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SANDIA LABORATORIES QUARTERLY REPORT - PLANETARY QUARANTINE PROGRAM

Planetary Quarantine Department 1740

SANDIA LABORATORIES

OPERATED FOR THE U. S. ATOMIC ENERGY COMMISSION BY SANDIA CORPORATION | ALBUQUERQUE, NEW MEXICO; LIVERMORE, CALIFORNIA

Sandia Laboratories Quarterly Report - Planetary Quarantine Program

Twelfth Quarterly Report of Progress

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Planetary Quarantine Department

Sandia Laboratories, Albuquerque, New Mexico

March 1969

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TABLE OF CONTENTS

		Page
I.	Contamination Control Study	3
II.	Bioburden Experimentation and Modeling	5
III.	Lunar Information System	13
IV.	Sterilization Modeling and Laboratory Support Work	14
V.	Presentations	17
VI.	Publications	18

FIGURES

Fig. 1.	Vertical Laminar Airflow Research Facility	6
Fig. 2.	Number of Viable Particles per Two-minute Intervals	9
Fig. 3.	Ratio of Number of Particles vs Angle	12

1740 QUARTERLY REPORT

I. Contamination Control Study (NASA Contract No. H-13245A)

A. Description. This project involves preparation of the NASA CONTAMINATION CONTROL HANDBOOK. The handbook assembles in one document reliable technical information and data and other information pertinent to the field but not readily available from any one source. It further provides practical information applicable to specific contamination control situations.

After the original version of the handbook was completed, additional work was authorized by Amendment 4 to the NASA contract, which extended the contract termination date to June 30, 1969.

B. Progress. The current status of the handbook is illustrated by the following activities and accomplishments:

1. The additional work authorized by Amendment 4 consisted of revising Sections 8, 9 and 11. This was completed and the new reproducible masters were sent to Marshall Space Flight Center (MSFC) on January 8, 1969.
2. The first printing of 200 copies was exhausted shortly after a NASA Tech Brief announced that the handbook was available from MSFC.
3. A second printing of 400 copies was run during the week of March 10. This issue included the revisions forwarded to MSFC in January.
4. A third printing of 1000 copies is scheduled for early April,1969.

5. As a follow-on project to the handbook, a Contamination Control Training Course Outline was developed for NASA use. This outline was published as Sandia document SC-M-69-127, dated March 1969.

This course outline considers the developing need for contamination control; the types, sources, and migration of contaminants; the methods for eliminating or controlling contaminants in liquids, gases, and on surfaces; and the means for evaluating the effectiveness of these controls. It also includes a treatment of the role of people in contamination control, how they both contribute and control contaminants.

Included in the document are 15 fairly detailed lesson outlines and a schedule of training which provides the lesson number, lesson title, and appropriate references for each lesson. It is hoped that this material can be added to the handbook in a subsequent revision.

6. As a result of the excellent reception to the handbook, many requests for copies have been received by Sandia Laboratories. Everyone requesting copies in this manner has been advised to redirect their requests to MSFC.

7. On January 23-24, 1969, the following NASA representatives visited Department 1740 to discuss the Contamination Control Handbook and other NASA projects: Larry Chambers, NASA Headquarters, Washington, D. C. ; F. J. Beyerle and M. Pickard

Marshall Space Flight Center, Huntsville, Alabama; and Q. T. Ussery, Manned Spacecraft Center, Houston, Texas."

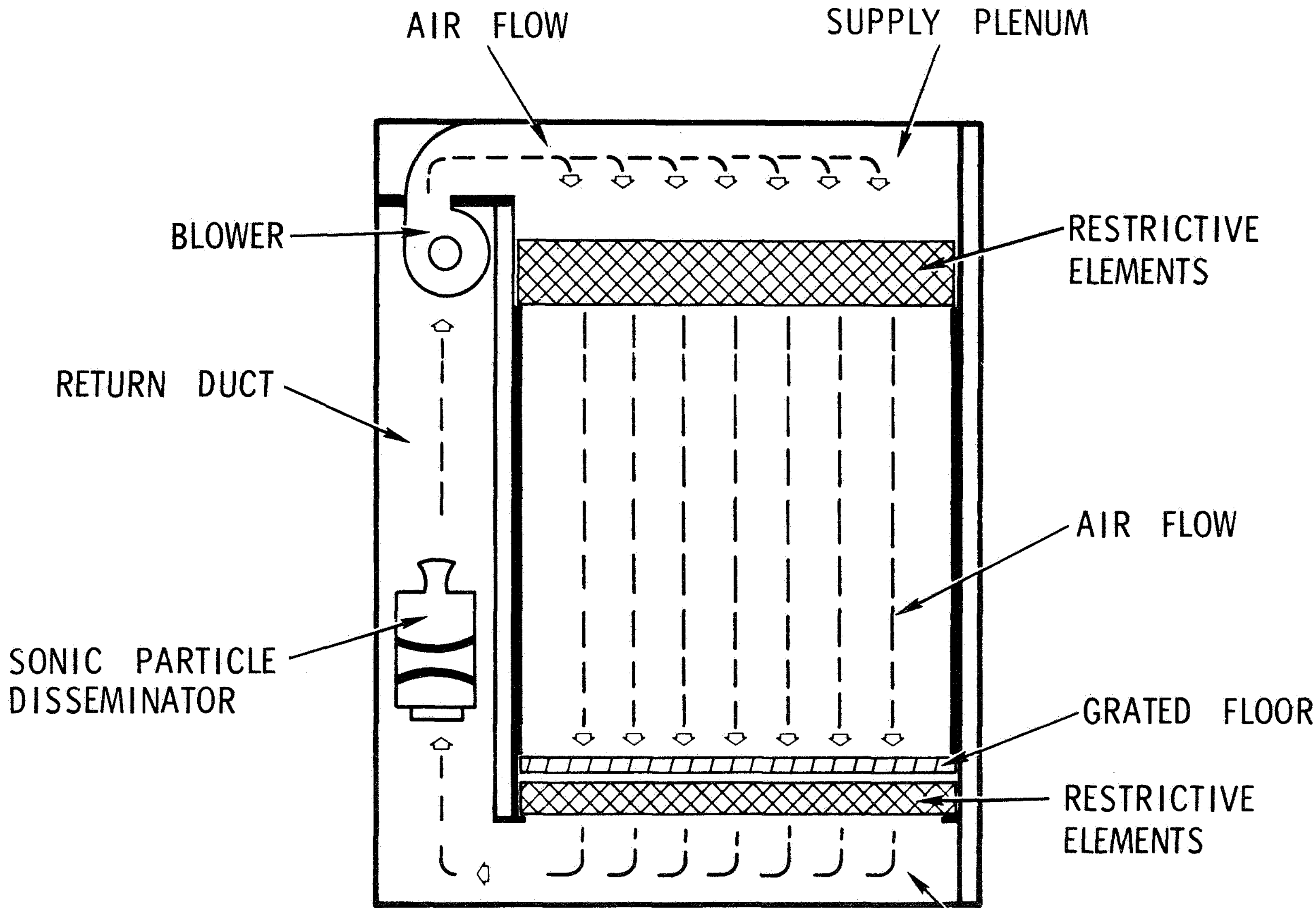
8. NASA Contract H-13245A has now been essentially completed within the funds provided by the contract. No further work is anticipated.

II. Bioburden Experimentation and Modeling

A. Description. Models for the estimation of spacecraft bioburdens are needed for use in "dirty" areas associated with manned lunar missions. One such model has been developed and is described in SC-RR-69-23, "The Determination of Quantitative Midrobial Sampling Requirements for Apollo Modules". An experimental program is in progress which should yield data for verification of this model and guide parameter selection for future models.

A vertical laminar airflow room has been constructed for studying the deposition of particles from the airflow in a laminar flow clean room (See QR 11). A description of the system is provided below and a diagram of the room is shown in Figure 1.

B. Progress. The principal difficulty encountered in conducting research on the deposition of particles in laminar airflow facilities is that no convenient method of generating a continuous and uniform aerosol has existed. If the aerosol is generated behind the HEPA filter as in a laminar flow clean room, the particles of the desired size are trapped in the filter. If the aerosol is generated in front of the filter the airflow is disturbed



VERTICAL LAMINAR AIRFLOW
RESEARCH FACILITY

FIG.1

and an aerosol of uniform density over a large area is difficult to achieve. The facility described here appears to have solved these difficulties.

The distinctive feature of the facility is the replacement of the HEPA filters with other less restrictive elements that do not remove an appreciable number of particles from the airstream. These restrictive elements are described in more detail later in this report.

The room that was constructed has approximately an 8' x 9' x 8' working volume. The air supply to the blowers is seeded with particles of the size needed with an acoustic dust feeder (QR 10). The blowers force the aerosol through the restrictive elements which evenly distribute the airflow while providing air velocities duplicating those normally encountered in a clean room. The restrictive elements generate approximately the same air flow conditions found in laminar flow clean rooms.

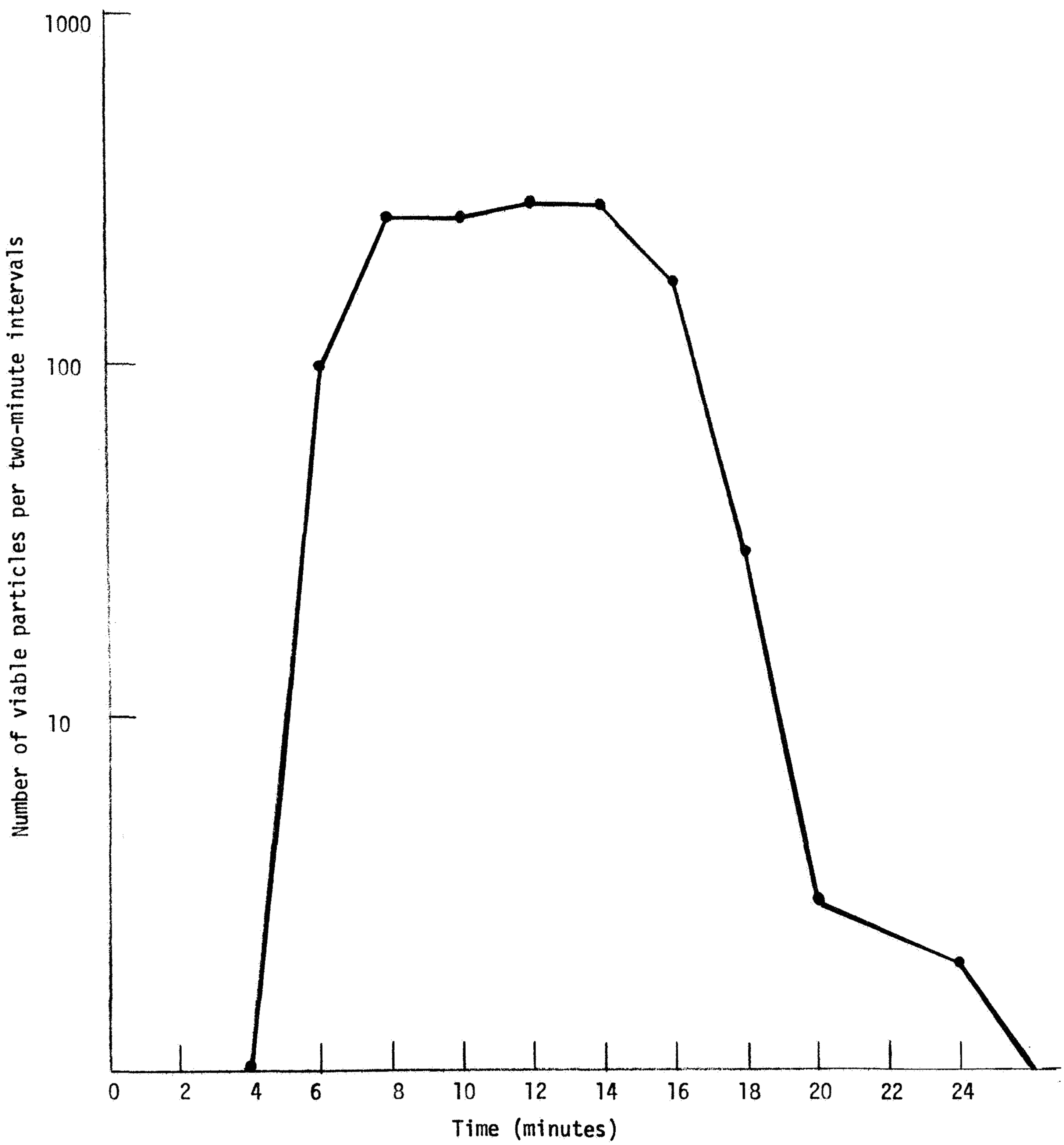
One component of the system, not shown in Fig. 1, is a high volume clean air supply which delivers clean air to the supply plenum through a flexible duct. When the aerosol generator is not in operation, the clean air supply flushes the aerosol out of the system in preparation for other experiments. When the aerosol generator is operating, the positive pressure generated by the clean air supply prevents unwanted particles from entering the supply plenum and the room.

In the first version of the room, clean room pre-filter material was used as the restrictive element. The air velocity varied only 10% over the entire room and the variation over prescribed test areas was even less. The air velocity could be changed from 70 to 150 feet per minute by changing motor-blower pulleys.

Two different aerosols were used in this set of experiments. One contained 10μ aluminum oxide particles that were tagged with Bacillus subtilis var. niger spores (QR 9) and the other contained individual 1μ Bacillus subtilis var. niger spores. Reyneir samplers, Anderson samplers, exposed rodac plates, exposed flat aluminum plates, and a Royco Particle counter were used to sample the aerosols.

Using the Royco Particle Counter and the Reyneir Sampler, it was determined that after a steady state level was reached, the density of the aerosol in one position remained constant with respect to time, but varied radically from other positions. A typical curve of density versus time as determined by a Reyneir Sampler is shown in Figure 2. In this test, the aerosol generator was loaded with 10μ tagged dust particles. The Reyneir Sampler was turned on at t = 0 and the aerosol generator was operated for 10 minutes, beginning at t = 4 minutes and ending at t = 14 minutes. Each value (sampling point) is the result of sampling 2 cubic feet of air over the preceding two minute periods at one sampling position. Over the 8 minute period that the plateau

FIG. 2


1000
100
10
Number of viable particles per two-minute intervals
0
2
4
6
8
10
12
14
16
18
20
22
24
Time (minutes)

was obtained, the variation from the mean was less than 6%. The constancy of the cloud was also verified using a Royco particle counter.

To test the aerosol density from point to point, rodac plates were placed one foot apart on a grid on the floor of the room and exposed to clouds of 10μ tagged dust particles.

The maximum percent variation from the mean over the entire room was 130%. This variation was still much too high even on adjacent segments of the grid to perform the experiments that were planned.

In the second phase of room operation, the following changes were instituted in an effort to produce more uniform aerosol density:

1. Lighter aerosol particles were used because they would follow the airstream more closely.
2. The aerosol in the plenum was more thoroughly mixed.
3. Modifications were made in the volume of the supply plenum to change the airflow patterns radically.
4. Higher density aerosols were used to reduce statistical fluctuations in sampling.
5. The flat plates and rodac plates were placed on a turntable that rotated at slow enough speed so that the lateral velocity was negligible compared to the air velocity. This motion changed the position of the sampling surface continuously without noticeably disturbing the airstream.

Each of these changes reduced the fluctuation somewhat, but did not produce the uniformity needed for the planned experimentation. These changes however, did indicate that the prefilter material was the main cause of the non-uniform aerosol density, because regardless of the changes, the areas of higher density remained higher and the areas of lower density remained lower.

To overcome this problem, the prefilter material was replaced with 1/2" thick open-celled foam sheet laid on a wire grid at the top of the room. No change was made in the restrictive prefilter material used under the grating floor.

For ease in identification, 10μ glass spheres were used as particles in generating the aerosol. The aerosol was sampled approximately isokinetically with .45μ membrane filters in a millipore filter holder. Three filter holders were placed on the vertices of an equilateral triangle 24" on each edge with the center of the triangle at the center of the room. Since the above modifications were made, the sample counted on each filter has not varied more than 15% from the mean of the three counts, and in most cases the variation was less. This variation is considered small enough for the planned experimentation to yield meaningful test results.

One of the first experiments using the modified system was to determine the collection efficiency of 1" x 1" polished metal plates exposed to the airflow. From three plates exposed to the aerosol of 10μ glass spheres, the collection efficiency has been calculated to be 28%. Another experiment that has been performed

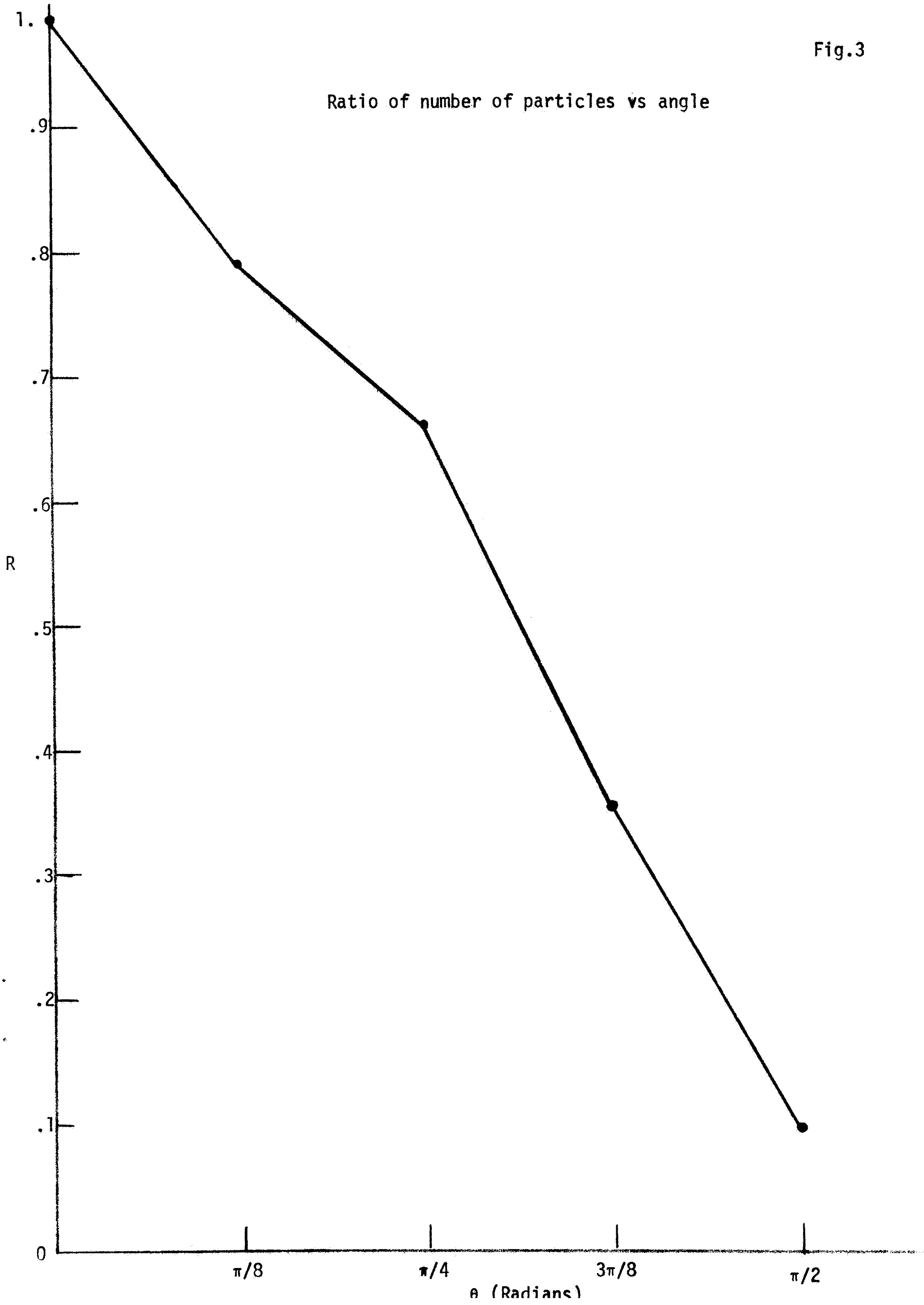


Fig.3
Ratio of number of particles vs angle
R
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
π/8
π/4
3π/8
π/2
θ (Radians)

is the microscopic measurement of the number of particles collected versus the angle to the horizontal of 1" x 1" polished metal plates. The data for this experiment is given in Figure 3 with the curve normalized to the number collected by a horizontal 1" x 1" plate. Additional experiments of this type are easily within the range of present experimental techniques and will be performed.

III. Lunar Information System

A. Description. Because of NASA's inability to contract the programming of the lunar information system design reported in "An Interactive Computer Information System for Planetary Quarantine for Lunar Programs", SC-RR-68-545, July 1968, in time for it to be useful on the first Apollo mission to the moon, we have attempted to implement a reduced version of this design.

B. Progress. During this quarter, the programming of a reduced version of both the File Preparation Routine and Data Storage Routine reported in the above reference has been completed. Check out of these routines is nearly complete. This system includes the appropriate models described in the reference.

The redesign is compatible with the original design and, with suitable effort, may be enlarged to the original program.

A reduced version of the Lunar Inventory Routine will be programmed as time permits. The predictions will be based upon our previous modeling efforts.

The reduced system is based upon the recent NASA policy documents and is compatible with them.

A document describing the completed system will be issued as time permits.

IV. Sterilization Modeling and Laboratory Support Work

A. Description. This activity has as its aim the development of an inactivation model that is physically based and consistent with all known forms of survival data.

B. Progress. During this quarter, the kinetic model developed by Sandia evolved to its expected final phase. The factors which we consider to be potentially important are now included, programming has been completed, and computer testing has been initiated. The model allows the potential reactions

$$A \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} B \overset{k_2}{\rightarrow} C$$

$$A \overset{k_3}{\rightarrow} D$$

$$2E \overset{k_4}{\rightarrow} F$$

with first order reactions degrading A and a second order reaction degrading E. Additional parameters enter through the numbers of first and second order systems, number of elements in the second system, and number of functioning elements required in a second order system.

Computer testing is proceeding with the following preliminary observations relative to areas of importance to planetary quarantine.

1. The sensitivity of the entropies of the reactions involved are such that inclusion of water activity as an environmental parameter presents no difficulty.

2. Rejection of excess systems and redundancies in order to reduce to the log model is automatic if the experimental data dictates that the log model, (or what is equivalent the single reaction

$$A \overset{k_3}{\rightarrow} D)$$

best fits the data. Here best fit means that the sum of the squares of the differences in logs between the data and the model predictions are minimum. (For the log case this is commonly called linear regressing in the other cases it means that from the family of all curves that can be generated by the model, the one is selected such that the indicated sum is minimum.)

Thus, the model as programmed provides the option of investigating a variety of data. Familiarization with model potential will continue as we work toward the completion of this effort.

Experimental work this quarter has been directed toward identifying the mechanism that makes "tailing" possible. Several conjectures based upon some recent work of Alberts and Doty, Halvorson, et.al., and Stafford and Donnellan seem promising, although results so far are inconclusive.

In particular, the results reported in QR 9 related to renaturation with slow cool down need to be more fully understood since they offer promise for forcing essentially logarithmic behavior from tailing stock.

V. Presentations

A. W. J. Whitfield, "Development of Laminar Flow Clean Room Techniques", presented to City Board of Export Development, January 22, 1969, at a luncheon meeting at the Petroleum Club, Albuquerque, New Mexico.

B. W. J. Whitfield, "Fine Particle Research", presented to NASA Spacecraft Sterilization Technology Seminar, Cape Kennedy, Florida, February 11,1969.

C. W. J. Whitfield, "Environmental Contamination Control", presented to WESTEC Engineering Conference, March 13, 1969, Los Angeles, Calif.

D. W. J. Whitfield, "Basic Principles of Laminar Flow Devices" presented to Technical Lecture Series on Contamination Control for Industry on March 13, 1969, Los Angeles, Calif.

E. D. M. Garst, "NASA Contamination Control Handbook" presented to the annual symposium of the Rio Grande Chapter, American Association for Contamination Control, March 3, 1969, Albuquerque, New Mexico.

F. J. P. Brannen, "Planetary Quarantine Models", Sterilization Technology Seminar, Cape Kennedy, Florida, February 11, 1969.

G. H. D. Sivinski, "The Planetary Quarantine Problem", Sandia Laboratories Colloquium, March 7, 1969.

H. C. A. Trauth, Jr., "Planetary Quarantine Research", Sandia Laboratories Colloquium, March 26, 1969.

I. C. A. Trauth, Jr., "The Nature of Planetary Quarantine", College of Santa Fe, February 28, 1969.

J. C. A. Trauth, Jr., "Understanding the Systems Approach", Sandia Laboratories Colloquium, March 10,11,12,14, 1969.

VI. Publications.

A. W. J. Whitfield, "Vacuum Probe: New Approach to the Microbiological Sampling of Surfaces", co-author, APPLIED MICROBIOLOGY, January 1969.

B. W. J. Whitfield and D. M. Garst, "Contamination Control - A State of the Art Review", SC-R-69-1154, February 1969.

C. K. F. Lindell and D. M. Garst, "Contamination Control Training Course Outline", SC-M-69-127, February 1969.

D. D. M. Garst, "5 Year Forecast for Contamination Control", CONTAMINATION CONTROL JOURNAL, February 1969.

E. A. L. Roark, "The Determination of Quantitative Microbial Sampling Requirements for Apollo Modules", SC-RR-69-23, January 1969.

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