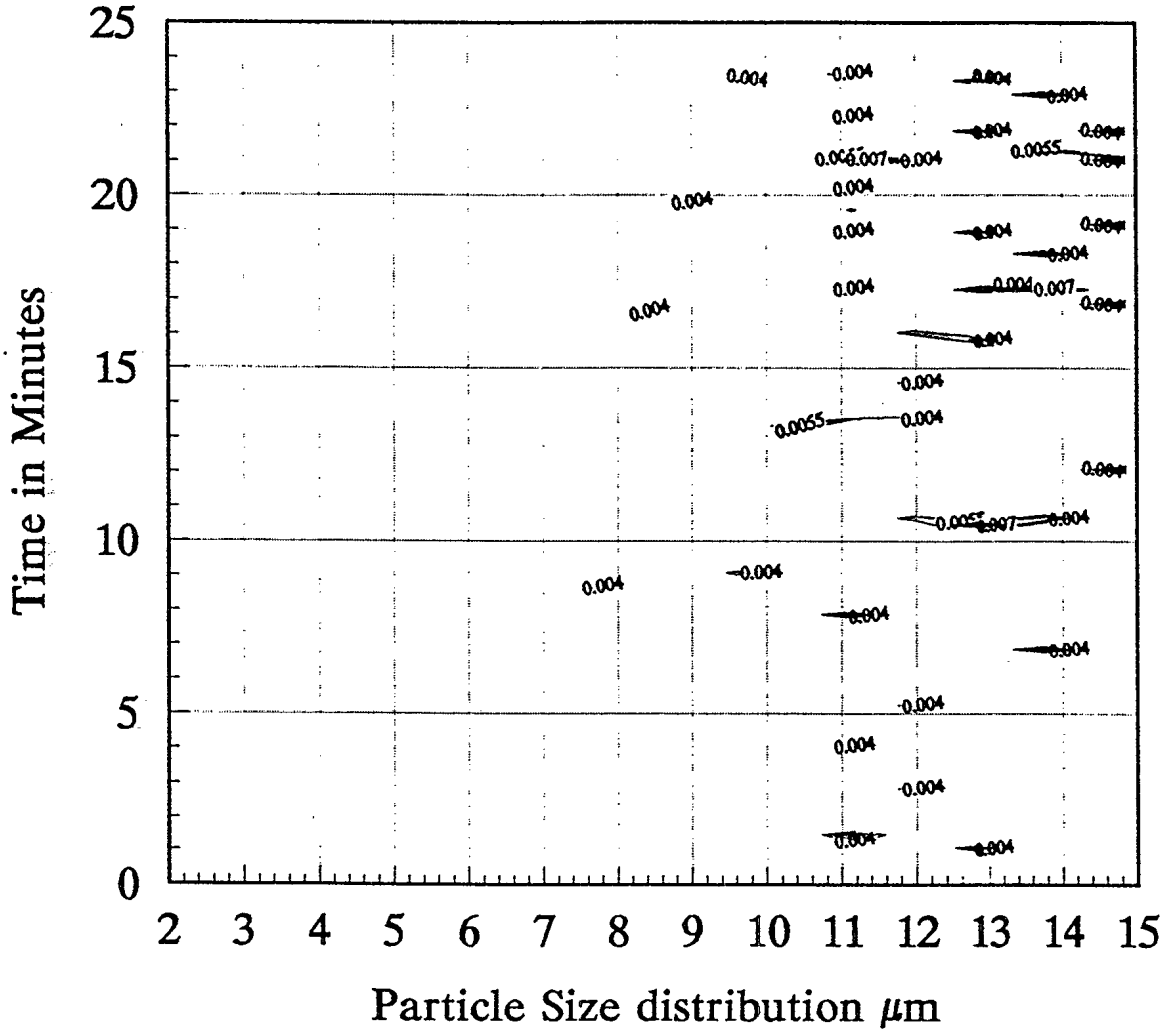


Figure 14

Dugway Trinational BW Field Trial

Day 271 Trial 3 1993

Propylene and Number Conc. Plot

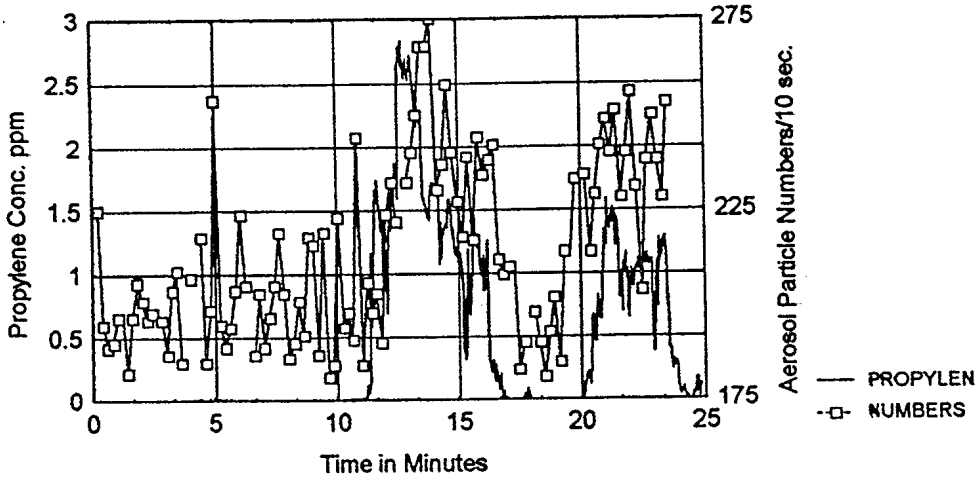


Figure 15. Data Analysis Procedures for Particle Number Concentration

Number data points were derived by summing particle numbers for each sampling period (10 sec). Each X and Y data set was imported into Tablecurve (Jandel Scientific) and plotted as native or transformed by different smoothing techniques. The bottom right panel shows a reference tracer plot of propylene gas. The peaks from the number data plots should match those of the reference.

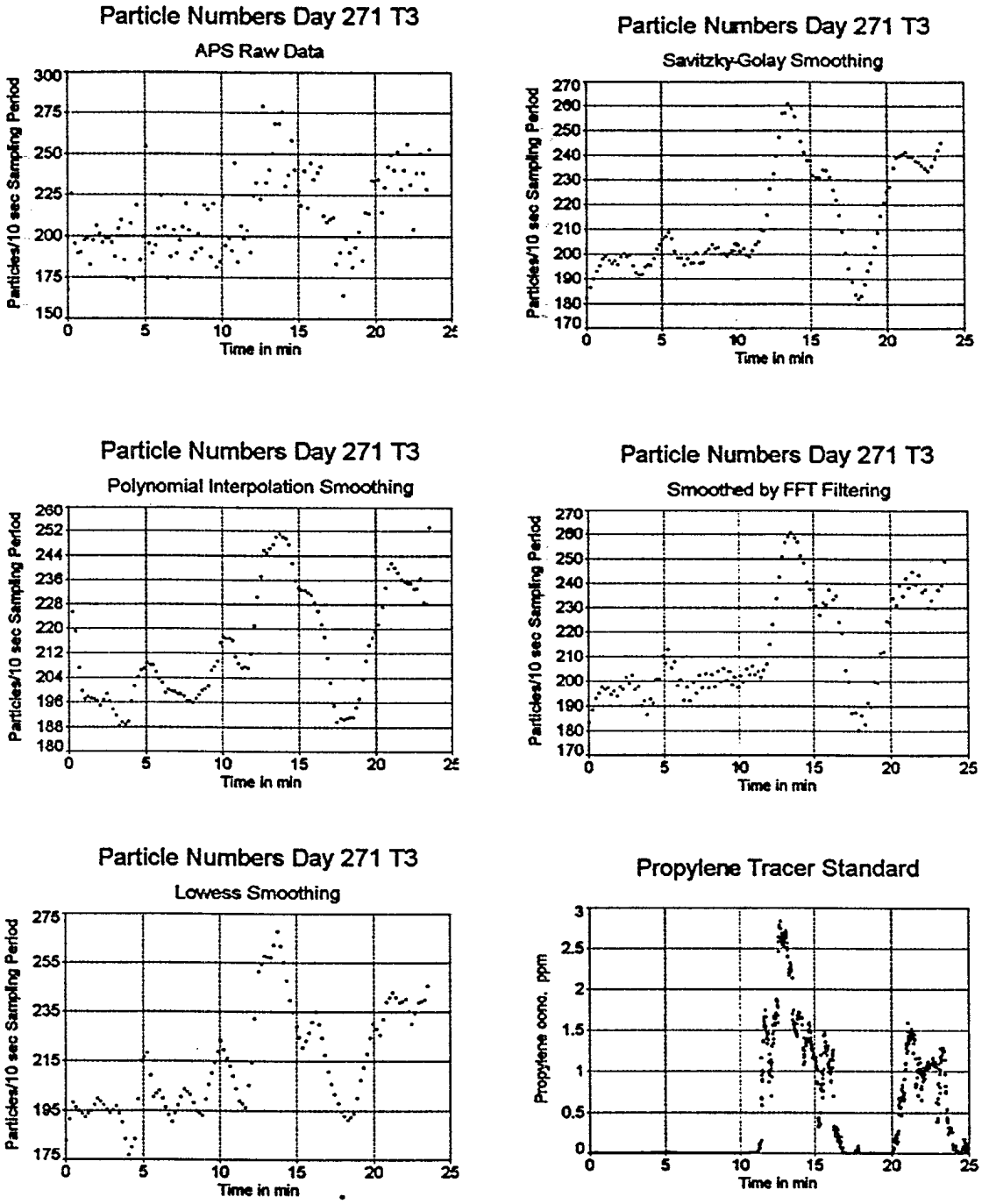


Figure 16. Data Analysis Procedures for Mass Concentration

Mass data points were derived by summing converted (volume x density) number concentration spectra at each time period. Each X and Y data set was imported into Tablecurve (Jandel Scientific) and plotted as native or transformed by different smoothing techniques. The bottom right panel shows a reference tracer plot of propylene gas. The peaks from the mass data plots should match those of the reference.

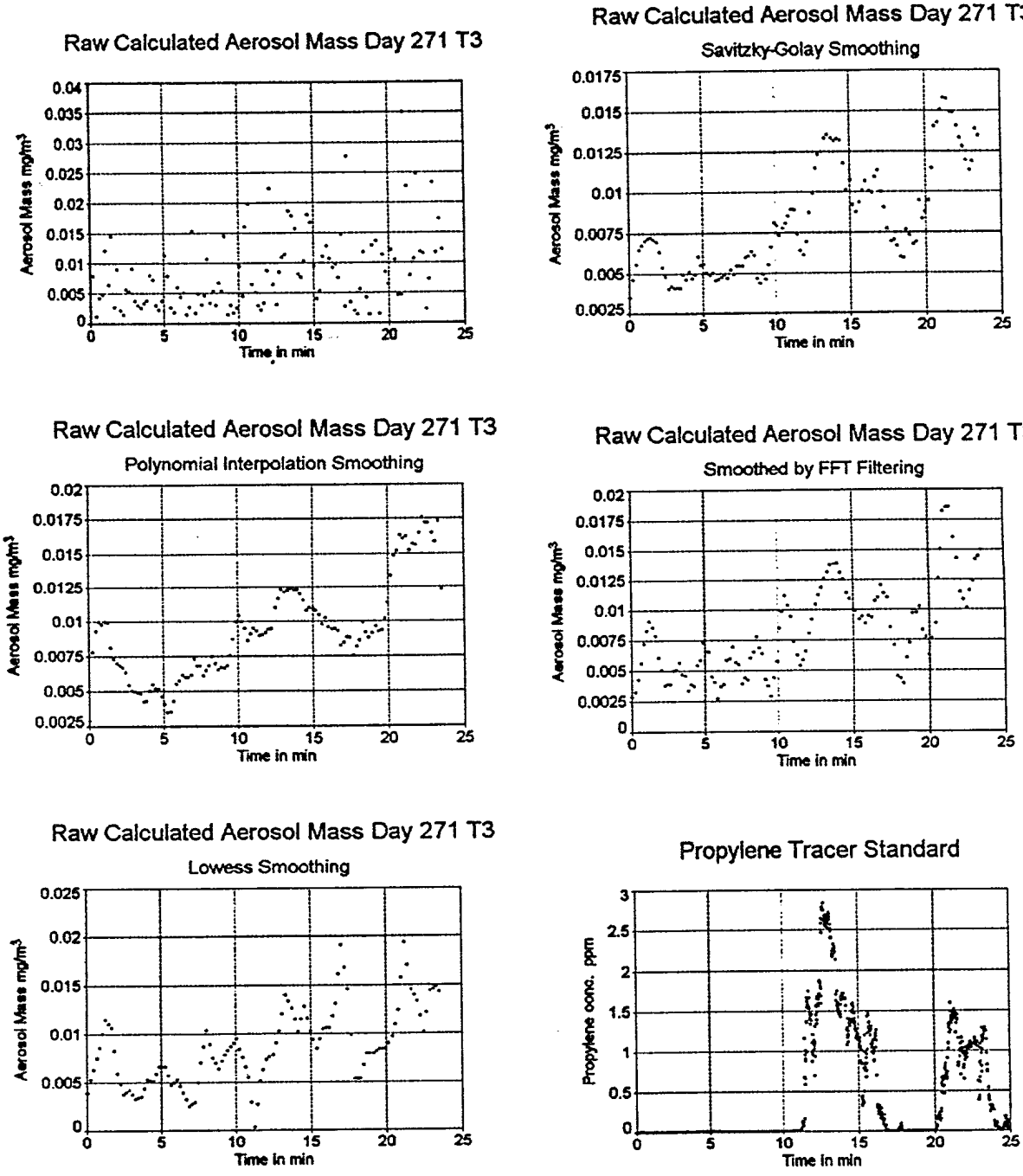
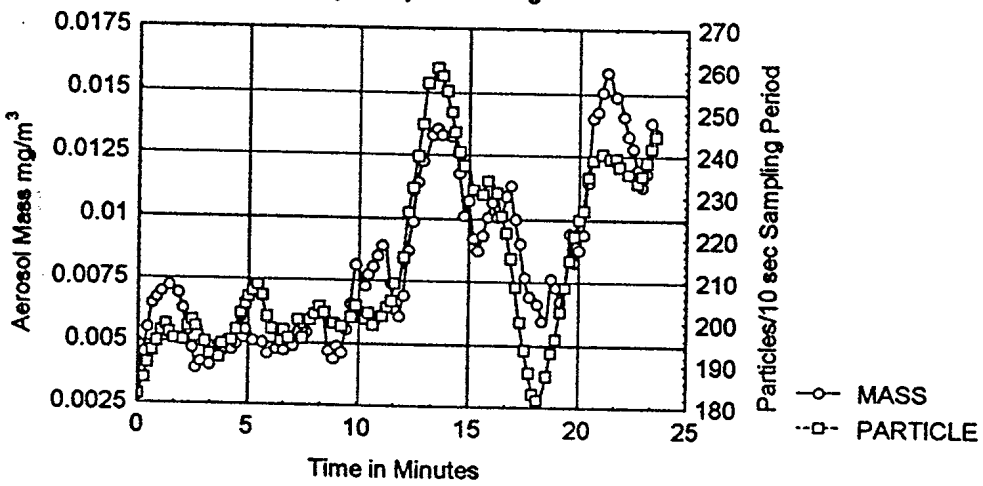


Figure 17
Plot of Particle Number and Mass Concentrations
Day 271 Dugway Trial 3
Savitzky-Golay Smoothing



UNCLASSIFIED

SECURITY CLASSIFICATION OF FORM
(highest classification of Title, Abstract, Keywords)

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Establishment sponsoring a contractor's report, or tasking agency, are entered in section 8.)

Defence Research Establishment Suffield
Box 4000 Medicine Hat AB T1A 8K6

2. SECURITY CLASSIFICATION (overall security classification of the document. including special warning terms if applicable)

Unclassified

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S,C,R or U) in parentheses after the title.)

Detection of BW Agents: Dugway Trinational BW Field Trial 20-30 October 1993, Dugway, Utah. Mobile Aerosol Sampling Unit Data Analysis

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

J. Ho, M. Spence and G. Fisher

5. DATE OF PUBLICATION (month and year of publication of document)	6a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc.)	6b. NO. OF REFS (total cited in document)
January 1995	18	3

6. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

DRES Suffield Report 619

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address.)

DRES 351SQ

9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant)	9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written)

10a. ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)	10b. OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor)
SR 619	

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification)

(X) Unlimited distribution
( ) Distribution limited to defence departments and defence contractors; further distribution only as approved
( ) Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved
( ) Distribution limited to government departments and agencies; further distribution only as approved
( ) Distribution limited to defence departments; further distribution only as approved
( ) Other (please specify):

12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availabilty (11). However, where further distribution (beyond the audience specified in 11) is possible, a wider announcement audience may be selected.)

Unlimited

UNCLASSIFIED

SECURITY CLASSIFICATION OF FORM

13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both offical languages unless the text is bilingual).

An aerosol of BW simulant (BG spores) was generated by Micronair disseminators as a point source at 800 m from sampling systems. Propylene gas was also disseminated concurrently as a tracer. Collection and measurement of aerosol were perform by the Mobile Aerosol Sampling Unit (MASU) consisting of an Aerodynamic Particle Sizer particle sizer and a dichotomous sampler. Environmental data (wind speed and direction among others) were also logged to assist analysis of cloud dynamics. Information gathered by the APS served to reveal the presence of unusual aerosol. By careful inspection of the data, it was anticipated that alarming algorithms could be developed. Samples collected by the DS provided important microbiological information like cell viability, a definitive indicator for the presence of biological aerosol.

Data from day 271, trial 3, were chosen to illustrate the capability of the MASU in defining aerosol characteristics. In this trial, the primary cloud passage was followed immediately by a second, both revealed by analysis of the data generated by the sampling system. This phenomenon was clearly shown by detection of two propylene concentration peaks within the 30 min trial period. Total particle count data from the APS also revealed two similar peaks at the same time period. Aerosol mass information was obtained by transforming particle size and number data. A time plot of these mass numbers also revealed corresponding agreement with the propylene tracer. Similarly, viable spore data also fell in line with these observations. From this experiment, it is shown that the APS was capable of detecting the presence of about 1 x 10^3 viable spores per litre aerosol.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus. e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Biological Aerosols
Aerosol Detection
BG Spores
Biological Warfare Agents

UNCLASSIFIED

150526

NO. OF COPIES NOMBRE DE COPIES	COPY NO. COPIE N°	INFORMATION SCIENTIST'S INITIALS INITIALES DE L'AGENT D'INFORMATION SCIENTIFIQUE
1	1	DAG
AQUISITION ROUTE FOURNI PAR ▶	DRES	
DATE ▶	2 MAY 95	
DSIS ACCESSION NO. NUMÉRO DSIS ▶		

DND 1158 (6-87)

National Defence / Défense nationale

PLEASE RETURN THIS DOCUMENT TO THE FOLLOWING ADDRESS:

DIRECTOR
SCIENTIFIC INFORMATION SERVICES
NATIONAL DEFENCE
HEADQUARTERS
OTTAWA, ONT. - CANADA K1A 0K2

PRIÈRE DE RETOURNER CE DOCUMENT À L'ADRESSE SUIVANTE:

DIRECTEUR
SERVICES D'INFORMATION SCIENTIFIQUES
QUARTIER GÉNÉRAL
DE LA DÉFENSE NATIONALE
OTTAWA, ONT. - CANADA K1A 0K2

UNCLASSIFIED