By use of the ARO equipment grant and the Clarkson matching fund, the existing one channel Aerometric Phase Doppler Particle Analyzer is upgraded to a two channel system with a Fourier Spectral Analyzer. The prices of the components of the system are listed in Appendix A. This system is integrated into a complete system for the experimental investigation of intermittent sprays. The complete system is depicted in Fig. 1 in Appendix B. The system is used to measure the distributions of velocity and size of droplets formed in stationary as well as intermittent sprays of Diesel fuel and other test liquids. Preliminary results of the measurement are given.
MECHANISM OF ATOMIZATION AND BEHAVIOR OF NON-DILUTE SPRAYS

FINAL REPORT

S.P. Lin

June 1992

U.S. ARMY RESEARCH OFFICE

DAAL03-91-G-0078

CLARKSON UNIVERSITY

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DISTRIBUTION UNLIMITED
THE VIEW, OPTIONS, AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHOR(S) AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER DOCUMENTATION.
The project 28829-EG-EQ "Mechanism of Atomization and Behavior of Non-dilute Sprays," was under the directorship of Dr. David Mann of the Division of Engineering and Environmental Sciences of the Army Research Office. The period of this project is from 15 March 1991 to 14 March 1992. The grant number of this project is DAAL03-91-G-0078. This project complements another project "Mechanism of Intermittent Atomization," DAAL03-89-K-0179 which is also under the directorship of Dr. David Mann. The writer is the principal investigator of both of the above mentioned projects.
1. Problem Statement

The fundamental mechanism of intermittent sprays such as that encountered in Diesel engines are investigated. A novel theory of intermittent sprays is developed. A complete development of the theory requires an accompanying experimental verification. The equipment grant is used to establish an experimental system for this purpose.

2. Summary of Research Results

The general layout of the constructed experimental system is shown in Fig. 1 in Appendix B. This system is used to obtain some preliminary results which characterize the intermittent sprays of various duration in a certain range of relevant flow parameters. Fig. 2 in Appendix B gives some typical results. The distributions of droplet size and velocity for an intermittent spray created by a pressure pulsation of 35 ms duration are given in the figure. The statistics of the droplets are taken at a point 0.25 in off the spray axis and 4 in downstream from the spray nozzle. More comprehensive results will be obtained. The results will be compared with theories to elucidate the fundamental mechanism of intermittent sprays. Fundamental knowledge is essential for rational design of fuel injection systems.

3. Participating Personnel

The following individuals have participated in the project.

a. Dr. S.P. Lin, Professor, Principal Investigator

b. Mr. D.R. Woods, Completed M.S. degree. Ph.D. Candidate, Research Assistant

c. Mr. V. Cook, Research Assistant, M.S. Candidate
d. Mr. Richard Webb, Research Assistant, M.S. Candidate

e. Dr. Z.W. Zhou, Research Associate

4. Bibliographies

Relevant bibliographies are cited in references of the published papers.

5. Publications


AEROMETRICS
Quotation Agreement

APPENDIX A

TO: Dr. S.P. Lin
Clarkson University
Department of Mechanical Engineering
9 Clarkson Avenue
Potsdam, New York 13676

FROM: (408) 738-6688
Fax: (408) 738-6671

REGIONAL OFFICE
Aerometrics, Incorporated
10500 Richmond Avenue, Suite 201
Houston, Texas 77042
Phone: (713) 266-3779
Fax: (713) 952-0289

QUOTE VALID FOR 60 DAYS
Quotation Number: 92-1007
Date of Quotation: January 15, 1992
Freight Terms: FOB Sunnyvale
Payment Terms: Net 30 Days

WE ARE PLEASED TO QUOTE ON THE FOLLOWING:

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<td>XMT 1240 Transmitter</td>
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<td></td>
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<td>2 Dimensional Transmitter, 40 MHz; 200, 500 &amp; 1000mm focal length lenses</td>
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<td>RCV 2200 Receiver</td>
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<td>2 Dimensional LDV Receiver, 500mm lens</td>
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<td>DSA 3220-P Doppler Signal Analyzer</td>
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<td>2 Dimensional FFT-based PDPA signal processor, 100 MHz maximum Doppler frequency peak detection capability, low pass filter choices at mixer outputs, variable oscillator frequencies &amp; fourier transform burst detector</td>
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<td>4</td>
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<td>SFT 5200-P DSA System Software</td>
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<td>System Software for the Doppler Signal Analyzer includes instrument setup &amp; control, data acquisition, analysis and management, Optional external data inputs and reverse system control</td>
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<td>DMS 4128 Data Management System</td>
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<td>IBM 33 computer: 64K cache, 20 MB Hard Drive, 8 MB KAM, 1.2 MB &amp; 1.44 MB Floppy, VGA Adapter, SONY 1304 Color Display, 101 Key Keyboard, Mouse, DOS, printer</td>
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January 15, 1992
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Delivery in person

Furnish Certificate of Insurance as described by attached statement to Office of Risk Management, Box 5563, Clarkson University, Potsdam, New York 13699-5563

FAXED 2-26-92

CLARKSON UNIVERSITY

FOR PURCHASING DEPARTMENT USE ONLY

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<td>331-281-325</td>
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CLARKSON UNIVERSITY IS EXEMPT FROM PAYMENT OF NEW YORK SALES TAX, CERTIFICATE EX 108085

IF DELIVERY CAN NOT BE MADE BY DATE NEEDED, ADVISE SHIPPING DATE.
Proposed System

Figure 1
Fig. 2-a

Pressure and Number of Drops
35ms symmetric pulse, position B-A

Pressure (at 1000psig)

Time (ms, relative to pressure peak)

- Pressure
- Number of Drops
Mean Velocity and Drop Size
35ms symmetric pulse, position B-A

Time (ms, relative to pressure peak)

Velocity (m/s)

Arithmetic Mean Diameter (microns)

Mean Velocity
Mean Diameter

Fig. 2.- b