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FINAL TECHNICAL REPORT

Experimental Support of the Development of a  
Nitrogen Pressurization System for Extinguishment  
of Fires in Confined Spaces.

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Sponsored by: Office of Naval Research  
Arlington, Virginia 22217

Contract No. N00014-80-C-0417

Georgia Tech Project No. A-2620

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## INTRODUCTION

The successful application of a nitrogen pressurization system for the suppression of submarine fires depends upon developing an understanding of the scaling parameters for predicting the mixing of inert nitrogen with crew compartment air. The system utilizes nitrogen jets exhausting into the compartment which reduces the ~~partial pressure~~ <sup>concentration</sup> of oxygen and thereby extinguishes the fire. The gas dynamic properties of the inert gas jets exhausting into the compartment must be measured and correlated with gas composition measurements as a function of time so that scaling laws can be developed.

Experimental facilities are being fabricated at the Naval Research Laboratory which will approximately simulate the size and geometry of a typical submarine compartment. Nozzles for pressurizing the compartment with inert gas will be suitably positioned to distribute the inflowing inert gas. Another small scale facility is being used for diagnostic techniques development and will also be used to acquire data at a reduced scale for comparison with full scale experiments.

The experimental gas dynamics program includes several complementary tasks which are designed to provide basic information on the time-dependent mixing phenomena taking place as the inert gas jet exhausts into the compartment atmosphere. These efforts include:

1. Flow visualization of the inert gas jets as a function of time.
2. Mapping the time-dependent nitrogen jet mean velocity field.
3. Characterization of the time and space dependent turbulent kinetic energy and turbulent energy spectra.



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## ORIGINALLY PROPOSED PROGRAM SUPPORT

In support of the previously described experimental program at the Naval Research Laboratory, Georgia Tech originally proposed to provide technical support in the following areas:

1. Application of flow visualization techniques
2. Design and application of experimental hardware for the hot wires/film anemometry systems
3. Application of data acquisition systems for on-line retrieval of pressure, temperature and velocity data
4. Interpretation and correlation of experimental data

The technical support in these areas will be accomplished by: (1) on-site visits at the Naval Research Labs and (2) hardware design, library research, mini computer programming and data analysis at Georgia Tech as required.

The Georgia Tech effort would be scheduled and coordinated with program personnel at the Naval Research Lab, and would be dependent on the pacing and timely completion of experimental facilities at NRL and on the acquisition of specialized instrumentation.

## PROJECT ACTIVITIES

The original contract period was April 1, 1983 through March 31, 1981. However, the acquisition of equipment and the scheduling of experiments at NRL was continually delayed and the contract was ultimately extended through March 31, 1983.

### Data acquisition assistance

In early 1982, Georgia Tech was contacted by NRL technical personnel and requested to provide assistance in interfacing a DISA laser doppler velocimeter to an HP 2116 computer. On February 4 and 5, 1982, Dr. P.E. Mackie from Georgia Tech visited NRL to work with Ms. Caroline Kaplan.

About one day was spent at Georgia Tech prior to the trip studying circuit diagrams and machine language code to attempt a resolution of the problem. When no success was met trying to fix the equipemnt from afar, plans were made to go to NRL on the 4th and 5th of February. At NRL, Dr. Mackie used a combination of

special purpose machine language test loops and signal tracing techniques to follow the progress of the DISA data flag which was failing to set at the HP 2116 computer. Ultimately, two problems were found and corrected. One problem was a broken trace on one of the DISA interface boards which prohibited the data flag signal from leaving the DISA interface. After the trace was repaired the data flag signal arrived at the HP interface (12566 board) but was still not being latched. Further signal tracing indicated a bad NAND gate in a 7400 TTL chip. Once this chip was replaced the HP 2116 and the DISA were able to communicate with each other.

Before leaving NRL, Dr. Mackie pointed out to Ms. Kaplan that the interface cabling was in very poor shape which could cause further trouble with data lines as a result of shorts and opens. The cable and connectors should be resoldered. At the completion of the visit, the DISA system and the HP 2116 were exchanging "handshake" signals as one would expect.

#### Equipment purchases

In early March, 1983 Georgia Tech was requested by Naval Research Lab personnel to use the remaining contract funds to purchase equipment needed for future experiments and to ship the instruments directly to NRL. The following equipment was ordered before March 31, 1983 thereby completing the statement of work per contract modifications:

- (1) DISA Data Rate Modules, 2 each  
Model 55L9]
- (2) DISA Mean Velocity Interface Modules  
Model 55L94 and Model 55L94B
- (3) DISA Accessories Package.