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EXPERIMENTAL ASSEMBLY & STERILIZATION LAB

- CLOTHING STUDY -

15 April 1967
Task 5.2
JPL CONTRACT 951624

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PASADENA, CALIFORNIA

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ABBREVIATIONS

Bio	Biological
C	Capacitor
°C	Degrees Centigrade
D	Diode
EASL	Experimental Assembly and Sterilization Laboratory
Mod	Module
OSE	Operational Support Equipment
PC	Printed Circuit
QA	Quality Assurance
Q. A. L.	Quality Assurance Log
R	Resistor
Rel	Relays
T	Transistors
V. P.	Variable Particles

I. INTRODUCTION

The major objective of this study was to determine the role clothing plays in controlling the dissemination of biological burden (microorganisms) from a worker constructing a printed circuit board assembly in the EASL facility.

The shedding of microorganisms from the human body is a well documented phenomenon (see Quarterly Summary Reports of Progress (1-7) Biophysics Section, U. S. Department of Health, Education and Welfare, November 1964 -- May 1966). Levels of shedding, approximately 10^3 to 10^5 viable particles per minute, were obtained from individuals wearing street clothes who showered approximately 1 to 2 hours before the test. The shedding was reduced to approximately 10^2 viable particles per minute when these tests were repeated with the same individuals when showered with Phisohex and, in addition, were wearing sterile scrub suits, sterile socks and sterile caps. Shedding therefore could be a major source of biological burden on an assembly built in the EASL facility. By comparing the buildup of biological burden on an assembly and in the immediate area produced by an individual dressed in a sterile hood, smock, gloves and mask with that produced by the same individual dressed in regular street clothes, a realistic evaluation of clothing requirements could be obtained.

II. TEST PLAN AND PROCEDURES

A. GENERAL APPROACH

Four assemblies, as described in Figure 1, were built by the assembler dressed in two types of clothing. The first two assemblies were built while the assembler wore street clothers plus a sterile hood, mask, smock and gloves. The second two assemblies were built by the assembler wearing only street clothing. A comparison will be made of the biological burden of the area (near working surfaces, beside the assembler, and intramural air) and the biological burden on the assemblies.

NOTE: The assembler will be instructed to maintain a consistent level of personal hygiene during the study (for example, bathing schedule, change of clothing, and change of underwear will be systematized).

B. BIOLOGICAL EXAMINATION OF THE AREA BEFORE THE START OF THE ASSEMBLY PROCESS

1. Using three Reynier slit samplers, the intramural air close to assembly area was sampled. The Reyniers were run 1/2 hour before the assembly work started.

2. The three Reyniers were run for 3 hours during the assembly.

3. The three Reyniers were also run for 1/2 hour after the assembly work was stopped.

4. The Reynier plates were incubated for 72 hours at 32° C, aerobically. Counts were made at 24, 48, and 72 hours. Only the 72-hour counts were reported.

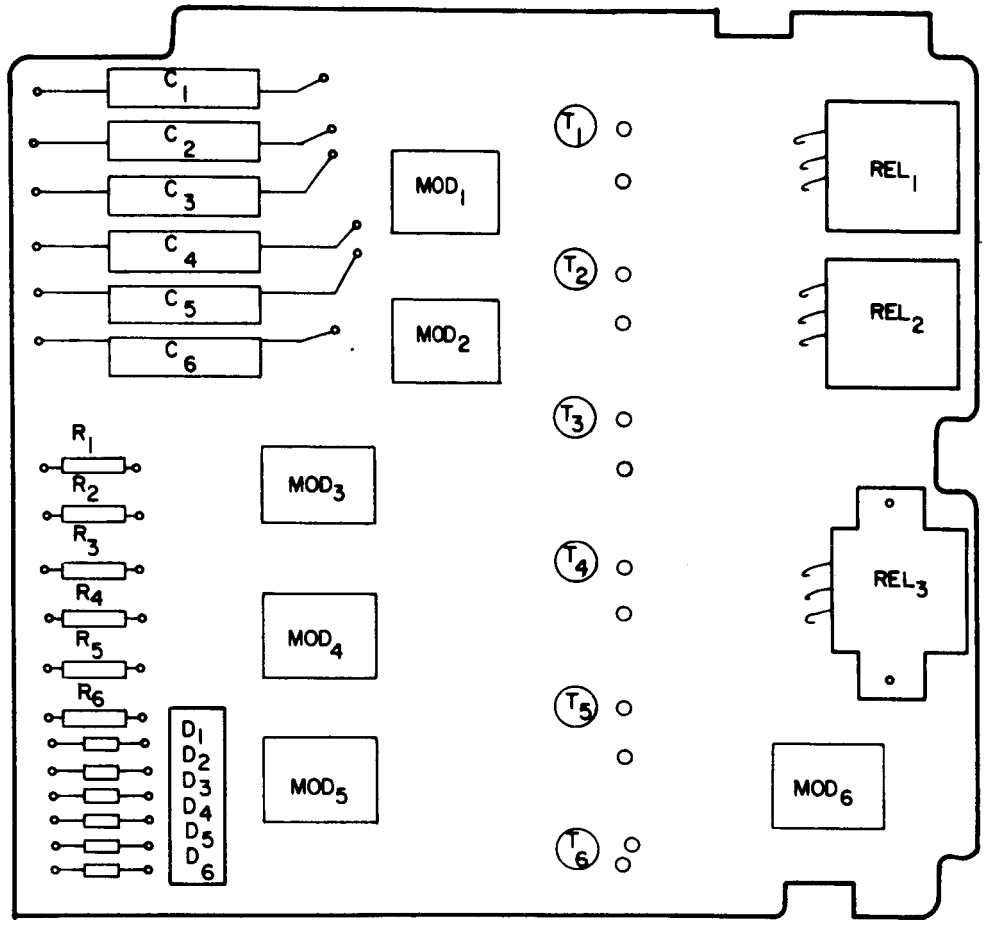
C. SAMPLING THE CLOSE WORKING AREA

1. Rodac plates were used to biologically assay the working area on which the assembly process took place.

   a. The area was assayed before the assembly process was started.

   b. Assays were performed both during the assembly process and at the end of the assembly process.

   c. A grid of the working area was made so that samples were taken in the same area from day to day.



C = CAPACITORS
D = DIODES
MOD = MODULES
REL = RELAYS
T = TRANSISTORS
R = RESISTORS

87-3007

Figure 1 LOCATION AND TYPES OF COMPONENTS USED TO CONSTRUCT PRINTED CIRCUIT BOARD ASSEMBLIES 1 TO 4

d. Four sites were biologically assayed: two on the left-hand side of the assembler's work table, and two on the right-hand side (5 Rodac plates per side). Rodac plates were incubated aerobically. Incubations were made at 32° C for 72 hours aerobically. Counts were made after 24, 48 and 72 hours of incubation. Only the 72-hour counts were reported.

2. Stainless steel strips were also used to assay the close working areas.

a. The strips were set out before assembly work was started and were removed during the assembly and after the assembly was stopped for the day.

1) Two trays of sterile stainless steel strips were located as close to the assembler as possible. One tray was placed on the left-hand side of the assembler, and the other on the right-hand side.

2) Three strips were withdrawn from each of the two trays per sampling.

3) Sampling periods were as follows:

a) sterility control sampling prior to assembly,

b) one sampling at the start of the assembly,

c) two samplings during the assembly, and

d) one sample at the end of the assembly.

b. The strips were assayed for aerobic, mesophilic organisms (spores and vegetative cells).

1) After a 12-minute sonication of the samples they were plated on trypticase soy agar, incubated at 32° C and counted after 24, 48 and 72 hours. Only the 72-hour counts were reported.

2) The counts were reported as total organisms, vegetative cells and spores.

c. Control strips were used to ascertain sterility of the strips before exposure.

D. BIOLOGICAL ASSAY OF CLOTHING

1. Sterile garments were used for the first two assemblies.

a. The garments were assayed by Rodac plate during the assembly process and after the completion of the assembly process.

b. Areas of the smock to be Rodac plated were the sleeves, cuffs, chest, bottom hem and rear shoulders.

c. The gloves were not assayed until the assembly was completed.

2. The second two assemblies were built while the assembler was wearing street clothes only.

a. Shirt sleeves, shirt cuffs, chest, rear shoulders, trouser seat, and area of trouser cuffs were Rodac plated during assembly and after completion of the assembly.

E. COORDINATION OF COUPON STUDY AND CLOTHING STUDY

1. Four assemblies were built, as follows:

a. One assembly was built with no coupons attached and the assembler dressed in sterile hood, smock, gloves and mask (Board 1).

b. One assembly was built with coupons attached and the assembler dressed in sterile hood, smock, gloves and mask (Board 2).

c. One assembly was built with no coupons attached and the assembler dressed in street clothes (Board 3).

d. One assembly was built with coupons attached and the assembler dressed in street clothes (Board 4).

2. Boards 1 to 4 were built in numerical order. The following biological assays were performed:

1) Board 1 -- clothing, intramural air, close working area (table top and next to assembler) and components were assayed.

2) Board 2 -- clothing, intramural air, coupons, close working area (table top and next to assembler) and components were assayed.

3) Board 3 -- clothing, intramural air, close working area (table top and next to assembler), and components were assayed.

4) Board 4 -- clothing, intramural air, coupons, close working area (table top and next to assembler), and components were assayed.

3. The experimental results (biological burden levels of clothing, intramural air, close working areas and components) were integrated with those of the coupon study.

F. QUALITY ASSURANCE LOG

1. A Quality Assurance Log (QAL) was kept.

a. The sequence of board assembly and disassembly, violations of technique, procedures performed, unusual incidents, and other pertinent information was recorded. See the appendix for the Quality Assurance Log.

III. RESULTS

Figure 2 shows the areas sampled in this study and the techniques used for sampling.

The biological burden values for the intramural air samples, close working areas, and the assembler's clothes, while the printed circuit board assemblies (Boards 1 to 4) were built, are given in Tables I to IV.

The biological burden values found on the components removed from Boards 1 to 4 are shown in Figures 3, 4, 5, and 6. These figures also show the location of the individual components in the boards.

Table V contains a list of the biological burden values found on the assembler's hands during three sampling periods.

Table VI contains the high and low biological burden values obtained from intramural air, surface of the work table, clothing of the assembler and the areas immediately beside the assembler (left and right sides) where Boards 1 to 4 were built.

Table VII lists the high and low biological burden values obtained from the components (piece parts) that were removed and assayed from Boards 1 to 4.

Table VIII lists the individual biological burdens obtained assaying the components and surfaces of Boards 1 to 4. It also lists the total biological burden for each board.

Table IX lists the biological burden on the components of Boards 1 to 4 and the manipulations required to mount the components.

The Quality Assurance Log for the assembly, disassembly and assay of Boards 1 to 4 is given in the appendix.

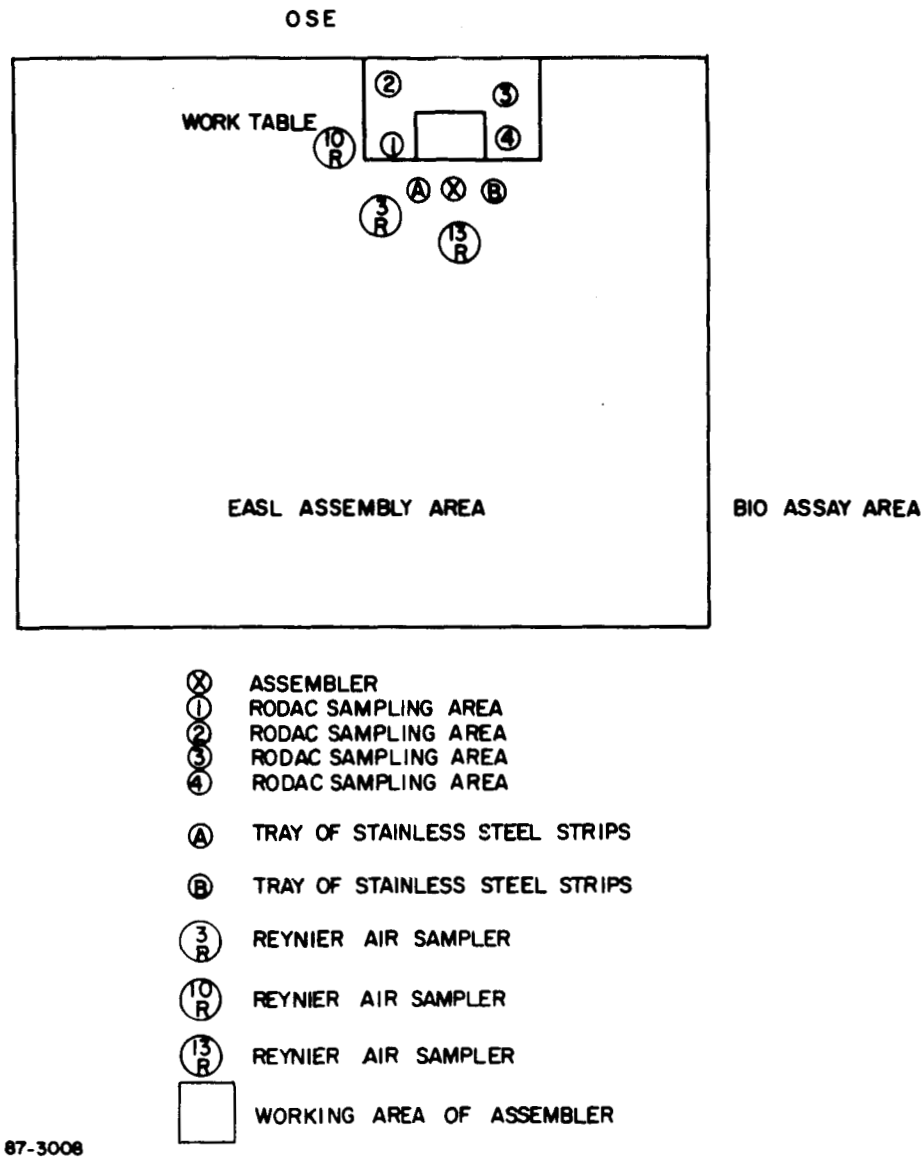
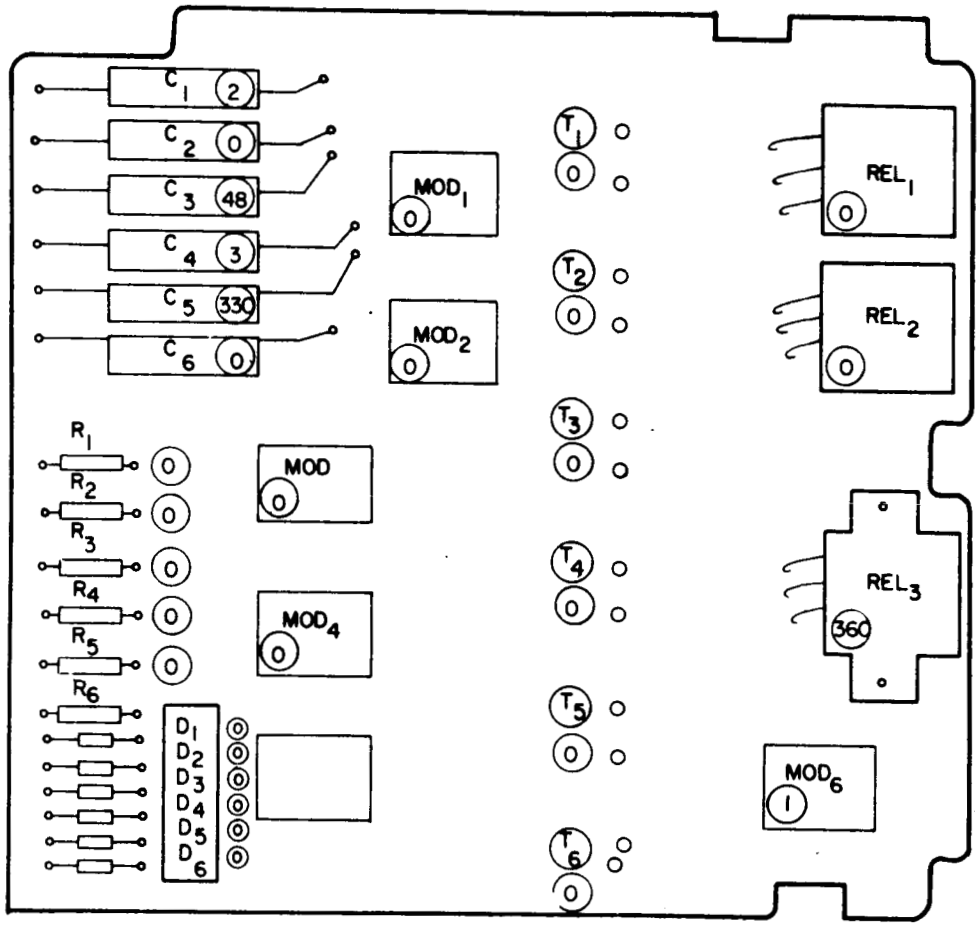


Figure 2 SAMPLING AREAS FOR CLOTHING AND COUPON STUDY



NUMBERS IN CIRCLES INDICATE BURDEN ON COMPONENT
SWAB 1 TOP SURFACE OF BOARD = 0
SWAB 2 BOTTOM SURFACE OF BOARD = 0
C = CAPACITORS
D = DIODES
MOD = MODULES
REL = RELAYS
T = TRANSISTORS
R = RESISTORS
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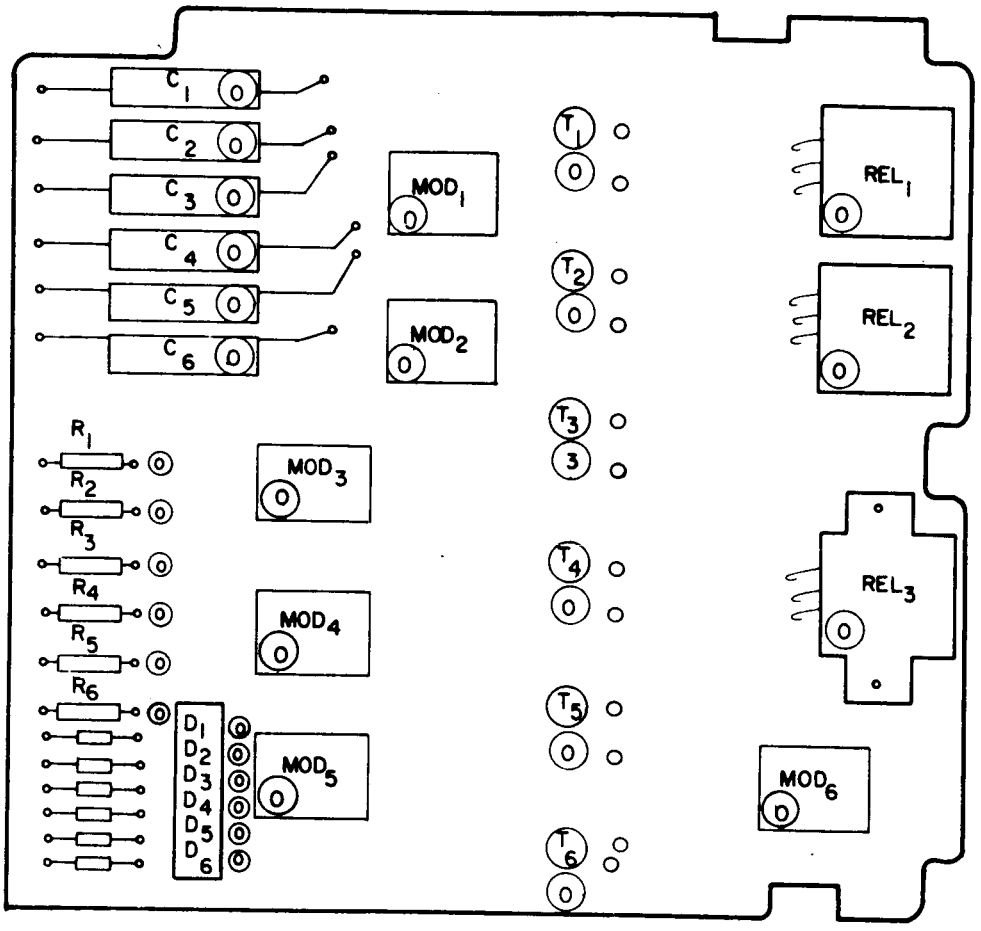
Figure 3 BIOLOGICAL BURDEN ON COMPONENTS OF BOARD 1 -- AEROBIC MESOPHILIC MICROORGANISMS



NUMBERS IN CIRCLES INDICATE BURDEN ON COMPONENT
SWAB 1 TOP SURFACE OF BOARD = 0
SWAB 2 BOTTOM SURFACE OF BOARD = 0
C = CAPACITORS
D = DIODES
MOD = MODULES
REL = RELAYS
T = TRANSISTORS
R = RESISTORS

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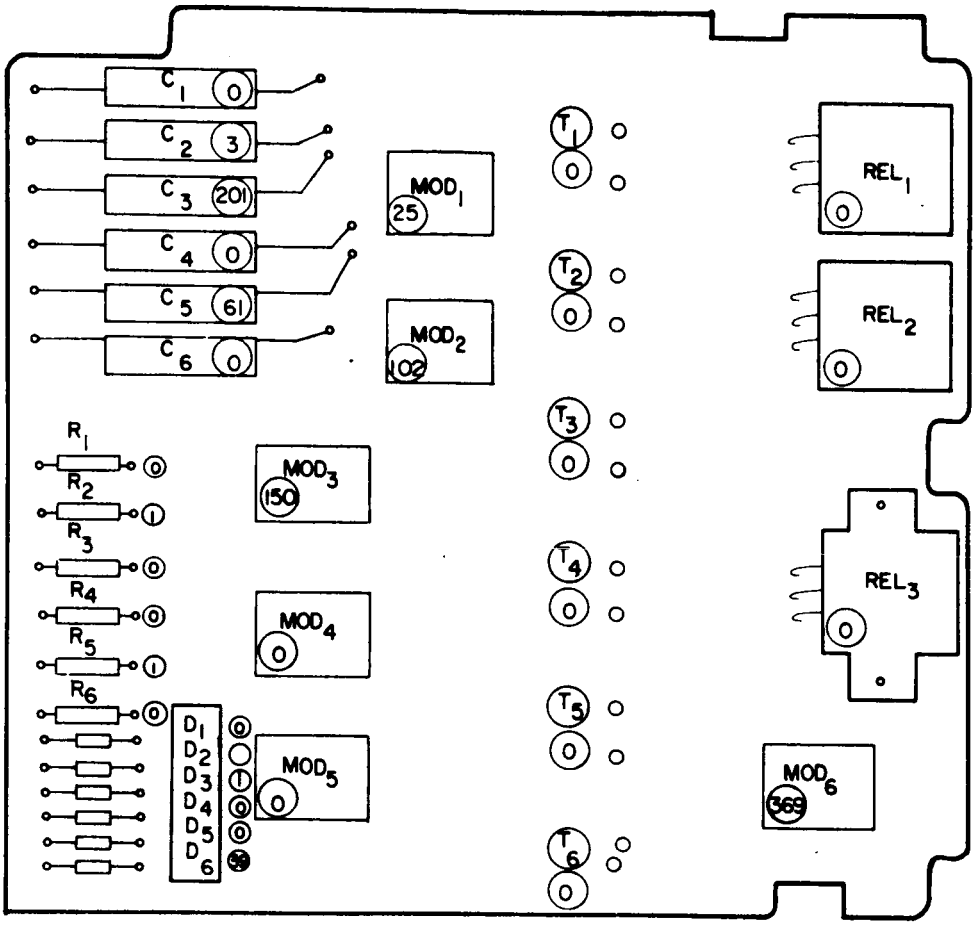
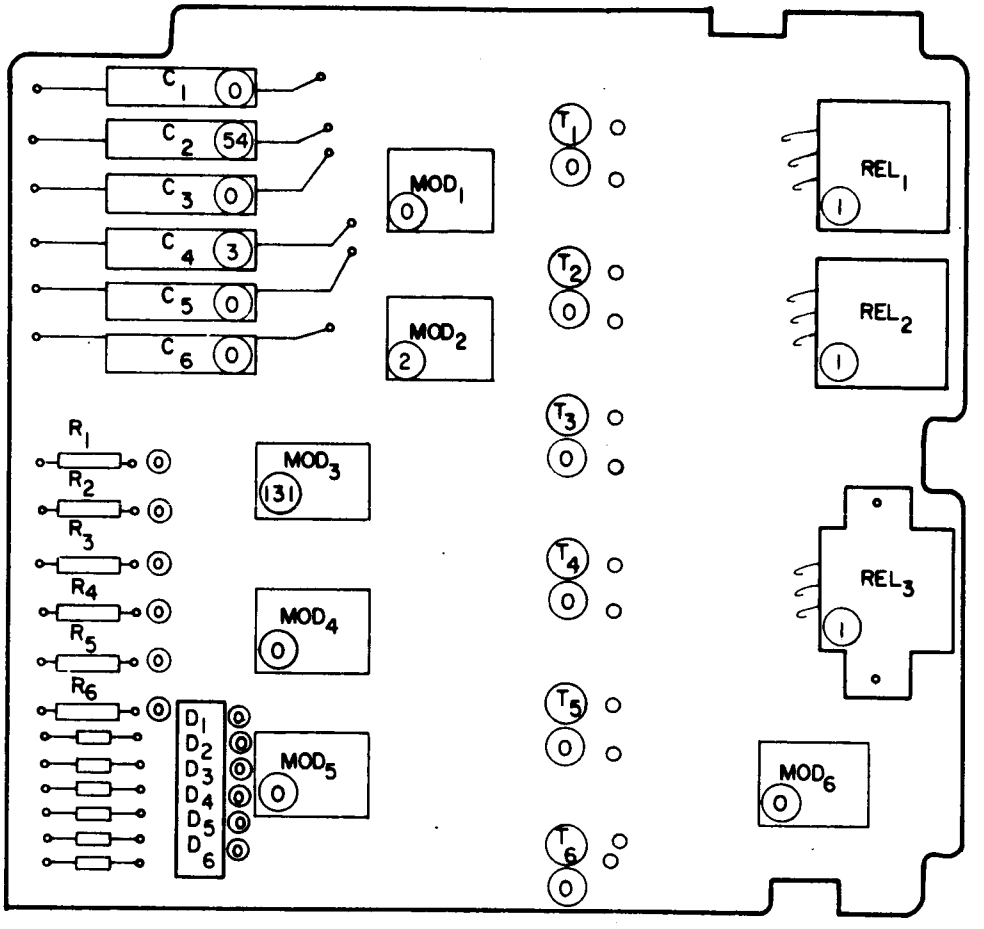
Figure 4 BIOLOGICAL BURDEN ON COMPONENTS OF BOARD 2 -- AEROBIC MESOPHILIC MICROORGANISMS



NUMBERS IN CIRCLES INDICATE BURDEN ON COMPONENT
SWAB 1 TOP SURFACE OF BOARD = 58
SWAB 2 BOTTOM SURFACE OF BOARD = 49
C = CAPACITORS
D = DIODES
MOD = MODULES
REL = RELAYS
T = TRANSISTORS
R = RESISTORS

87-3011

Figure 5 BIOLOGICAL BURDEN ON COMPONENTS OF BOARD 3 -- AEROBIC MESOPHILIC MICROORGANISMS



NUMBERS IN CIRCLES INDICATE BURDEN ON COMPONENT
SWAB 1 TOP SURFACE OF BOARD = 3
SWAB 2 BOTTOM SURFACE OF BOARD = 1
C = CAPACITORS
D = DIODES
MOD = MODULES
REL = RELAYS
T = TRANSISTORS
R = RESISTORS
87-3012

Figure 6 BIOLOGICAL BURDEN ON COMPONENTS OF BOARD 4 -- AEROBIC MESOPHILIC MICROORGANISMS

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TABLE I

DATA FORM FOR CLOTHING STUDY
ASSEMBLY OF BOARD 1

Assembler: A. G.
Assembler: Right-handed
Clothing: Street clothes, plus sterile gown, hood, mask and gloves

Date Assembled: 6 Dec. 1966
Date Assayed: 7 Dec. 1966
Assayers: A. G., J. B., & E. S.

INTRAMURAL AIR (REYNIER SAMPLER)

(Aerobic mesophilic viable particles/ft^3)

Time	Site 3	Site 10	Site 13
1/2 hour before start	0	0	0
1st hour	0	0.067	0
2nd hour	0	0.067	0.016
3rd hour	0	0	0
4th hour (end of assembly)	0	0.100	0.003

CLOTHING BIOLOGICAL BURDEN (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2)

Time	Left Side of Assembler						Right Side of Assembler					
	Smock Sleeve	Trouser Cuff	Smock Chest	Smock Hem	Smock Shoulder	Glove	Smock Sleeve	Trouser Cuff	Smock Chest	Smock Hem	Smock Shoulder	Glove
Start	0	0	0	0	0	0	0	0	0	0	0	0
End 1st hour	108	0	38	0	0	0	76	0	76	0	0	0
4th hour (end of assembly)	506	76	0	506	0	0	1102	38	152	647	0	684

BIOLOGICAL BURDEN BESIDE ASSEMBLER (STAINLESS STEEL STRIPS)

(Aerobic mesophilic viable particles/ft^2. Counts are average of three strips.)

Time	Left Side of Assembler			Right Side of Assembler		
	Spores	Vegetative Cells	Total Count	Spores	Vegetative Cells	Total Count
Controls	0	0	0	0	0	0
Start	0	38	38	0	0	0
1st hour	0	0	0	0	0	0
3rd hour	0	0	0	48	48	96
4th hour (end of assembly)	0	0	0	0	0	0

BIOLOGICAL BURDEN SURFACE WORK TABLE (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2. Counts are average of 5 Rodac plates.)

Time	Left Side of Assembler		Right Side of Assembler	
	Site 1	Site 2	Site 3	Site 4
Controls	0	0	0	0
Start	0	0	0	0
1st hour	7	0	0	7
3rd hour	0	7	4	14
4th hour (end of assembly)	7	14	14	0

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TABLE II

DATA FORM FOR CLOTHING ONLY
ASSEMBLY OF BOARD 2

Assembler: A. G.
Assembler: Right-handed
Clothing: Street clothes, plus sterile gown, hood, mask and gloves

Date Assembled: 12/8/66
Date Assayed: 12/9/66
Assayer: A. G., J. B., E. S.

INTRAMURAL AIR (REYNIER SAMPLER)

(Aerobic mesophilic viable particles/ft^3)

Time	Site 3	Site 10	Site 13
1/2 hour before start	0.016	0	0
1st hour	0	0.05	0
2nd hour	0	0.03	• 0.016
3rd hour	0	0	0.016
4th hour after start	0	0	0

CLOTHING BIOLOGICAL BURDEN (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2)

Time	Left Side of Assembler						Right Side of Assembler					
	Smock Sleeve	Trouser Cuff	Smock Chest	Smock Hem	Smock Shoulder	Glove	Smock Sleeve	Trouser Cuff	Smock Chest	Smock Hem	Smock Shoulder	Glove
Start	0	0	0	0	0	0	0	0	0	0	0	0
End 1st hour	0	0	76	0	0	38	228	76	0	38	38	0
End 4th hour	912	72	38	266	38	0	2052	38	76	646	38	38

BIOLOGICAL BURDEN BESIDE ASSEMBLER (STAINLESS STEEL STRIPS)

(Aerobic mesophilic viable particles/ft^2. Counts are average of 3 strips.)

Time	Left Side of Assembler			Right Side of Assembler		
	Spores	Vegetative Cells	Total Count	Spores	Vegetative Cells	Total Count
Controls	0	0	0	0	0	0
Start	0	0	0	0	86	86
1st hour	0	0	0	0	0	0
3rd hour	0	0	0	0	0	0
End of assembly	0	0	0	0	0	0

BIOLOGICAL BURDEN SURFACE WORK TABLE (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2. Counts are average of 5 Rodac plates.)

Time	Left Side of Assembler		Right Side of Assembler	
	Site 1	Site 2	Site 3	Site 4
Controls	0	0	0	0
Start	0	0	0	0
1st hour	0	0	0	0
3rd hour	28	21	7	7
4th hour (end of assembly)	4	7	7	0

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TABLE III

DATA FORM FOR CLOTHING STUDY
ASSEMBLY BOARD 3

Assembler: G. C. M.
Assembler: Right - handed
Clothing: Street clothes

Data Assembled: 12/13/66
Data Assayed: 12/13/66
Assayed: G.C.M., J.B., E.S.

INTRAMURAL AIR (REYNIER SAMPLER)

(Aerobic mesophilic viable particles/ft^3)

Time	Site 3	Site 10	Site 13
1/2 hour before start	0	0	0
1st hour	0	0.03	0
2nd hour	0	0	0
3rd hour	0	0	0
4th hour after start	0	0	0

CLOTHING BIOLOGICAL BURDEN (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2)

Time	Left Side of Assembler						Right Side of Assembler					
	Sleeve	Shirt Cuff	Chest	Trouser Seat	Shoulder	Cuff	Sleeve	Cuff	Chest	Trouser Seat	Shoulder	Cuff
Start	0	0	0	0	0	0	0	0	0	0	0	0
End of 1st hour	342	570	646	1634	913	3800	988	836	988	1673	1482	2014
End of 4th hour	266	152	114	722	646	1443	228	380	304	913	342	1294

BIOLOGICAL BURDEN BESIDE ASSEMBLER (STAINLESS STEEL STRIPS)

(Aerobic mesophilic viable particles/ft^2. Count is average of 3 strips.)

Time	Left Side of Assembler			Right Side of Assembler		
	Spores	Vegetative Cells	Total Count	Spores	Vegetative Cells	Total Count
Controls	0	0	0	0	0	0
Start	960	1.4×10^3	2.4×10^3	0	1.4×10^5	1.4×10^5
1st hour	144	1.8×10^5	1.8×10^5	0	9.6×10^3	9.6×10^3
3rd hour	394	6.9×10^4	7.0×10^4	0	1.7×10^4	1.7×10^4
End of assembly	0	0	0	48	9.6×10^1	1.4×10^2

BIOLOGICAL BURDEN SURFACE WORK TABLE (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2. Count is average of 5 Rodac plates.)

Time	Site 1	Site 2	Site 3	Site 4
Controls	0	0	0	0
Start	0	0	0	0
1st hour	7	7	0	0
3rd hour	0	0	7	0
4th hour (end of assembly)	14	14	14	0

TABLE IV

DATA FORM FOR CLOTHING STUDY
ASSEMBLY OF BOARD 4

Assembler: G. C. M.
Assembler: Right-handed
Clothing: Street clothes

Date Assembled: 12/14/66
Date Assayed: 12/15/66
Assayers: G. C. M., J. B., E. S.

INTRAMURAL AIR (REYNIER SAMPLER)

(Aerobic mesophilic viable particles/ft^3)

Time	Site 3	Site 10	Site 13
1/2 hour before start	0	0	0
1st hour	0	0	0.016
2nd hour	0	0	0.016
3rd hour	0	0	0
4th hour after start	0	0.03	0.03

CLOTHING BIOLOGICAL BURDEN (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2)

	Left Side of Assembler						Right Side of Assembler					
Time	Sleeve	Shirt Cuff	Chest	Trouser Seat	Shoulder	Trouser Cuff	Sleeve	Shirt Cuff	Chest	Trouser Seat	Shoulder	Trouser Cuff
Start	0	0	0	0	0	0	0	0	0	0	0	0
End of 1st hour	228	456	114	912	152	3800	114	342	190	1370	304	3496
End of 4th hour	114	266	304	494	342	2660	684	342	608	494	418	1900

BIOLOGICAL BURDEN BESIDE ASSEMBLER (STAINLESS STEEL STRIPS)

(Aerobic mesophilic viable particles/ft^2. Count is average of 3 strips.)

	Left Side of Assembler			Right Side of Assembler		
Time	Spores	Vegetative Cells	Total Count	Spores	Vegetative Cells	Total Count
Controls	0	0	0	0	0	0
Start	0	8.0×10^4	8.0×10^4	0	2.4×10^2	2.4×10^2
1st hour	0	4.8×10^2	4.8×10^2	48	1.75×10^4	1.75×10^4
3rd hour	0	1.4×10^4	1.4×10^4	0	8.0×10^3	8.0×10^3
End of assembly	288	2.9×10^5	3×10^5	0	4.0×10^2	4.0×10^2

BIOLOGICAL BURDEN SURFACE WORK TABLE (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2. Count is average of 5 Rodac plates.)

	Left Side of Assembler		Right Side of Assembler	
Time	Site 1	Site 2	Site 3	Site 4
Controls	0	0	0	0
Start	0	0	0	0
1st hour	0	0	0	0
3rd hour	0	0	0	0
4th hour (end of assembly)	0	0	0	0

TABLE V

BIOLOGICAL BURDEN ON ASSEMBLERS HANDS (RODAC PLATES)

(Aerobic mesophilic viable particles/ft^2)

Hand Area	Date		
	12/13/66	12/13/66 (3 hours later)	12/14/66
Fingers -- right hand	532	1290	190
Fingers -- left hand	114	1520	3040
Palm -- left hand	190	1180	609
Palm -- right hand	190	796	609

Note: Assembler insturcted to follow usual daily hygienic routine (wash hands in lorning, wash before lunch, wash before dinner, and wash before bed).

TABLE VI

HIGH AND LOW LEVELS OF BIOLOGICAL BURDEN FOUND DURING CONSTRUCTION OF BOARDS 1 TO 4

	Board 1*	Board 2*	Board 3*	Board 4*
Intramural air				
high	0.1VP/ft^3	0.05VP/ft^3	0.03VP/ft^3	0.03VP/ft^3
low	0.0VP/ft^3	0.0 VP/ft^3	0.0 VP/ft^3	0.0 VP/ft^3
Clothing				
high	1102 VP/ft^2	2052 VP/ft^2	3800 VP/ft^2	3800 VP/ft^2
low	0 VP/ft^2	0 VP/ft^2	114 VP/ft^2	114 VP/ft^2
Beside Assembler				
high	96 VP/ft^2	86 VP/ft^2	1.8x10^{5}VP/ft^2	2.9x10^{5}VP/ft^2
low	0 VP/ft^2	0 VP/ft^2	0 VP/ft^2	2.4x10^{2}VP/ft^2
Surface Work Table	14 VP/ft^2	28 VP/ft^2	14 VP/ft^2	0 VP/ft^2
high	0 VP/ft^2	0 VP/ft^2	0 VP/ft^2	0 VP/ft^2
low				

*VP = Viable Particles

TABLE VII

HIGH AND LOW LEVELS OF BIOLOGICAL BURDEN

(Found on Components Removed from Boards 1 to 4)

	Board 1 (viable particles)	Board 2 (viable particles)	Board 3 (viable particles)	Board 4 (viable particles)
Capacitors				
High	330[a]	0	201	54
Low	0	0	0	0
Diode				
High	0	0	39	0
Low	0	0	0	0
Module				
High	1	0	369	131
Low	0	0	0	0
Relay				
High	360[a]	0	0	1
Low	0	0	0	1
Resistor				
High	0	0	1	1
Low	0	0	0	0
Transistor				
High	0	3	1	0
Low	0	0	0	0

[a] See Discussion for explanation of these values.

TABLE VIII

BIOLOGICAL BURDEN ON COMPONENTS AND SURFACES
OF BOARDS 1 TO 4

		Board 1 (viable particles)	Board 2 (viable particles)	Board 3 (viable particles)	Board 4 (viable particles)
Capacitor	1	0*	0	0	0
	2	0*	0	3	54
	3	48*	0	201	0
	4	3*	0	0	3
	5	330*	0	61	0
	6	0*	0	0	0
Diode	1	0	0	0	0
	2	0	0	4	0
	3	0	0	1	0
	4	0	0	0	0
	5	0	0	0	0
	6	0	0	39	0
Module	1	0	0	25	0
	2	0	0	102	2
	3	0	0	150	131
	4	0	0	0	0
	5	0	0	0	0
	6	1	0	369	0
Relay	1	0	0	0	1
	2	0	0	0	1
	3	360*	0	0	1
Resistor	1	0	0	0	1
	2	0	0	1	0
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
	6	0	0	1	0
Transistor	1	0	0	0	0
	2	0	0	0	0
	3	0	3	0	0
	4	0	0	0	0
	5	0	0	1	0
	6	0	0	0	0
Surfaces					
Top		0	0	58	3
Bottom		0	0	49	1
Total Biological Burden		741 Viable Particles	3 Viable Particles	1065 Viable Particles	197 Viable Particles

* See Discussion for explanation of values.

TABLE IX

BIOLOGICAL BURDEN ON COMPONENTS (BOARDS 1 TO 4)
AND THE MANIPULATIONS NEEDED TO MOUNT THEM

Component[a]	Biological Burden[b] (viable particles)		Manipulations
Board 1			
Capacitor(6)	(0)(0)(48*)(3*)(330*)(0)	= 380*	Bend leads, mount on terminals, solder, cut excess lead.
Diodes(6)	(0)(0)(0)(0)(0)(0)	= 0*	Bend leads, mount on terminals, solder, cut excess lead.
Modules(6)	(0)(0)(0)(0)(0)(0)	= 0*	Modules cemented on board.
Relays(3)	(0)(0)(360*)	= 360*	2 relays cemented on Board 1 bolted on board.
Resistors(6)	(0)(0)(0)(0)(0)(0)	= 0	Bend leads, mount on terminals, solder, cut excess lead.
Transistors(6)	(0)(0)(0)(0)(0)(0)	= 0	Bend leads, mount on terminals, solder, cut excess lead.
Board 2			
Capacitors(6)	(0)(0)(0)(0)(0)(0)	= 0	Same as Board 1
Diodes(6)	(0)(0)(0)(0)(0)(0)	= 0	
Modules(6)	(0)(0)(0)(0)(0)(0)	= 0	
Relays(3)	(0)(0)(0)(0)(0)(0)	= 0	
Resistors(6)	(0)(0)(0)(0)(0)(0)	= 0	
Transistors(6)	(0)(0)(3)(0)(0)(0)	= 3	
Board 3			
Capacitors(6)	(0)(3)(201)(0)(61)(0)	= 265	Same as Board 1
Diodes(6)	(0)(4)(1)(0)(0)(39)	= 44	
Modules(6)	(25)(102)(150)(0)(0)(366)	= 646	
Relays(3)	(0)(0)(0)	= 0	
Resistors(6)	(0)(1)(0)(0)(0)(1)	= 2	
Transistors(6)	(0)(0)(0)(0)(1)(0)	= 1	
Board 4			
Capacitors(6)	(0)(54)(0)(3)(0)(0)	= 57	Same as Board 1
Diodes(6)	(0)(0)(0)(0)(0)(0)	= 0	
Modules(6)	(0)(2)(131)(0)(0)(0)	= 133	
Relays(3)	(1)(1)(1)	= 3	
Resistors(6)	(1)(0)(0)(0)(0)(0)	= 1	
Transistors(6)	(0)(0)(0)(0)(0)(0)	= 0	

[a] The numbers in the component column indicate the number of components used i.e. diodes(6).

[b] The biological burden column lists the number of viable particles per component and the total for the components.

* Indicates abnormal situations which yielded high burden for the particular component; see Discussion for an explanation.

IV. DISCUSSION

The use of sterile protective clothing (smock, hood, gloves and mask) during the assembly of the experimental Boards 1 and 2 was found to significantly reduce the biological burden in the immediate area of the assembler and on the printed circuit board assemblies being constructed.

There was a reduction of approximately 3 to 4 orders of magnitude of burden in the immediate area to the left and to the right of the assembler when he was protected with the sterile clothing, as compared to when he was dressed in street clothes. The burden on the components and the printed circuit boards was 2 or 3 orders of magnitude lower when the assembler was protectively clothed. The differences in burden appear to be related to the location of the board or area to the assembler. The closer the board or area to the assembler, the higher the burden. This is true whether or not the assembler was clad in protective clothing. The drop-off of the burden accumulation was due to the action of the vertical laminar flow sweeping the burden down into the plenum. If the vertical laminar flow were not functioning, a greater aerosol of organisms would have formed and the organisms would have been more widely distributed.

The intramural air as it came into the assembly room from the HEPA filters was not a significant source of contamination during the construction of the boards. The intramural air was contaminated by the assembler's biological shedding when building the boards in street clothes. The contamination was limited to an area close to the assembler due to the vertical downflow of the EASL assembly area.

The contamination on boards (3 and 4) built when the assembler was in street clothes was most likely due to the transfer of burden from the assembler's hands. Airborne contamination, under the construction conditions used, played only a limited role in the burden accumulation on the boards. Examination of the burden accumulations indicated that the burden source was most likely the biological shedding of the areas of the face and neck which are unprotected. The burden accumulated on the shoulders and sleeves of the assembler eventually worked its way down to the hands. The assembler's hands also had a native microbiological burden of their own. The hands therefore contributed to burden in two ways: 1) the native flora of the hands, and 2) the burden which was shed from the face and neck areas which worked its way down the shoulders onto the sleeves and then onto the hands.

In this study, the burden distribution was controlled in two ways: 1) by the vertical laminar flow which swept into the plenum, and 2) experimental constraint (the assembler was instructed to move slowly and judiciously and not to lean over his work). As a result, the burden was not widespread. This second type of burden control can play a significant role only when the

assembler has a limited degree of motion and a sedentary degree of activity. This is true in our particular situation, since the assembler is seated and is working at a table. If the assembler were standing and reaching overhead, reaching sideways, bending down over the work, closer to the work, or moving around vigorously, there could be a greater biological shedding and microbial aerosol generation. Thus, there could be a greater distribution and accumulation of biological burden.

Quality Assurance monitoring was of the utmost importance during the assembly of boards and other activities requiring bio-assay. The Quality Assurance Log, the record of all activities and environmental conditions, made it possible to correlate burdens with activities, procedures, violations, and laboratory accidents. Examination of the Quality Assurance Log several times yielded information which explained unusual burdens. For example, when examining the components of Board 1 built while the assembler was wearing sterile protective clothing, capacitors 3 and 5 were found to have a significant amount of burden (capacitor 3 had 48 viable particles, and capacitor 5 had 350 viable particles). Since the board was built under rigorously controlled conditions (the assembler was sterily garbed, and the components were presterilized) contamination must have occurred. Examining the Q. A. L., it was noted that the assembler's glove top was not covering his cuff as prescribed in the approved dressing technique. This meant that the assembler's bare wrist area was exposed to the environment. Further examination of the Q. A. L. revealed that the assembler's exposed wrist had touched the area where capacitors were being mounted. It was therefore assumed that the bare wrist of the assembler contaminated capacitors 3 and 5. A similar situation was noted with relay 3. Relay 3 was found to have a burden of 360 viable particles. This should not have occurred if all the procedures and precautions of the technique were followed. Examining the Q. A. L. again, it was found that removing relay 3 for assay gave a considerable amount of trouble (relay 3 was bolted to the printed circuit board). During the process of removal, difficulty was encountered while removing the bolts, and an excessive amount of manipulation was required to remove the relay for assay purposes. Therefore, it was assumed that the abnormal burden on relay 3, 365 viable particles, was not due to a break in technique during assembly, but to the problems of removing the relay from the board.

V. CONCLUSIONS

1. The use of sterile protective clothing significantly reduced the biological burden in the immediate area of the assembler and on the printed circuit board assembly being constructed. There was a reduction of approximately three to four orders of magnitude of burden immediately to the left and the right side of the assembler when he was protectively clothed compared to when he was in street clothing. There was a two to three order of magnitude reduction in biological burden on the components and printed circuit when the assembler was protectively clothed when building the boards.

2. The keeping of a Q. A. L. during the assembly process and during the bioassay process was essential.

3. The use of vertical laminar flow significantly reduced the accumulation of burden in the immediate area of the assembler and on the assemblies being built.

4. The biological burdens of Boards 1 and 2 built while the assembler was wearing protective clothing were insignificant.

5. There is a definite spatial relationship between the assembler and the biological burden accumulation. The further the assembler is from his work, the lower the burden on the work.

6. When the assembler was working in street clothes, the biological burden of concern was found concentrated mainly on the surface areas of the hands, sleeves and shoulders.

7. The assembler's physical activity can act as a means of distributing biological burden.

8. The factors of motion, activity, and orientation of the assembler to the work during the construction of the boards play a significant role in the accumulation of the biological burden when the assembler is dressed only in street clothing. If the assembler is in protective clothing, the importance of these factors in the buildup of biological burden is reduced.

9. Quality assurance monitoring is of the utmost importance during the assembly of the boards, or other activities requiring bioassay. Using the Quality Assurance Log, it was possible to correlate burdens with activities, procedure violations and laboratory accidents. Unusual burden levels on components or coupon could, in several situations, be explained by examining the Quality Assurance Log to see what had occurred.

VI. RECOMMENDATIONS

1. Wherever possible, sterile protective clothing should be worn.

2. Assembly workers and others who are involved with assembly or fabrication should perform their duties with a minimum amount of contact with their work and at as great a distance from their work as possible.

3. Assembly workers and others who are involved with assembly or fabrication should perform their duties in a sedentary manner. Rapid, violent, or excessive motion or activity should be discouraged.

4. Quality Assurance monitoring of activities should be carried on when feasible.

5. Vertical laminar flow work areas or stations should be used wherever possible.

APPENDIX

QUALITY ASSURANCE LOG
FOR THE CONSTRUCTION AND ASSAY OF
PRINTED CIRCUIT BOARD ASSEMBLIES 1 TO 4

COUPON AND PERSONNEL CLOTHING STUDY

ASSEMBLY BOARD #1

6 December 1966

Bio Assayer, W. Graff, #4
Assembler, A. Gould #3

Q.A. PERSONNEL ASSEMBLY PROCEDURE LOG

08:00 W. Graff, #4, has entered the EASL facility and signed the personnel log.

08:17 W.G. has entered the assembly room.

08:20 Reynier plates are placed into the Reynier air samplers, at sites 10, 3, and 13. These Reynier plates will run for 30 minutes and will be removed and replaced with other Reyniers.

08:25 The assemblyman's tools are removed from the assembly bench and the bench top is completely wiped down with Amphyl.

08:30 The Rodac plates are identified for specific locations of the work bench.

08:32 The Rodac plates are placed into position #1 on the work bench. 5 Rodac samples are taken at this location.

08:34 5 Rodac plates are used at location #2 on the work bench.

08:35 5 Rodac samples are taken at location #3 on the work bench.

08:36 5 Rodac samples are taken on station #4 of the work bench.

08:40 The Reynier plates are removed from Reynier air sampler at sites 3, 10, and 13 and are replaced with new Reynier plates.

08:59 The Reynier plates are placed into the pass-thru.

09:00 Rubber gloves are placed into the pass-thru to be used as replacements for the cotton gloves that are presently being worn.

09:01 The rubber gloves are put on.

09:02 Two trays of steel strips are removed from the pass-thru.

09:05 Assemblyman #3 has just entered the dressing room.

09:10 Assemblyman #3 has entered the assembly room, then proceeds into the bio-assay room for Rodac samples. Smock sleeves are sampled, left and right. Smock cuffs are samples, left and right. Smock front at chest is sampled, left and right side. Smock bottom hem, left and right side are samples. Rear shoulders, left and right side. Glove fingertips, left and right hand. Back of hands, left and right hand. Palm of hands, left and right hand. Rodac sampling of assemblyman is completed at this time.

09:16 Stainless steel strips are placed on left side of work bench.

09:17 The second tray of stainless steel strips is placed on the table right side.

09:19 Three stainless steel strips are removed from the tray on left side of work bench.

09:23 Three stainless steel strips are removed from the tray on right hand side of work bench.

09:25 The circuit board and parts to be assembled to the circuit board, including the coupons are removed from the pass-thru. It is observed at this time that the outer plastic bag has a tear approximately four and one half inches long (inner bag undamaged).

09:27 The circuit board is placed into its holding fixture.

09:30 Assemblyman removes a transistor from its plastic envelope.

09:37 The transistor is soldered into position in its terminal.

09:38 Two pair of pliers are removed from the table top work bench because they had been touched with rubber gloves that had agar on the finger tips.

09:39 Excess wire protruding beyond the terminal is cut and removed.

09:40 The second transistor is placed on the circuit board. The wire leads are bent to proper configuration and placed into the terminal.

09:41 The wire leads are soldered to the terminal. The excess wire protruding beyond the terminal is cut and removed from the board.

09:43 The third transistor is placed on the circuit board. The wires are bent to the proper shape and placed into the terminals.

09:44 The wires are soldered into the terminals. The excess wires protruding beyond the terminal are cut and removed from the circuit board. Sequence operation of assembly A is completed at 09:44.

09:45 Sequence operation B is started, which includes placing resistors into the proper terminals.

09:47 Six resistors and six diodes are placed into position on the circuit board.

09:48 The resistors are soldered into position.

09:52 The six diodes are soldered into position in their appropriate terminals.

09:53 The excess wire protruding beyond the terminal is cut with the diagonal cutters.

09:53 The Reynier air sampler plates are removed from the Reynier air sampler at sites 3, 10, and 13, and are replaced with new Reynier sampler plates.

09:54 Operation sequence B is completed.

09:55 Operation sequence C is started.

09:55 The relays are coated with an epoxy on one side and placed on the board. A second relay is placed on the board for mechanical fastening.

09:58 Operation D is completed. The relay is mechanically fastened to the circuit board.

10:00 Rodac sample at position 1 was made.

10:01 Rodac sample at position 2 was made.

10:01 The capacitors are being fitted to the board.

10:01 Rodac samples for position 3 are being made.

10:02 The Rodac samples for position 4 are being made and the capacitors are being soldered to the board.

10:05 The substitute modules under item G were glued to the board.

10:06 The substitute modules under area H were glued to the board.

10:07 The relay under item I was glued to the board.

10:10 The transistors in area J were placed on the board and by 10:15 they had been soldered in place.

10:14 Item K is installed to the board and the installation is completed, This is one of the modules.

10:15 Assemblyman #3 moved away from the assembly bench towards the emergency exit door and started a coughing spell into the mask.

10:16 A new mask was furnished to him throught the pass-thru.

10:17 Assembly of the circuit board is completed.

10:20 The assemblyman has exited the assembly room and entered the bio-assay room.

10:21 The bio man #4 is taning Rodac samples of the assemblyman's smock sleeves.

10:22 The smock cuff and left hand and right hand, are Rodac sampled. The left and right side of the chest is Rodac sampled. The bottom hem of the smock on left and right side are Rodac sampled. The left and the right side of the rear shoulder are sampled. The gloves' fingertips, left and right hand, are sampled. The glove palms, left and right hand are sampled. The back of hand, left and right hand, are Rodac sampled.

10:23 The Rodac sampling of Assemblyman #3 smock and clothing study is completed.

10:24 The Rodac samples are placed into the pass-thru.

10:25 The assembly man #3 has exited the bio-assay room into the OSE area.

10:44 Stainless steel strips are removed from tray on right hand corner of work bench.

10:45 Removal of three stainless steel strips from this tray is completed.

10:46 Three stainless steel strips are being removed from the tray on the left hand corner of the work bench.

10:47 5 Rodac samples are taken on location #1 of the work bench.

10:48 5 Rodac samples are taken of location #2 of the work bench.

10:49 5 Rodac samples are taken of location #3 on the work bench.

10:50 The two trays of the remaining stainless steel strips are put into the pass-thru, for removal from the assembly room.

10:50 5 Rodac plates of location #4 on their work bench has been completed.

10:52 Reynier plates are removed from the Reynier air samplers.

10:53 The Reynier plates are placed into the pass-thru.

10:54 The table-top of the work bench is wiped down with amphyl.

10:55 The circuit board is removed from its holding fixture and placed into a plastic bag.

10:56 The plastic bag containing the circuit board is placed into its second outer covering plastic bag, and placed into the pass-thru.

10:58 The plastic cover is placed over the tools and the work bench.

11:00 The bio man #4 has exited the bio assay room into the OSE area. The coupon and clothing study for 6 December 66 has terminated and is completed for today.

NOTE: It has been decided that the coupon and clothing study will continue for today, 6 December 1966.

13:15 Warren Graff entered the EASL facility and continued on into the assembly room, to set up a repeat effort of the coupon and clothing study.

13:40 A. Gould, assemblyman #3, entered the EASL facility.

13:55 A. Gould entered the assembly room. Upon entering the assembly room, he then checks the work and arrangement over the table for the necessary and proper tools. This has been done. He now walks into the bio assay room.

13:58 Rodac samples are taken from the smock or various clothing locations. Rodac samples are taken of the smocks' sleeves with the left arm and right arm. The smock cuffs, left arm and right arm. The chest, left side and right side. The bottom hem of the smock, left side and right side. Rear shoulders, left shoulder and right shoulder. The glove's fingertips, left hand and right hand. The left palm and right palm, and the back of the left and the right hand. The Rodac samples of the assemblyman are completed and 13:59.

14:00 The assemblyman has removed the first pair of gloves he had on because of agar being on the finger tips. He replaced these gloves by putting on another pair of sterile gloves.

14:01 The Reynier air samplers are opened and a Reynier sampler plate is installed. The units are then turned on. The Reynier air samplers are set at sites 3, 10 and 13.

14:04 The stainless steel strip tray is placed on location on the left hand corner of the work bench.

14:05 The tray of stainless steel strips is placed on the right hand corner of the work bench.

14:07 Three stainless steel strips are removed from the right hand tray of the work bench. The stainless steel strips are placed in bottles.

14:09 Three stainless steel strips are removed from the left hand tray of the work bench and are placed in bottles.

14:12 The double-wrapped printed circuit board is removed from the plastic bag. The individual detail parts are also removed from the plastic bag.

14:13 The printed circuit board is mounted into the holding fixture.

14:16 Operation A of the sequence assembly chart is started.

14:17 A transistor is removed from its plastic envelope and placed on the circuit board.

14:18 The transistor wires are bent into shape and placed into the terminal.

14:20 The transistor wires are soldered into the terminal.

14:21 The excess wire projected beyond the terminal is cut and removed from the board.

14:24 The second transistor wires are shaped into position and placed on the circuit board.

14:25 The transistor wires are soldered into the terminal.

14:26 Excess wire protruding beyond the terminal is cut and removed from the circuit board. The third transistor is placed on the circuit board. The wires are bent to proper shape and placed into the terminals.

14:31 The solder of wires is completed on the transistors.

14:35 The operations for operation B are started. Diodes are placed into position at their appropriate terminals.

14:42 It was noted that the package did not contain the six resistors necessary for the buildup on the circuit board. This is to be marked as a violation infraction. *

14:50 It is decided that 6 resistors will be placed into the autoclave and processed in that manner.

14:54 The diodes are completely soldered into position.

14:56 Three stainless steel strips are removed from the tray at the right hand corner of the work bench.

14:59 Three stainless steel strips are removed from the tray in the left hand corner of the work bench.

15:01 The Reynier plates are removed from the Reynier air samplers and replaced with new Reynier plates.

15:05 5 Rodac samples are taken at location #1 of the work bench.

15:06 5 Rodac samples are taken at location #2 of the work bench.

15:07 5 Rodac samples are taken at station #3 at the work bench.

15:08 5 Rodac samples are taken at location #4 of the work bench.

15:09 The table top is wiped in four locations with amphyl.

15:13 This should be noted as a violation. The bio man's gloves had a hole punctured in one of the fingers. The bio man was informed to remove the gloves and replace them with a sterile pair of gloves furnished to him throught the pass-thru. *

*Operational discrepancy

15:18 It is decided that a slight intermission will be taken at this time.

15:40 6 resistors were placed in the pass-thru and received in the assembly room.

15:41 The bio man coughed in his mask and requested a replacement mask. *

15:42 One resistor is placed on the board and the wires set into the terminals.

15:43 The wires are soldered to the terminals.

15:43 The other resistors are placed in the terminals.

15:45 The resistors are soldered to their respective terminals.

15:47 The excess wire protruding beyond the terminal is cut and removed from the board.

15:48 All functions of operation B are completed.

15:49 Operation C relay is bonded into position.

15:50 Operation D, placement of the relay on the board, is mechanically fastened with hardware. The hardware is secured with the use of a screwdriver and a mini socket.

15:52 Operation E is started, and the one c apacitor is placed on a circuit board, the wires positioned into the terminal.

15:53 The wires are soldered into position.

15:57 Three steel strips are removed from the right hand tray of the work bench.

16:00 Three stainless steel strips are removed from the tray on the left hand corner of the work table.

16:03 The Reynier plates are removed from the Reynier samplers, and replaced with new ones. The Reyniers are started.

16:04 Additional capacitors are added to the circuit board and soldered into position. Excess wire protruding beyond the terminals is cut and removed.

16:05 Assemblyman #3 is notified to extend the gloves over the cuffs of the smock. Wrist in contact with capacitors on board. *

16:06 Another capacitor is placed into position on the board and the wires soldered to the terminals.

*Operational discrepancy

16:08 The last of the capacitors is placed on the circuit board, the wires are soldered to the terminal. The excess wire protruding beyond the terminal is cut and removed.

16:10 Operation F is started and the module is bonded to the circuit board.

16:10 Operation G is started and the module is bonded to the circuit board.

16:11 The second module at operation G is bonded to the circuit board.

16:12 Operation H is started and the first module is bonded to the circuit board.

16:13 Operation F is started and the relay is bonded onto the board.

16:15 Operation J is started.

16:16 First transistor is placed on the circuit board and the wire soldered to the terminal. The excess wire from that terminal is cut and removed.

16:17 Another wire from the transistor is placed in a terminal and soldered into position.

16:19 Another transistor is placed into position on the board. Wire from that transistor is placed in the terminal and soldered. The excess wire protruding beyond the terminal is cut and removed.

16:20 Another wire from the transistor is placed into position in the terminal. The wire is soldered into position with solder. Excess wire protruding beyond the terminal is cut and removed.

16:22 Another transistor is placed into position on the board. The wire is placed into the t erminal and soldered. The excess wire is cut and removed.

16:23 Another wire from the transistor is soldered to the terminal. The excess wire protruding beyond the terminal is cut and removed.

16:40 Operation K is started. The module is bonded into position on the board.

16:51 Three stainless steel strips are removed from the tray, placed at the right hand corner of the table.

16:55 Three steel strips are removed from the tray at the left hand corner of the workbench.

16:57 Reynier plates are removed from the Reynier air samplers and new ones are replaced. The Reyniers are started.

17:00 5 Rodac samples are taken of location #1 on the table.

17:01 The assembled circuit board is removed from the holding fixture and placed into a plastic bag.

17:02 5 Rodac samples are taken at location #2 on the work bench.

17:02 The assembled circuit board is placed into another plastic bag, providing a second cover.

17:03 5 Rodac samples are taken of location #3 on the work bench.

17:04 5 Rodac samples are taken of location #4 on the work bench. The two trays containing the extra stainless steel strips are removed from the assembly room and placed into the pass-thru.

17:05 The table is wiped down with amphyl on the specific locations where the Rodac samples were taken.

17:06 The plastic cover is placed over the work bench.

17:07 The smock sleeves are Rodac, the left and right smock cuffs are rodaced.

17:08 The left and right side of chest is rodac sampled. The left and right bottom hem of smock is Rodac sampled. The left and right shoulders of smock are Rodac sampled.

17:09 The left hand and right hand glove fingertips are Rodac sampled. The left hand and right hand palm are Rodac sampled. The left and right hand back of hand are Rodac sampled.

17:10 The assemblyman #3 has exited the bio assay room into the OSE room.

Assembly operations are terminated for today.

17:30 The Reynier plates are removed from the Reynier air samplers, and placed into the pass-thru.

17:31 The bio man exited the bio assay room into the OSE area. All operations have terminated and been completed for this day.

COUPON AND CLOTHING STUDY

#1 BOARD

7 December 1966
A. Gould #3
J. Bowie #2

Q.A. PERSONNEL ASSEMBLY PROCEDURE LOG

Disassembly of printed circuit Board #1. This printed circuit Board was assembled in the EASL assembly room on 6 December 1966 and is being disassembled in the sterilization Lab. on 7 December 1966.

08:30 Assemblyman #3 scrubs hands with PhiSoHex.

08:35 Don hood, smock, mask and gloves.

08:48 It was observed that the pliers and diagonal cutters were rusty and coated with a residue film upon removing them from the tray which was used as a carrying tray. The tools were autoclaved and should not have been. This is creating a delay in disassembly of the printed circuit board because other tools must be made available by removing them from the EASL facility assembly room. *

09:30 A.G. and J.B. have re-entered the lab for disassembly of the PC Board.

09:31 Printed Circuit Board is removed from the double envelope.

09:32 Upper bonded relay is removed and placed into bottle.

09:33 Lower bonded relay is removed and placed into bottle.

09:34 Bolted relay is removed. Difficulty encountered removing relay from board.

09:35 Wire leads on relay are bent to fit into bottle.

09:36 Module is removed and placed into bottle.

09:37 Transistors are removed and placed into bottles.

09:38 Modules are removed and placed into bottles.

09:40 Capacitor wires are cut, removed and placed into bottles.

09:43 Resistors are cut, removed and placed into bottles.

09:45 Diodes are cut, removed and placed into bottles.

09:48 The P.C.B. is swabbed with distilled water and the swabs are placed into bottles.

09:52 The P.C.B. is placed into its plastic envelope.

09:53 Disassembly operation is terminated and completed.

*Operational discrepancy

L. Paquin

COUPON AND CLOTHING STUDY

ASSEMBLY OF BOARD #2

8 December 1966
W. Graff #4
A. Gould

Q.A. PERSONNEL ASSEMBLY PROCEDURE LOG

07:58 W.G. #4 has entered the EASL facility.

08:05 W.G. has entered the assembly area of the EASL facility.

08:06 He has placed Reynier sampler plates into the Reynier air samplers and started the samplers.

08:08 The plastic cover is removed from the assembly work bench.

08:10 The top of the work bench is wiped with amphyl.

08:12 Rodac samplers are removed from the pass-thru.

08:15 Rodac samples are taken in the #1 position of the work bench. (5 Rodacs)

08:16 5 Rodac samples are taken of the #2 position on the work bench.

08:16 5 Rodac samples are taken at the #3 position of the work bench.

08:17 5 Rodac samples are taken at the #4 position of the work bench.

08:20 The table top of the bench is wiped down after the Rodac sampling is completed.

08:22 A.G. #3 assemblyman has entered the EASL facility.

08:23 Two trays of stainless steel strips have been placed on the table top, one on the left hand corner, one in the right hand corner.

08:30 Assemblyman #3 has entered the assembly room of the EASL facility.

08:30 The Reynier plates from the Reynier air samplers have been removed and replaced with new ones.

08:35 Three stainless steel strips are removed from the tray at the left hand corner of the work bench.

08:37 Three stainless steel strips are removed from the right hand corner of the work bench.

08:40 Assemblyman #3 enters the bio assay room with the bio man for Rodac of the clothing.

08:41 The smock sleeves, left and right are Rodaced.

08:41 Rodac samples are taken of the left and right cuff.

08:42 Rodac samples are taken from the left and right side of the smock chest area. Rodac samples are taken on the left and right side bottom hem of the smock. Rodac samples are taken on the left and right shoulder.

08:43 Rodac samples are taken of the rubber glove finger tips, left hand and right hand. Samples are taken of the left hand and right hand palm of the glove. Rodac samples are taken of the left hand and right hand back of the hands.

08:44 The Rodac sampling of personnel clothing is completed. The Rodacs are placed into the pass-thru.

08:45 The gloves are replaced and both the assemblyman #3 and the bio man #4. Number 4's gloves were punctured. #3's gloves were coated with agar. *

08:46 The printed circuit board is removed from the pass-thru.

08:48 The p.c. board is removed from its plastic envelope.

08:49 The p.c. board is placed into its holding fixture.

08:50 In an attempt to re-arrange the coupons on the P.C. board, #3 used a pair of tweezers from the work bench to move the coupons. This action should have been done with sterilized forceps. *

09:01 Coupon D was removed from the top of the H and J coupon and relocated to its proper position.

09:05 The first transistor is placed on the p.c. board. The wires are placed into their respective terminals and soldered.

09:07 The second transistor is placed on the p.c. board. The wires are placed into their respective terminals and soldered. The excess wire protruding beyond the terminals is cut and removed.

09:10 The third transistor is placed on the p.c. board. The wires are placed into the respective terminals and they are soldered.

09:12 The excess wire protruding beyond the terminals is cut and removed.

09:14 All actions necessary to complete operation A are completed.

09:21 Three stainless steel strips are removed from the tray at the left hand corner of the work bench.

09:25 Three stainless steel strips are removed from the tray at the right hand corner of the work bench.

09:26 The bottles containing the stainless steel strips are placed into the pass-thru for pickup.

09:26 5 Rodac samples are taken at location #1 of the work bench.

09:27 5 Rodac samples are taken at location #2 of the work bench.

09:27 5 Rodac samples are taken at location #3 of the work bench.

*Operational discrepancy

09:28 5 Rodac samples are taken of location #4 of the work bench.

09:29 The work bench table top is wiped down with amphyl on those specific locations where the Rodac samples were taken.

09:30 The Reynier air samplers are opened and the Reynier plates are removed. New plates are installed and the Reynier air samplers are again started. The Reynier air samplers are located at sites 3, 10, and 13.

It is noted that the air sampler at location #10 does not have the * full volume of suction represented on its indicator, due to the fact that the spring up above the regulating plunger, which indicates the flow of suction; the spring is restricting or jamming the indicating device from traveling the full limit of the indicator.

09:35 Coupon B is removed from the p.c. board. During the operation of * removing the coupon from the p.c. board, it was inadvertently squeezed in the forceps and dropped to the grated floor.

09:40 The coupon B was picked up from the grated floor, placed in a bottle * then placed into the pass-thru

09:41 The first of six diodes is placed on the p.c. board and soldered into position.

09:42 The second diode is placed on the p.c. board and soldered into position.

09:43 The third diode is placed on the p.c. board and soldered into position. The excess wire protruding beyond the terminals is cut and removed.

09:45 Assemblyman #3 was required to change gloves due to an inadvertent contact with the bio man.

09:46 The fourth diode is placed on the p.c. board and soldered into position.

09:47 The excess wire protruding beyond the terminal is cut and removed.

09:48 The fifth diode is placed on the p.c. board and soldered into position. The excess wire protruding beyond the terminal is cut and removed.

09:50 The sixth diode is placed on the p.c. board and soldered into position.

09:51 Excess wire protruding beyond the terminals is cut and removed.

10:00 The bio man and the assembler stopped work long enough to put a cough drop (using proper technique) in their mouth and change their gloves and masks.

***Operational discrepancy**

10:07 The assembler #3 placed the sic resistors in their position, soldered them, and cut the wires to the proper length.

10:08 The assembler #3 had to pull his rubber gloves back up over his smock. He still has troubler with these items coming apart.

10:09 The assembler #3 removes stainless steel strip C.

10:10 The assembler places glue on the back of the relay and glues it to the printed circuit board.

10:11 The assembler #3 removes stainless steel strip D. Places glue on the back of the relay and glues it to the board. The assembler has changed his technique. The proper relay at that position is bolted on. He determined this just before he placed the relay with the glue on it onto the board.

10:14 The second relay is in place.

10:16 Stainless strip E was removed and the first capacitor is placed and soldered to the board.

10:17 The wires extending from that part is snipped off.

10:18 The second capacitor is placed on the board, soldered in place and the wires snipped off.

10:20 The third capacitor is soldered to the board and the wires snipped off.

10:22 The fourth capacitor is soldered to the board.

10:23 The wires are snipped off.

10:24 The last capacitor is soldered in place and the ends snipped off. The assembler #3 has left the work bench for the other side of the room.

10:30 Three stainless steel strips are removed from the right hand corner of the work bench and are placed into bottles.

10:31 Three stainless steel strips are removed from the tray in the left hand corner and are placed into bottles.

10:32 Assemblyman #3 coughed into his mask while away from the work bench, * removed the mask and replaced it with a new sterile mask.

10:34 Reynier sampler plates are removed from the Reynier air samplers and are replaced with new Reynier sampler plates. This is performed at sites 3, 10 and 13.

10:37 Coupon F is removed from the p.c. board and is placed into a bottle being held by the bio man and then it is capped.

*Operational discrepancy

10:38 Assemblyman #3 has coated the module with contact cement and has placed the module on the p.c. board in area F.

10:40 Operation F is completed.

10:40 Coupon G is removed from the p.c. board by assemblyman #3 and placed into a bottle held by the bio man, and it is capped. Assemblyman #3 has coated the module with contact cement.

10:41 The module is placed into position on the p.c. board.

10:42 The second module is coated with contact cement and placed into position on the p.c. board.

10:43 Operation G is completed.

10:44 Assemblyman #3 has removed coupon H from the p.c. board and placed it into the bottle held by the bio man. The bottle is then capped.

10:44 Assemblyman #3 has coated the first module with contact cement and placed it on the p.c. board.

10:45 Coupon I is removed from the p.c. board and placed into a bottle held by the bio man. The bottle is then capped.

10:46 Assemblyman #3 has coated a relay with contact cement and has placed it on the p.c. board, in its respective position.

10:47 Operation I is completed.

11:02 Coupon J is removed from the p.c. board. The coupon is placed into a bottle, then capped.

11:03 The first transistor is placed on the printed circuit board and soldered into position. The excess wire protruding beyond the terminal is cut and removed.

11:05 The second transistor is placed onto the p.c. board. The wires are bent to proper shape and placed into the terminals.

11:07 The wires are soldered into position. The excess wire protruding beyond the terminals is cut and removed.

11:08 The third transistor is placed on the p.c. board. The wires are bent into shape and placed into the terminals.

11:09 The wires are soldered into position. The excess wire protruding beyond the terminal is cut and removed.

11:19 Coupon K is removed from the p.c. board. The coupon is placed into a bottle which is capped.

11:20 The assemblyman applies contact cement to a module which is then placed into area K on the p.c. board.

11:26 Three stainless steel strips are removed from the tray at the left hand corner of the bench. They are placed into bottles. The bottles are then capped.

11:27 The assembly of the p.c. board is completed.

11:28 Three stainless steel strips are removed from the right hand tray of the work bench and placed into bottles and capped. The bio man has placed the bottles and the forceps in the pass-thru.

11:30 W.G. #4 has removed the Reynier plates from the Reynier air samplers and replaces them with new Reynier plates.

11:31 The Reynier air samplers are set for the one half hour continuous operation.

11:32 5 Rodac samples of location #1 of the work bench are taken.

11:33 5 Rodac samples are taken at location #2 of the work bench.

11:34 5 Rodac samples are taken at location #3 of the work bench.

11:34 5 Rodac samples are taken at location #4 of the work bench.

11:35 The two trays containing the remainder of the steel strips are removed from the work bench and are placed into the pass-thru, to be removed into the OSE area.

11:36 The bio man #4 is wiping the work bench table top with amphyl.

11:37 Rodac samples are taken of the assemblyman's smock sleeve on the right and the left. Rodac samples are taken of the right and the left smock sleeve cuff.

11:38 Rodac samples are taken of the chest, left and right side. Rodac samples are taken of the left and right side of the smock bottom hem. Rodac samples are taken of the left and right shoulders.

11:38 Rodac samples are taken of the glove finger tips, left hand and right hand. Rodac samples of the glove palm, left and right hand. Rodac samples are taken of the glove back of the hand, left and right.

11:39 The Rodacs are placed into the pass-thru for removal from the bio assay room.

11:40 Assemblyman #3 has exited the bio assay room into the OSE area.

11:41 Assemblyman #3 has signed the personnel entry log upon exiting the EASL facility.

11:58 The steel tray which has been autoclaved is placed into the pass-thru to be received into the assembly area.

11:59 The printed circuit board is removed from the holding fixture, placed * into the tray, and is then covered with the aluminum foil covering. Two small pin holes are noted in the aluminum foil which were caused by the ridges of the forceps which were used to handle the tray. The tray containing the p.c. board is then placed into the pass-thru, to be transferred down to the bio chem lab.

12:00 The last of the Reynier plates are removed from the Reynier air samplers and are placed into the pass-thru.

12:02 The plastic cover is placed over the work bench covering the tools and the table top.

12:03 The bio man #4 has exited the bio assay room into the OSE area. The experiment for 8 December 1966 is terminated and complete.

*Operational discrepancy

RE-ORDER No. 67-108

COUPON AND CLOTHING STUDY

9 December 1966
A. Gould #3
J. Bowie #2

Q.A. PERSONNEL ASSEMBLY PROCEDURE LOG

Disassembly of Printed Circuit Board #2. This p.c. board was assembled in the EASL assembly room on 8 December 1966 and is being disassembled in the sterilization Lab on 9 December 1966.

08:35 Assembly and bio man - don hood, smock, mask and gloves.

08:43 Assembly man #3 removes tools and p.c. board from plastic bags.

08:44 Upper bonded relay is removed from p.c. board and placed into bottle.

08:44 Lower bonded relay is removed from p.c. board and placed into bottle.

08:45 Bolted relay is removed from p.c. board, the screw and nuts are placed into a bottle. The wire terminals extending from the relay are bent with pliers and the relay is placed into a bottle.

08:46 Modules are removed from the p.c. board and placed into bottles.

08:46 Three transistors are removed from the p.c. board by cutting the wires with dikes and the transistors are placed into bottles.

08:47 Three transistors are removed from the p.c. board by cutting the wires with dikes and the transistors are placed into bottles.

08:48 Five modules are removed from the p.c. board and are placed into bottles.

08:49 Six capacitors are removed from the p.c. board by cutting wires and placing the capacitors into bottles.

08:50 Six resistors are cut from the p.c. board and placed into bottles.

08:51 Six diodes are cut from the p.c. board with dikes and are placed into bottles.

08:53 Two bottles are wiped down and are to be used for collecting swabs after swabbing of p.c. board.

08:55 p.c. board is swabbed with sterile water, the swabs are placed into bottles.

08:58 This terminates and completes the disassembly of the second p.c. board.

08:59 A.G. and J.B. have exited the lab.

L. Paquin

COUPON AND CLOTHING STUDY

PRINTED CIRCUIT BOARD #3

12 December 1966

Assembler, C. Miles *
Bio-Assayer, W. Graff
*Chet Miles substituted for A. Gould on this assembly.

Q.A. PERSONNEL ASSEMBLY AND PROCEDURE LOG

Assembly of this printed circuit board is being performed by the Assemblyman #3, who is not wearing any protective clothing, mask or gloves. The bio assay man is gowned.

07:50 W.G. #4, entered the EASL facility.

08:05 W.G. entered the assembly room to begin work.

08:06 Reynier plates were placed into the Reynier air samplers at stations 3, 10 and 13.

08:08 The plastic cover was removed from the assembly work bench.

08:09 The table top of the assembly work bench is completely wiped down with amphyl.

08:11 The bio man has removed Rodac plates from the pass-thru.

08:12 5 Rodac samples are taken at location #1 of the table top of the work bench.

08:12 5 Rodac samples are taken at location #2 of the work bench.

08:13 4 Rodac samples are taken at location #3 of the work bench. One Rodac disk could not be used as the agar was in the wrong side of * the plastic, in the cover rather than in the plate.

08:14 5 Rodac samples are taken at location #5 of the work bench.

08:15 The table top is wiped down the Amphyl at the location where the Rodac samples were taken.

08:30 The first one half hour Reynier plates are removed from the air samplers, and new plates are placed in the air samplers.

08:40 The bio man has exited the bio assay area into the OSE area. He has removed his garments, the smock, hood, gloves and mask.

There is a delay of approximately 35 minutes upon re-entry of the bio man into the EASL facility.

09:15 The bio man has re-entered the EASL facility.

09:25 He has entered the assembly area of the EASL facility.

09:26 Rodac samples are taken of Chet Miles who has entered the bio assay area from the OSE area. He has entered in regular street clothes for the purpose of this test.

*Operational discrepancy

09:27 Rodac samples are taken of the left and right shirt sleeve; are taken at the left and right of the chest; Rodac samples are taken at the left and right trouser cuff. Rodac samples are taken of the left and right trouser seat.

09:30 The stainless steel strip trays are placed at the left hand corner and the right hand corner of the work bench.

09:31 Three stainless steel strips are removed from the right hand tray and placed into bottles and capped.

09:32 Three stainless steel strips are removed from the left hand tray, placed into bottles and capped.

09:33 The printed circuit board, the detailed parts, and the tools to be used for the assembly of the printed circuit board, are removed from the pass-thru.

09:33 The printed circuit board and the detailed parts are removed from the plastic bags which are double wrapped.

09:34 The Reynier plates are removed from the Reynier air samplers at sites 3, 10 and 13, and replaced with new Reynier plates.

09:34 The printed circuit board is placed into the holding fixture.

09:42 The first transistor is placed on the printed circuit board and the wire leads are bent into position and placed into the terminal.

09:44 The transistor wires are soldered into the terminal.

09:50 The second transistor is soldered into position. Excess wire protruding beyond the terminal is cut and removed.

09:50 The third transistor is placed on the board and the bent wires are placed into the terminals.

09:55 The wires are soldered into the terminals.

From 09:35 to 10:00, C.M. has placed his left hand to his cheeks and mouth fifteen times. He has also coughed twice into his left hand.

10:05 The first resistor is placed into position with the wire leads into their terminals.

10:07 The wires are soldered into the terminal. Excess wire is cut and removed.

10:08 The second resistor is placed onto the board and the wires are placed into their terminals.

10:09 The wires are soldered into position.

10:10 The third resistor is placed onto the p.c. board. The wires are placed into the terminals.

10:11 The wires are soldered into the terminals.

10:12 The fourth resistor is placed on the p.c. board. The wires are placed into their terminals and soldered. The excess wire protruding beyond the terminal is cut and removed.

10:13 The fifth resistor is placed on the p.c. board. The wires are pressed into the respective terminals and are soldered into position.

10:14 The sixth resistor is placed into position on the p.c. board and the wires are placed into the terminals.

10:15 The wires are soldered into position.

10:16 The first diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

10:17 The second diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

10:18 C.M. has coughed twice into his left hand.

10:18 The third diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

10:19 The fourth diode is placed into position on the p.c. board. The wires are placed into the terminals and are soldered.

10:20 The fifth diode is placed into position on the p.c. board. The wires are placed into their terminals.

10:21 The wires are soldered into position.

10:22 The sixth diode is placed into position on the p.c. board. The wires are placed into the terminals and are soldered.

10:26 Three stainless steel strips are removed from the right hand tray and are placed into bottles and capped.

10:28 Three stainless steel strips are removed from the left hand tray, are put into bottles, and are capped.

10:30 5 Rodac samples are taken at location #1 on the work bench.

10:30 C.M. has coughed into his left hand.

10:31 5 Rodac samples are taken at location #2 of the work bench.

10:31 5 Rodac samples are taken at location #3 of the work bench.

10:32 5 Rodac samples are taken at location #4 of the work bench.

10:33 The table top is wiped down the Amphyl at the locations that were Rodac sampled.

10:35 The Reynier plates are removed from the Reynier air samplers and new plates are installed.

10:36 The relay is placed onto the p.c. board and it is cemented into position.

NOTE: C.M. is constantly removing and replacing the eyeglasses he is wearing. It is difficult to determine the number of occasions that this arises, or happened.

10:48 C.M. has coughed into his left hand.

10:54 The second relay is positioned onto the p.c. board. The hardware fastener screws are placed into position through the holes and screwed into the nut held below with the mini socket. While fastening the screws into position, C.M. has placed his head directly over the p.c. board.

11:00 C.M. has placed and removed his glasses from the top of the work bench.

11:10 The first capacitor is placed into position on the p.c. board and the wires are placed into their terminals, and are soldered.

11:11 C.M. has coughed into his right hand.

11:12 Two throat lozenges are placed into the pass-thru for use.

11:15 The second capacitor is placed into position on the board, the wires are placed into their terminals and are soldered.

11:16 The bio man and the assembly man have each taken lozenges.

11:16 The third capacitor is placed onto the p.c. board, the wires are placed into their terminals and are soldered.

11:17 C.M. has placed his left hand over his mouth and wiped his mouth area and his cheek.

11:18 The fourth capacitor is placed into position on the board, the wires are placed into their terminals and are soldered. The excess wire protruding beyond the terminal is cut and removed.

11:19 The fifth capacitor is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

11:21 The left hand is rubbed along the left cheek of C.M.

11:22 The sixth capacitor is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. The excess wire protruding beyond the terminal is cut and removed.

11:23 C.M. rubs his cheek with his left hand. He has also coughed into his left hand.

11:27 Three stainless steel strips are removed from the right hand tray above the work bench. The strips are placed into bottles and are capped.

11:29 Three stainless steel strips are removed from the left hand tray on top of the work bench.

11:30 The first module is clasped into the assemblyman's hand. It is then coated with the bonding cement, placed into position on the p.c. board.

11:31 The assemblyman rubbed his nose with his left hand.

11:32 The assemblyman rubs his forehead with his left hand fingers.

11:34 The Reynier air samplers plates are removed from the Reynier air samplers and are replaced with new ones.

11:35 A module is coated with cement, placed into position, on the p.c. board.

11:37 Another module is coated with cement and placed into position on the p.c. board.

11:39 Two lozenges are placed through the pass-thru and are taken by both the bio man and the assemblyman.

11:40 The assemblyman has wiped the side of his nose with his right hand.

11:46 The assemblyman, C.M., has rubbed the top of his head (toward the back of his head) with his right hand.

11:48 The assemblyman has wiped the right side of his face with his right hand.

11:48 The assemblyman has coughed into his right hand.

11:49 The assemblyman is applying cement to one of the modules. Cement is applied to another module.

11:50 A module is placed into position on the p.c. board.

11:51 Another module is placed into position on the p.c. board.

11:57 The assemblyman is sitting with his arms folded and his arms are in direct contact with each other due to the fact that he has a short sleeved shirt on.

11:59 A relay is coated with contact cement. The relay is placed into position on the board.

12:01 A module is coated with bonding cement. The module is placed into position on the p.c. board.

12:04 A transistor is placed into position on the p.c. board, the wires are placed into their respective terminals and are soldered.

12:06 Another transistor is placed into position on the board. The wires are placed into their respective terminals and are soldered.

12:07 A transistor is placed on the p.c. board. The wires are bent into position, and placed into position at the respective terminals and they are soldered.

12:11 The last module is placed on the p.c. board after being coated with adhesive cement.

12:13 Several tools are removed from the table top work bench and put into the pass-thru.

12:16 The assemblyman has placed his right hand over his mouth and right cheek.

12:25 The assemblyman removed the printed circuit board from the holding fixture and placed it into a plastic envelope. This plastic envelope is placed within another plastic envelope and is closed. The double wrapped p.c. board is then placed into the pass-thru.

12:26 Rodac samples are taken from the left shirt sleeve and right shirt sleeve. Rodac samples are taken of the right shirt sleeve cuff and the left shirt sleeve cuff. Rodac samples are taken of the right and left chest area.

12:27 Rodac samples are taken of the left and right seat area. Rodac samples are taken of the left and right s oulder area. Rodac samples are taken of the left and right trouser cuffs.

12:28 The assemblyman has exited the bio assembly area into the OSE area.

12:29 The plastic cover that is normally used to cover the table top of the work bench is dropped on the grated floor in the bio assay room. The cover was immediately removed from that area.

12:30 The Reynier plates are removed from the Reynier air samplers and are replaced with new ones, at sites 3, 10 and 13.

The air sampler at the site #10 does not indicate the proper flow of vacuum on the indicator due to the spring preventing the float from properly indicating on the scale. *

12:32 Three stainless steel strips are removed from the right hand tray and placed into bottles and capped.

12:33 There are three stainless steel strips removed from the left hand tray, placed into bottles and capped.

*Operational discrepancy

12:35 5 Rodac samples are taken at location #1 of the table top.

12:35 5 Rodac samples are taken at location #2 of the work bench, table top.

12:36 5 Rodac samples are taken at location #3 of the work bench table top.

12:36 5 Rodac samples are taken at location #4 of the work bench table top. The Rodac samples and the stainless strips are placed into the pass-thru for removal from the assembly area.

12:38 The two trays containing the extra or remaining stainless steel strips have been removed from the assembly area.

12:39 The table top of the work bench is completely wiped down with Amphyl.

13:00 The Reynier plates are removed from the Reynier air samplers. These plates are the one-half hour count. The Reynier plates are placed into the pass-thru and are removed from the assembly area.

13:01 The bio man has exited the bio assay area and entered the OSE area.

The experiment for 12 December 1966 has terminated and is completed.

13 December 1966
C. Miles # 6
J. Bowie # 2

Quality Assurance Personnel and Assembly Procedure Log.

Disassembly of Printed Circuit Board # 3.

This P.C. Board was assembled in the EASL assembly room 12 December, 1966 and is being disassembled in the Sterilization Lab. on 13 December, 1966.

08:30 Assembly man and Bio-man wash and scrub hands.

08:38 Don hood, smock, mask- and gloves.

08:43 Assembly man and Bio-man enter the clean room.

08:45 After removing tools from the plastic bag, the upper bonded relay is removed from the P.C. board, placed into a bottle and capped.

08:46 The lower bonded relay is removed from the P.C. board with forceps, placed into a bottle and capped.

08:48 The bolted relay is removed from the p.c. board by cutting a slot from the edge of the board to the fastening hardware. This was done as the nut could not be removed with the mini-socket; the nut seized into position and could not be removed.

08:49 Removed modules with individual forceps, placed them into bottles and capped them.

08:50 Cut wires and removed three transistors from the P.C. Board and placed them into bottles.

08:52 Cut wires and removed three transistors from the P.C. board and placed them into bottles.

08:53 Removed two modules with individual forceps from the P.C. board and placed them into bottles.

08:54 Removed two modules with individual forceps from the P.C. board and placed them into bottles.

08:55 Using another pair of diagonal cutters, wire was cut and six capacitors were removed from the P.C. board and with the use of individual forceps they were placed into bottles.

08:59 Using another pair of diagonal cutters, wires were cut and six resistors were removed from the P.C. board and with the use of individual forceps they were placed into bottles.

09:04 With the use of another pair of diagonal cutters, wires were cut and six * diodes were removed from the P.C. board. Individual forceps were used to place the diodes into bottles. While removing one of the resistors, it shattered into several pieces.

09:05 The P.C. board was swabbed with four swabs that were dipped into sterile water and then placed into bottles.

09:06 This terminates and completes the disassembly of p.c. Board # 3.

09:07 C.M. and J. B. have exited the lab.

*Operational discrepancy

14 December 1966
C. Miles #6
W. Graff #4

Q.A. PERSONNEL ASSEMBLY AND PROCEDURE LOG
PRINTED CIRCUIT BOARD #4 COUPON AND CLOTHING STUDY

Assembly of this printed circuit board is being performed by Assemblyman #6 who is not wearing any protective clothing, such as a smock, mask, or gloves or hood. Assayer #4 was gowned in sterile clothing.

Due to failure of equipment in the EASL facility to maintain temperature and relative humidity control, a delay has been experienced whereby the personnel who were schedules to enter the EASL facility at 08:00 were unable to do so. This experiment is now commencing at 11:15.

11:16 W.G. entered the EASL facility.

11:30 W.G. entered the assembly area of the EASL facility.

11:32 Reynier sample plates are placed into the Reynier air samplers, and the samplers are started.

11:34 The table top of the work bench is wiped down with amphyl.

11:42 5 Rodac samples are taken at location #1 of the work bench.

11:43 5 Rodac samples are taken at location #2 of the work bench.

11:43 5 Rodac samples are taken at location #3 of the work bench.

11:44 5 Rodac samples are taken at location #4 of the work bench.

11:45 One finger of the glove being worn by the bio man #4 was punctured. Another pair of gloves was placed into the pass-thru for replacement of the punctured glove on the bio man.

11:58 A reading of the temperature chart for the assembly room indicates that the temperature is 70 degrees and the relative humidity is 42%, well within specification.

12:00 The first one half hour Reynier sampler plates are removed from the Reynier air samplers and are replaced with new ones. The Reynier air samplers are then started.

12:04 Assemblyman #6, C. Miles, has entered into the bio assay room from the OSE room.

12:05 Rodac samples are taken of the left sleeve and the right sleeve.

12:05 Rodac samples are taken of the right cuff and the left cuff.

12:05 Rodac samples are taken of the left and right seat of the trousers.

12:06 Rodac samples are taken of the left shoulder and the right shoulder.

12:06 Rodac samples are taken of the left cuff and right cuff of the trousers.

12:07 Two trays of stainless steel strips are placed on top of the work bench, one at the left corner and one at the right corner.

12:07 The aluminum foil covering the trays of stainless steel strips are removed and the strips are now exposed.

12:07 The aluminum foil is removed from the tray at the right hand corner of the work bench.

12:08 Three stainless steel strips are removed from the right hand tray, placed into bottles and capped.

12:10 Three stainless steel strips are removed from the left hand tray, are placed into bottles and capped.

12:13 The printed circuit board is being taken out of its wrapper. Forceps are being removed from the package.

12:15 The printed circuit board is being put into the holding fixture. It is now being tightened in place. Diagonal cutting pliers are now being taken out of the wraps, as are the other tools, at 12:15, screwdriver, wrench and longnose pliers, all taken out of their wrappers.

12:16 Solder is being taken out of its envelope. All the components are being taken out of their bags prior to their assembly on the printed circuit board.

12:17 Observing much discoloration on the long nose pliers.

12:17 All components are being placed on the table.

12:18 Two lengths of solder have been cut from the roll. The assembler has removed his eyeglasses and put them in his upper left breast pocket.

12:19 All paper bags, plastic bags, are being placed into the pass-thru.

12:21 The metal chair is being wiped down with amphyl. Water is being passed thru to wet the soldering sponge. The assembler is pouring the water into and onto the soldering iron assembly. Bio assayer is changing his rubber gloves.

12:24 The assembler removed coupon A. Coupon A is being put into a sterile bottle and it is now being capped at 12:26.

12:26 The forceps used to remove coupon A have been put back in their container and both are being removed from the assembly area through the pass-thru. The assembler is now picking up a transistor; he is putting on his eyeglasses. He is now cutting the leads to the transistor.

12:28 The assembler has coughed on his wrist on the same hand in which he is holding the transistor. The leads are being bent by hand. They are now being clipped with a pair of diagonals, being placed onto the board and with a pair of forceps the leads are being forced into the terminals.

12:30 The soldering iron tip is being wiped. It is being applied to the terminals, the wires are being held to the terminals by the tip of the soldering iron. Solder is now being applied at the point where the soldering gun tip and the terminal and the wire all join together. Terminal 1 has been soldered and terminal #2 is now in contact with the iron. Solder is now being applied to the terminal where the wire is coming through the center of same. The terminal has been soldered. The excess lead leading through the terminal has been clipped with a pair of diagonal cutters. The second transistor has been picked up. The third terminal has been clipped. The remaining two leads are being formed by hand and they are being placed onto the printed circuit board.

12:32 The leads are being placed through the terminals with the use of forceps.

12:34 The first terminal and lead leading through it is being soldered.

12:35 The second lead has been soldered.

NOTE: The bio assay man who is wearing the new long gauntlet-type glove, has his sleeve tucked on the inside of his glove, and with the glove rolled all the way up it seems to make for very good protection. There are at least 3 to 4 inches of overlap that can be observed.

12:35 The second lead successfully soldered into place. Both leads are being clipped -- excess length clipped off. The third transistor has been picked up. One of the leads has been clipped off. The remaining two leads are being formed by hand.

12:36 The transistor is being placed onto the printed circuit board.

NOTE: The assembler constantly takes his glasses off after each operation. When he does not take his glasses off and leaves them on, his hands are then resting on his lap. Both leads have been placed into the terminals and both terminals are now being soldered.

12:38 Both leads have been soldered.

12:40 Coupon B is being removed by forceps, has been placed in a sterilized bottle. The bottle is being capped and is being passed through the pass-thru. The first resistor has just been picked up.

12:41 The leads have been stretched out by being pulled at each end by hand, and are being placed in position.

12:43 The wires from the resistor are being placed into the terminals, and are soldered. The excess wire protruding beyond the terminal is cut and removed.

12:43 The second resistor is placed into position on the board. The wires are placed into their terminals and are soldered. The excess wire projecting beyond the terminal is cut and removed.

12:45 The third resistor is placed into position on the p.c. board. The wires are placed into the terminals and are soldered. The excess wire projecting beyond the terminal is cut and removed.

12:46 The fourth resistor is placed into position on the p.c. board. The wires are inserted into the terminals and are soldered. The excess wire protruding beyond the terminals is cut and removed.

12:47 The fifth resistor is placed on the p.c. board. The wires are inserted in their terminals and are soldered. The excess wire protruding beyond the terminals is cut and removed.

12:48 The sixth resistor is placed on the p.c. board. The wires are placed in their terminals and are soldered. The excess wire protruding beyond the terminal is cut and removed.

12:50 Assemblyman #6 has coughed twice into his left hand.

12:52 Two cough drops are passed into the pass-thru for consumption by the assemblyman and the bio assay man.

12:55 Three stainless steel strips are removed from the right hand tray on the work bench, are placed into bottles, and they are capped.

12:57 Three stainless steel strips are removed from the left hand tray atop the work bench. They are placed into bottles and the bottles are capped.

12:59 5 Rodac samples are taken at location #1 of the work bench.

13:00 5 Rodac samples are taken at location #2 on top of the work bench.

13:01 5 Rodac samples are taken at location #3 on top of the work bench.

13:01 5 Rodac samples are taken at location #4 on top of the work bench.

13:02 The four locations on top of the work bench that were Rodac sampled have been wiped with amphyl.

13:03 The first diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

13:04 Reynier sample plates are removed from the Reynier air samplers and new Reynier plates are installed in the units and are started.

13:04 The second diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. The wires extending beyond the terminals are cut and are removed.

13:06 The third diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

13:06 The Reynier plates removed from Reynier samplers at locations 3, 10 and 13 have been placed into the pass-thru. The excess wire protruding beyond the terminals is cut and removed.

13:07 The fourth diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. The excess wire extending beyond the terminals is cut and removed.

13:08 The fifth diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. The excess wire extending beyond the terminals is cut and removed.

13:10 The sixth diode is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. The excess wire extending beyond the terminals is cut and removed. Assemblyman #6 has wiped the side of his face with his right hand and has coughed into his left hand.

13:13 An accident occurred in which the tray containing the jars with the * strips, the Rodac samples, and the Reynier sampler plates, was dropped upon exiting the OSE area to deliver the items to the sterilization lab. It is not possible to determine at this time the extent of the effect this may have on the carrying out of the experiment. Possibly, two or more Rodac samplers may be of no value, (samples later found to be acceptable).

13:19 Coupon C is removed from the p.c. board. It is placed into a bottle and the bottle is capped.

13:20 The surface of a relay is coated with contact cement. The relay is then placed into position on the p.c. board.

13:25 Assemblyman #6 is sitting with his arms folded and has short sleeves on. Therefore, providing skin contact between the hands and upper arms.

13:27 Coupon D is removed from the printed circuit board. It is placed into a bottle and the bottle is capped.

13:28 The p.c. board is shifted to another location in the holding fixture.

13:29 A relay is placed into position on the p.c. board. A screw is placed through the holding flange of the relay, and the p.c. board, the nut applied to the screw and fastened with a mini-socket and a screwdriver.

13:30 The other screw is placed into position through the relay flange in the p.c. board. The nut is applied to the screw and fastened tight with the mini-socket and a screwdriver. During this operation the exposed left arm is placed directly over the p.c. board until the relay is secured tightly into position.

13:31 The assemblyman #6 has rubbed his left and right hands across his trousers at the upper thighs.

13:32 #6 has rubbed his upper lip with his right index finger.

13:34 #6 has scratched the top of his head and the side of his head with his right hand.

13:35 Coupon E is removed from the p.c. board with a screwdriver to free it, then a pair of sterile forceps to raise it from the board and place it into the bottles. The bottle is capped.

*Operational discrepancy

13:36 The p.c. board is shifted into another position within its holding fixture.

13:37 The first capacitor is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. Excess wire extending beyond the terminals is cut and removed.

13:40 The second capacitor is placed into position on the p.c. board. The wires are placed into their terminals and are soldered. Excess wire extending beyond the terminals is cut and removed.

13:42 The third capacitor is placed into position on the p.c. board. The wires are placed into the terminals and they are soldered. Excess wire extending beyond the terminals is cut and removed.

13:43 The fourth capacitor is placed into position on the p.c. board. The wires are placed into the terminals and they are soldered.

13:45 The excess wire protruding beyond the terminals is cut and removed.

13:45 The fifth capacitor is placed into position on the p.c. board. The wires are placed into their terminals and they are soldered.

13:46 The excess wire extending beyond the terminals is cut and removed.

13:47 The sixth capacitor is placed into position on the p.c. board. The wires are placed into their terminals and are soldered.

13:48 Excess wire extending beyond the terminals is cut and removed.

13:50 Assemblyman #6 has wiped his right hand across his right cheek and upper lip.

13:57 Assemblyman #6 has coughed into his right hand. He has coughed again into his right hand.

13:59 Three stainless steel strips are removed from the right hand tray. They are placed into bottles and they are capped.

14:01 Three stainless steel strips are removed from the left tray and are placed into bottles and are capped.

14:03 The Reynier sampler plates are removed from the Reynier air sampler and replaced with new plates. The Reynier air samplers are started.

14:12 Assemblyman #6 has coughed into his left hand.

14:13 Coupon F is removed from the p.c. board. It is placed into a bottle which is capped.

14:14 A module is coated with contact cement. It is placed into position on the p.c. board.

14:15 Assemblyman #6 has wiped the side of his head with the palm of his left hand, from the top of his head down to the lower portion of the left cheek.

14:18 Coupon G is removed ffom the p.c. board. It is placed into the bottle which is capped.

14:19 A module is coated on one surface with contact cement. It is then placed onto the p.c. board in its respective position.

14:20 Another module is coated on one surface with contact cement. It is placed onto the p.c. board into its respective position.

14:22 Assemblyman #6 has coughed into his left hand.

14:23 Coupon H is removed from the p.c. board with forceps. It is placed into a bottle and the bottle is capped.

14:24 A module is coated on one surface with contact cement. The module is placed onto the p.c. board into its respective position.

14:25 A module is coated on one surface with contact cement. The module is placed on the p.c. board into its proper position.

14:27 Coupon I is removed from the p.c. board. It is placed into a bottle with forceps and the bottle is capped.

14:28 A relay is coated on one surface with contact cement. It is placed into position on the printed circuit board.

14:28 Coupon J is removed from the p.c. board. The coupon is placed into a bottle with forceps and the bottle is capped.

14:30 A transistor is placed onto the p.c. board. The wires are shaped and placed into the terminals and they are soldered.

14:35 A transistor is placed onto the p.c. board. The wires are bent to proper configuration and placed into the respective terminals, and they are soldered. The excess wire extending beyond the terminals is cut and removed.

14:42 A transistor is placed on the p.c. board. The wires are bent to configuration and placed into the terminals and they are soldered.

14:44 Excess wire extending beyond the terminals is cut and removed.

14:46 Coupon K is removed from the p.c. board with forceps. The coupon is placed into a bottle and it is capped.

14:47 The tools which were used during the assembly process are removed from the table and are placed into the pass-thru.

14:47 A module is coated on one side with contact cement and the module is placed into position on the p.c. board.

14:48 5 Rodac samples are taken at location #1 of the work bench.

14:48 5 Rodac samples are taken at location #2 of the work bench.

14:49 5 Rodac samples are taken at location #3 of the work bench.

14:49 5 Rodac samples are taken at location #4 of the work bench.

14:52 Rodac samples are taken of the right shirt sleeve and left shirt sleeve. Rodac samples are taken of the right shirt sleeve cuff and the left shirt sleeve cuff of assemblyman #6.

14:53 Rodac samples are taken of the right chest and the left chest. Rodac samples are taken of the right rear shoulder and the left rear shoulder.

14:54 Rodac samples are taken of the left trouser seat and the right trouser seat. Rodac samples are taken of the right trouser cuff and the left trouser cuff. Rodac samples are taken of the right hand fingers and the left hand fingers.

14:55 Three stainless steel strips are removed from the right hand tray. They are placed into bottles and are capped.

14:56 Three stainless steel strips are removed from the left hand tray on the work bench. They are placed into bottles and the bottles are capped.

14:59 The Reynier plates are removed from the Reynier air samplers at sites 3, 10 and 13 and are replaced with the last one half hour of Reynier plates.

15:02 The bio man #4 has removed the printed circuit board from its holding fixture and placed it into the plastic bag. The p.c. board is then placed into another plastic bag making a double wrap.

15:04 The p.c. board is placed into the pass-thru.

15:05 The two trays containing the remaining stainless steel strips are removed from the work bench table top and are placed into the pass-thru to be removed from the assembly area.

15:06 The work bench table top is completely wiped down with amphyl.

15:30 The bio man has removed the first Reynier plate sampler.

15:31 The second cover is coming off the Reynier and the second plate is being taken up.

15:32 The third Reynier cover is being taken off and the plate is removed. The cover has been placed on the plate and it is removed.

15:32 The bio man #4 has exited the assembly area into the OSE room.

This terminates and completes the clothing and coupon study of 14 December 1966, for printed circuit board #4.

Quality Assurance Personnel and Assembly Procedure Log

Disassembly of Printed Curcuit Board # 4

15 December 1966
C. Miles #6
J. Bowie #2

TIME:

This P.C. board was assembled in the EASL Assembly room on 14 December, 1966 and is being disassembled in the Sterilization Lab. on 15 December, 1966.

08:37 Assembly man and Bio man wash and scrub hands.

08:42 Assembly man and Bio man enter the clean room.

08:43 Don hood, smock, mask and gloves.

08:47 The p.c. board is removed from the plastic bag.

08:48 The hand tools are removed from the plastic bag.

08:49 The upper bonded relay is removed from the p.c. board with forceps, placed into a bottle and capped.

08:49 The lower bonded relay is removed from the p.c. board with individual pair of forceps, placed into a bottle and capped.

08:50 The bolted relay is removed from the p.c. board by removing the screws and nuts with screw driver and mini-socket, the wire terminals are bent and the relay is placed into a bottle and capped.

08:51 Modules are removed from the P.C. board with forceps, placed into bottle and capped.

08:54 Cut wires and removed six transistors from the p.c. board with individual forceps, placed them into bottles, and they are capped.

08:55 Removed two modules with individual forceps from p.c. board and placed them into bottles.

08:56 Removed remaining modules with individual forceps from the P.C. board and placed them into bottles.

08:59 Using another pair of diagonal cutters, wires were cut and six capacitors were removed from the P.C. board and with the use of individual forceps they were placed into bottles.

09:02 Using another pair of diagonal cutters, wires were cut and six resistors were removed from the p.c. board and using individual forceps, the resistors were placed into bottles and capped. Two of the resistors * were dropped from the forceps onto the laminar flow bench table top before being placed into the bottles.

*Operational discrepancy

15 December 1966

09:05 With the use of another pair of diagonal cutters, wires were cut and six diodes were removed from the p.c. board with individual forceps and the diodes were placed into bottles and capped.

09:08 The p.c. board was swabbed with four swabs they were dipped into bottles.

09:09 C.M. and J.B. have exited lab.

This terminates and completes the disassembly of p.c. board #4.