LAMS-725

Series A

20

[redacted]

10 May 1948

This document contains 24 pages.

STUDIES OF AIR-BORNE CONTAMINATION RESULTING FROM OPERATIONS HANDLING PLUTONIUM METAL AND PLUTONIUM ALLOYS

(Ref:Lab-CMR-12)

Report Written By:

W. R. Kennedy

UNCLASSIFIED

[redacted]

ABSTRACT

Using standard methods of air sample testing, three rooms handling plutonium metal and plutonium alloys were checked to place the causes of peak air-borne contamination during operations.

The tests emphasized that plutonium cannot be handled in an open room, and transfers of the material through the room must be held to an absolute minimum.

Such operations must be handled in an adequately ventilated hood or drybox system, by personnel provided with a complete set of protective clothing. These people should be checked periodically for retention of material in the body, and for damage to the blood forming organs. The working area should be tested throughout the working day for air-borne contamination.

STUDIES OF AIR-BORNE CONTAMINATION RESULTING FROM OPERATIONS HANDLING PLUTONIUM METAL AND PLUTONIUM ALLOYS.

INTRODUCTION

Several series of air-borne contamination surveys have been made on three rooms in D Building. All three of the rooms under consideration work with metallic plutonium and its alloys.

All air contamination samples were taken using the standard Filter Queen with the flat plate collector operating at a sampling rate of four cubic feet per minute. Filter papers were counted on the standard flat plate alpha counter operating in the proportional range. Results were corrected for products with short half lives (radon and thoron). For further information on the collection and counting of air-borne contamination samples see AM-1205 (Instructions and Precautions in the Use of Filter Queen Air Tester and Associated Apparatus).

Operation surveys were made by running two instruments side by side in the usual location, one for the entire day and the other for half hour periods. Time studies were made of the work going on during these periods in order to place the causes of peak contamination.

PART A

ROOM 107 - D BUILDING

1. Operations

The room is used to determine physical properties of plutonium and plutonium alloys at various temperatures.

2. Equipment

Balances, hardness testers, and test presses are used in the determinations. Some of the equipment is enclosed in dryboxes or hoods.

3. Air Contamination History

As can be observed from the enclosed Graph No. 1 and its data sheet, the monthly average contamination level has been below tolerance for 13 out of the 14 months under survey. The maximum air count for any one day during the month has been over tolerance 10 out of the 14 months. A minimum of work has been carried out in the room while emphasis has been on the design of proper equipment to control contamination while doing the work.

4. Air-Borne Contamination Surveys During Operations

On August 5, 1947, a continuous survey of the air-borne contamination level was made during the work period. Graph No. 2 and its data sheet record the results obtained. The test showed beyond doubt that the peak contamination periods were due to loading and unloading the press can, and occurred when the active material was out in the air of the room.

5. Recommendations and Results

It was recommended that the process equipment or technique be so redesigned that the active material at no time is exposed to the room air. A new type of press can has been designed to facilitate sample manipulation without opening the can, and a hood was designed with a forced air evacuation to fit over the press. The equipment has not yet been installed and tested. Until such changes are completed the work in the room is being held to a minimum.

A small, open front hood with a forced draft has been built around the air lock of the drybox. This provides some protection when opening and closing the air lock door, by disposing of any contaminated air escaping from the drybox during the transfer.

PART B

ROOM 134 - D BUILDING

1. Operation

The room is used for the melting and casting of plutonium and plutonium alloy samples.

2. Equipment

Furnaces, small hand grinders, and a laboratory press are used in preparation of the samples. All equipment except the crucible out-gassing furnace is enclosed in dryboxes.

3. Air Contamination History

As may be observed from Graph No. 1 and its data sheet, the monthly average contamination level has been above tolerance for 10 out of the 13 months under survey. There has been at least one over tolerance day every month. The maximum single air count recorded was over 100 times tolerance (in August, 1947). Considerable improvement can be noted in the last four months of operation, since major changes were made in the room ventilation; but sources of contamination still exist in the operation.

4. Air-Borne Contamination Surveys During Operation

a. On September 12, 1947 a continuous survey of the contamination level was made during the day. Graph No. 3 and its data sheet show the results obtained. The daily average contamination level was 4 to 5 times tolerance. The results indicate that the contamination in every case is due to opening a drybox or furnace housing, either transferring material or repairing equipment.

b. On September 25, 1947, tests were started in the hallway outside the room. The air flow in the area was such that every time room 134 was over tolerance, the hallway was also over tolerance. The operation was shut down October 2, 1947 after ventilation adjustments had been tried and found insufficient to remedy the situation. An air evacuation system was installed in the floor of the room, and operations were started again November 19.

c. Another contamination level survey was made November 20, 1947. Graph No. 4 and its data sheet record the results. These results indicate that the furnace of the melting train is the greatest single source of contamination. At the present time it is necessary to open the furnace housing in order to load or repair the furnace.

5. Conclusions and Recommendations

It has been recommended that drybox gloves be installed in the melting train furnace housing, and the furnace be worked through the gloves. These recommendations have not been carried out. While the room has showed considerable improvement since the ventilation system has been installed, it continues to run very close to tolerance.

A similar equipment set-up is being installed in room 136. The problems of room ventilation and of sealing off the melting furnace have been taken into account and proper equipment designed.

PART C

ROOM 317 - D BUILDING

1. Operation

The room is used to prepare metallographic specimens of plutonium and plutonium alloys. The specimen is mounted in a lucite holder, and the exposed

surface is ground, polished, and etched before making a microphotograph. The actual photography is done in room 319.

2. Equipment

Mounting, grinding, polishing, and etching are all handled in dryboxes. Final inspection before the specimen leaves the room is done with a microscope on a table in the open room. The enclosed flow sheet indicates the locations of the various equipment used in the operation, and the sequence of each operation. Note the number of transfers of material through the room. The specimens are transferred about in small open screw top jars until after the final inspection.

3. Contamination History

Graph No. 1 indicates that the monthly average air contamination has been erratic. Following surveys made during August and September, 1947 the average level dropped well below tolerance. The surveys pointed out the sources of peak contamination and the improvement was due to care and planning of operation technique taken by personnel working in the room. New personnel were put to work in the operation in October and November, 1947. During their indoctrination in laboratory procedures, the average contamination level increased.

4. Air-Borne Contamination Surveys During Operations

a. A continuous survey of the air-borne contamination level in the room was made August 15, 1947. Graph No. 5 and its data sheet record the results obtained. The air contamination varies directly with the number of transfers of active material made through the room. Care and planning of operations to limit the number of transfers necessary, and to provide a "cooling" period for a drybox before making a transfer seems to pay dividends in reduced average contamination.

b. The clean up operation following specimen preparation was suspected of being a principal source of air-borne contamination. Accordingly a survey was made on September 3, on which day only the clean up operation was done in the room. Graph No. 6 and its data sheet record the results. The period of greatest air contamination occurred after the work was finished, and was due to the final transfer of material out of the drybox.

5. Conclusions and Recommendations

During the first survey made, the air-borne contamination level in the room varied directly as the number of transfers made. The fact that transfers are the greatest source of contamination is emphasized by the second survey.

Later efforts to cut down on the number of transfers made have reduced the amount of contamination released in the room. For example, present practice is to transfer all specimens at the same time from one unit to another rather than having a complete set of transfers for each specimen.

It has been recommended that the equipment be redesigned so that only one transfer is necessary to get the material into a closed system where the complete preparation cycle can be carried out. Then each step in the process is finished and the material moved on to the next without passing through the room. This principle has been adopted and used to design equipment which will be installed as soon as sufficient laboratory space can be obtained. At the present time quarters are too cramped to connect the dryboxes in series.

[redacted]

SUMMARY

CONCLUSIONS AND RECOMMENDATIONS

1. In every case of air-borne contamination in a working area the contamination can be traced to working with active material in the open, or to transferring the material through the room. A partial solution is found by limiting the number of transfers and by enclosing all work with active material or grossly contaminated equipment.

2. A drybox or enclosed hood is not in itself a sure way to control contamination. While it may keep the active material under control as the work is going on, it also serves as a collection agency for very highly contaminated air, some of which escapes into the room when any transfer is made into or out of the drybox. To give adequate protection a drybox must be vented into a forced air evacuation system, provided with filtered clean air inlets, and operated at an inside pressure slightly below room pressure. The present installations in use in all three rooms have small Welch Duo Seal Vacuum Pumps connected to the dryboxes. Such an installation does provide a very slight negative pressure inside a drybox, but fails to purge the box of the very highly contaminated air. An evacuation system capable of handling a volume of air equal to that of the drybox several times a minute should be provided, with this evacuated air properly filtered before releasing it to the atmosphere.

3. An alternative modification is the construction of a small open front hood with an adequate* forced evacuation system around each drybox air lock. Such an addition will not prevent the build up of highly contaminated air in the drybox, but will prevent such air escaping into the room during transfers into or out of the drybox.

* Air velocity across the open face of a hood in excess of 100 linear feet per minute.

[redacted]

4. Air-borne contamination tests should be run continuously in areas where plutonium metal or alloys are worked.

5. Approved dust filter respirators (Bureau of Mines Approved) should be immediately available to all workers handling plutonium metal or alloys.

6. All workers in such operations should wear a complete change of protective clothing, including hair covering and rubber gloves for the hands.

7. Periodic health tests such as urine radioassay and differential blood count should be made on all personnel working with plutonium metal or its alloys. The frequency of such tests depends upon the individual's exposure, individuals with the most severe exposure taking the tests monthly or every six weeks.

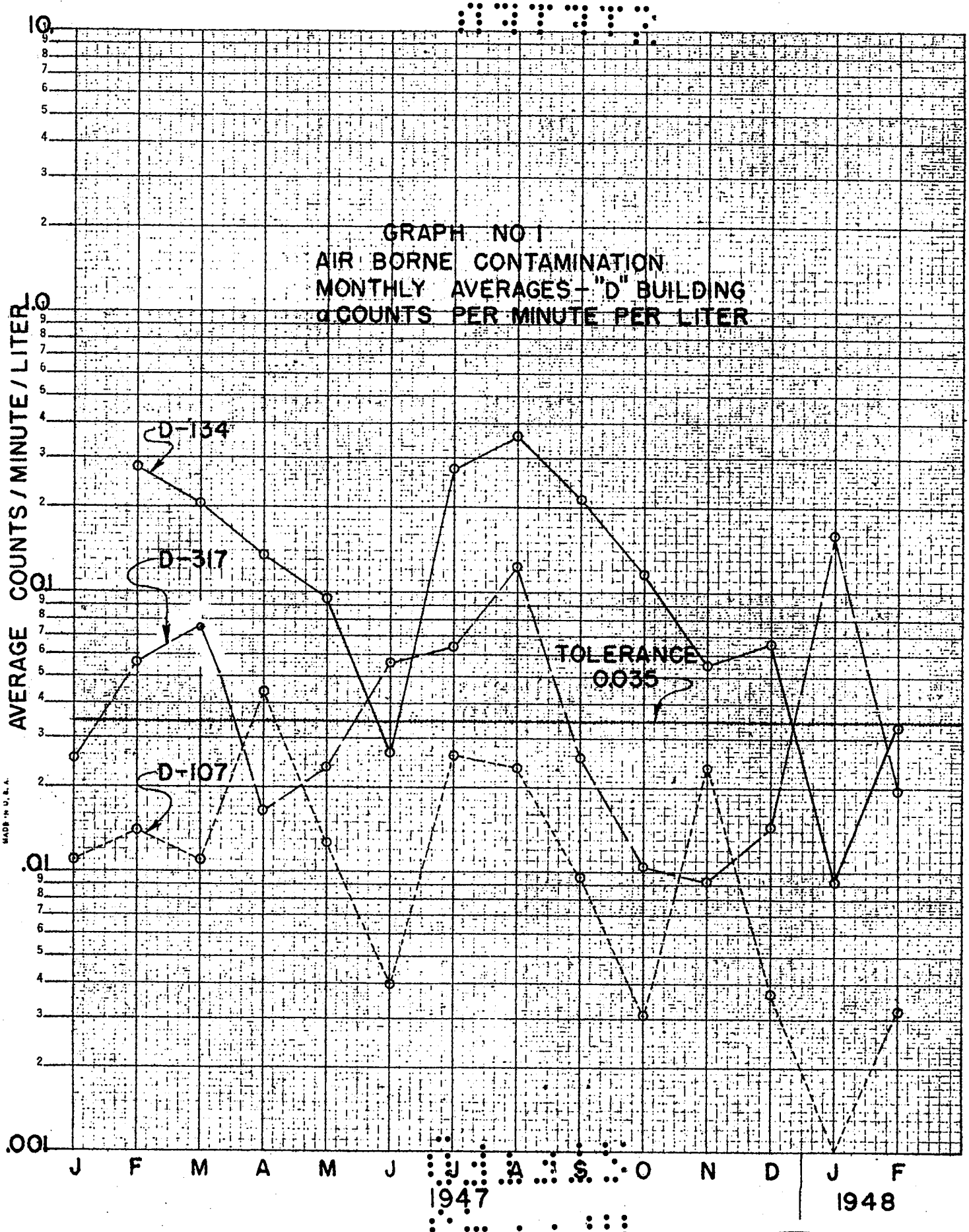
[redacted]

DATA SHEET ACCOMPANYING GRAPH NO. 1

AIR-BORNE CONTAMINATION IN D BUILDING

	D-107		D-134		D-317	
	Ave.c/m/L	Max.c/m/L	Ave.c/m/L	Max.c/m/L	Ave.c/m/L	Max.c/m/L
January, 1947	0.0109	0.0793			0.0253	0.1329
February	0.0140	0.0263	0.2767	0.7130	0.0563	0.2472
March	0.0110	0.0415	0.2031	0.9960	0.0758	0.2200
April	0.0444	0.3827	0.1345	0.8199	0.0163	0.0493
May	0.0128	0.1018	0.0956	0.8843	0.0234	0.0724
June	0.0040	0.0343	0.0268	0.1954	0.0559	0.5357
July	0.0258	0.1412	0.2711	2.5263	0.0641	0.7097
August	0.0238	0.2127	0.3658	3.6680	0.1205	0.7560
September	0.0096	0.1771	0.2104	1.0581	0.0252	0.2328
October	0.0021	0.0324	0.1173	1.3071	0.0105	0.0549
November	0.0239	0.3309	0.0527	0.4067	0.0091	0.0130
December	0.0037	0.0470	0.0670	1.2447	0.0144	0.0512
January, 1948	0.0004	0.0084	0.0092	0.0582	0.1582	2.7437
February	0.0022	0.0417	0.0344	0.5190	0.0199	0.1522

[redacted]



DATA SHEET ACCOMPANYING GRAPH NO. 2

AIR-BORNE CONTAMINATION ROOM 107 D BUILDING, AUGUST 6, 1947

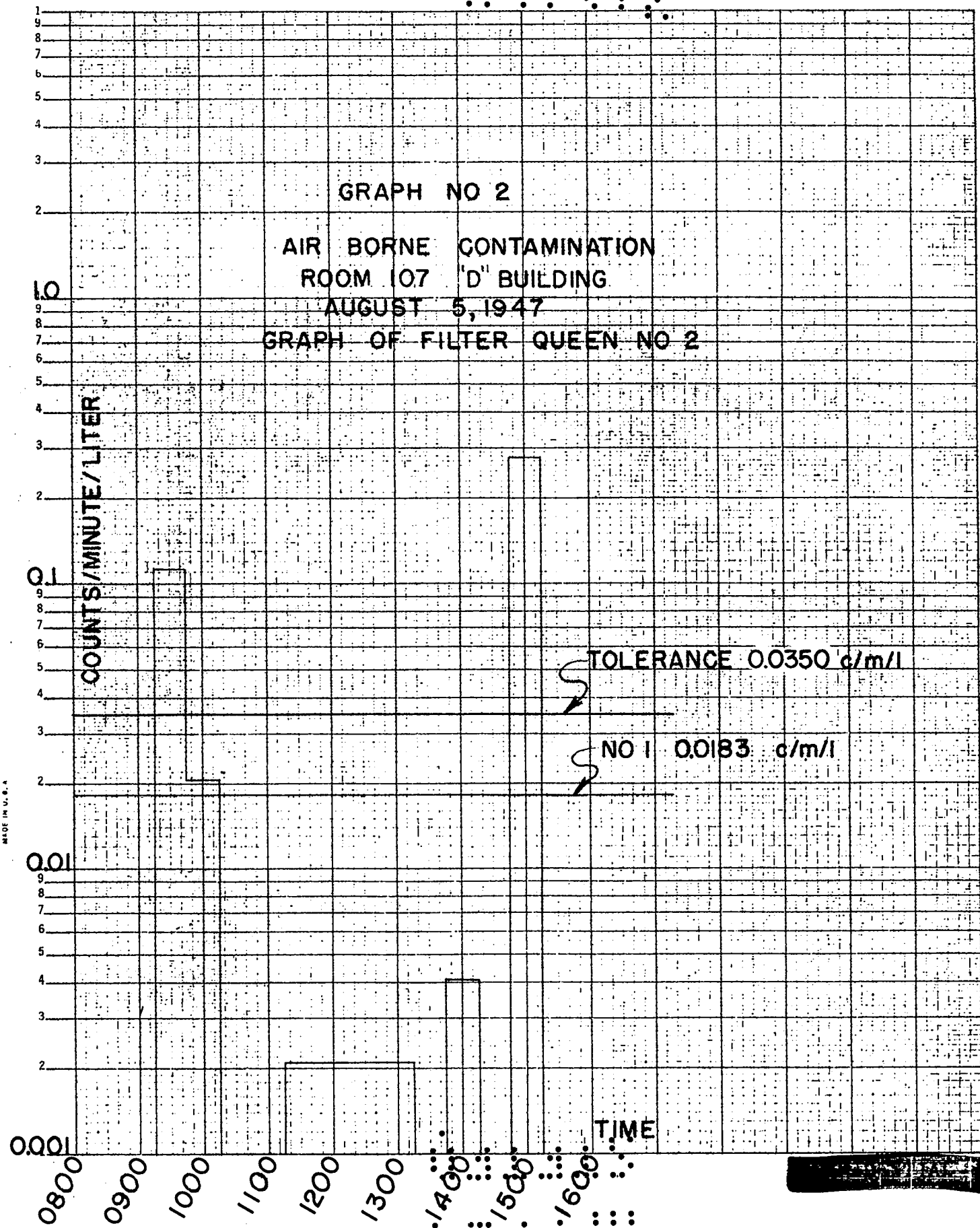
Filter Queen No. 1

0815 - 1545	0.0183 Counts per minute per liter	

Filter Queen No. 2

0815 - 0845	0.0000	No activity
0845 - 0915	0.0000	No activity
0915 - 0945	0.1130	Preparing sample, loading press
0945 - 1015	0.0209	Evacuating
1015 - 1045	0.0000	Evacuating and heating
1045 - 1115	0.0006	Evacuating and heating
1115 - 1315	0.0021	Argon charge, pressing, cooling
1315 - 1345	0.0000	Cooling
1345 - 1415	0.0041	Cooling
1415 - 1445	0.0000	Cooling
1445 - 1515	0.2790	Unloading press, inspecting sample
1515 - 1545	0.0000	Sample to storage, all work over

[redacted]



[redacted]

DATA SHEET ACCOMPANYING GRAPH NO. 3

AIR-BORNE CONTAMINATION, D-134 - SEPTEMBER 12, 1947

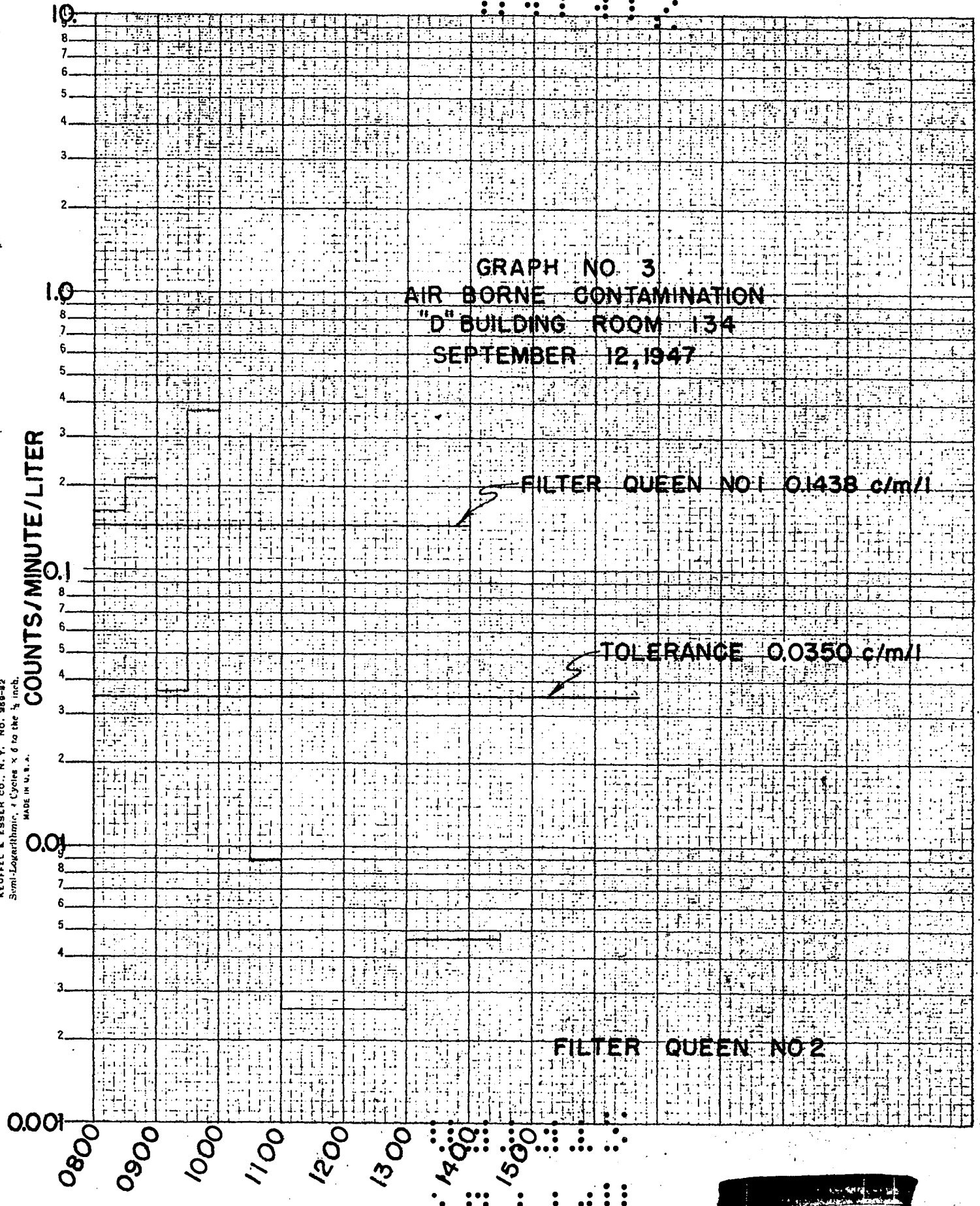
Filter Queen No. 1

0800 - 1430	0.1438 c/m/L	

Filter Queen No. 2

0800 - 0830	0.1612	Furnace hood door ajar - repairing
0830 - 0900	0.2147	Loading furnace, grinding samples
0900 - 0930	0.0362	No activity
0930 - 1000	0.3791	
1000 - 1030	0.3068	Grinding samples
1030 - 1100	0.0088	All hoods and dryboxes closed at 1030 - (no activity)
1100 - 1300	0.0026	No activity
1300 - 1430	0.0047	Heating

[redacted]



[redacted]

[redacted]

DATA SHEET ACCOMPANYING GRAPH NO. 4

AIR-BORNE CONTAMINATION, D-134 - November 20, 1947

Filter Queen No. 1

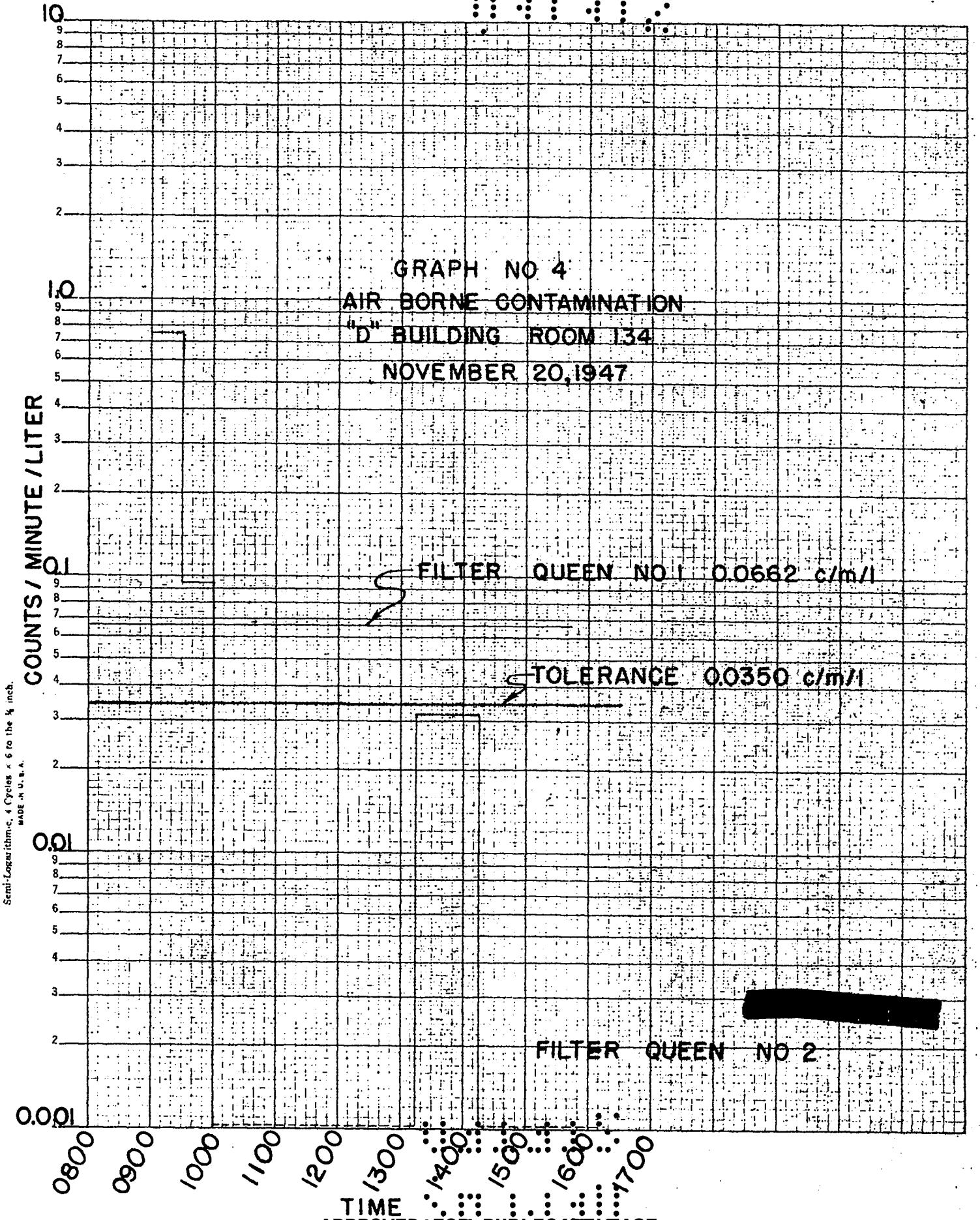
0830 - 1530	0.0662 c/m/L	

Filter Queen No. 2

0900 - 0930	0.7550	Loading furnace. Shearing in other train.
0930 - 1000	0.0950	Close furnace housing door at 9:33. Transfer out of shear train at 9:58
1000 - 1030	0.0000	Filing in drybox. Shear train furnace housing open 1003 - 05.
1030 - 1100	0.0000	Transfer out of shear train at 1033. End of activity at 1040.
1100 - 1130	0.0000	No activity.
1130 - 1315	0.0007	Furnace heat on at 1200.
1315 - 1415	0.0339	No explanation
1415 - 1515	0.0000	Furnace heat off at 1440
1515 - 1615	0.0000	No activity

[redacted]

[redacted]



DATA SHEET ACCOMPANYING GRAPH NO. 5

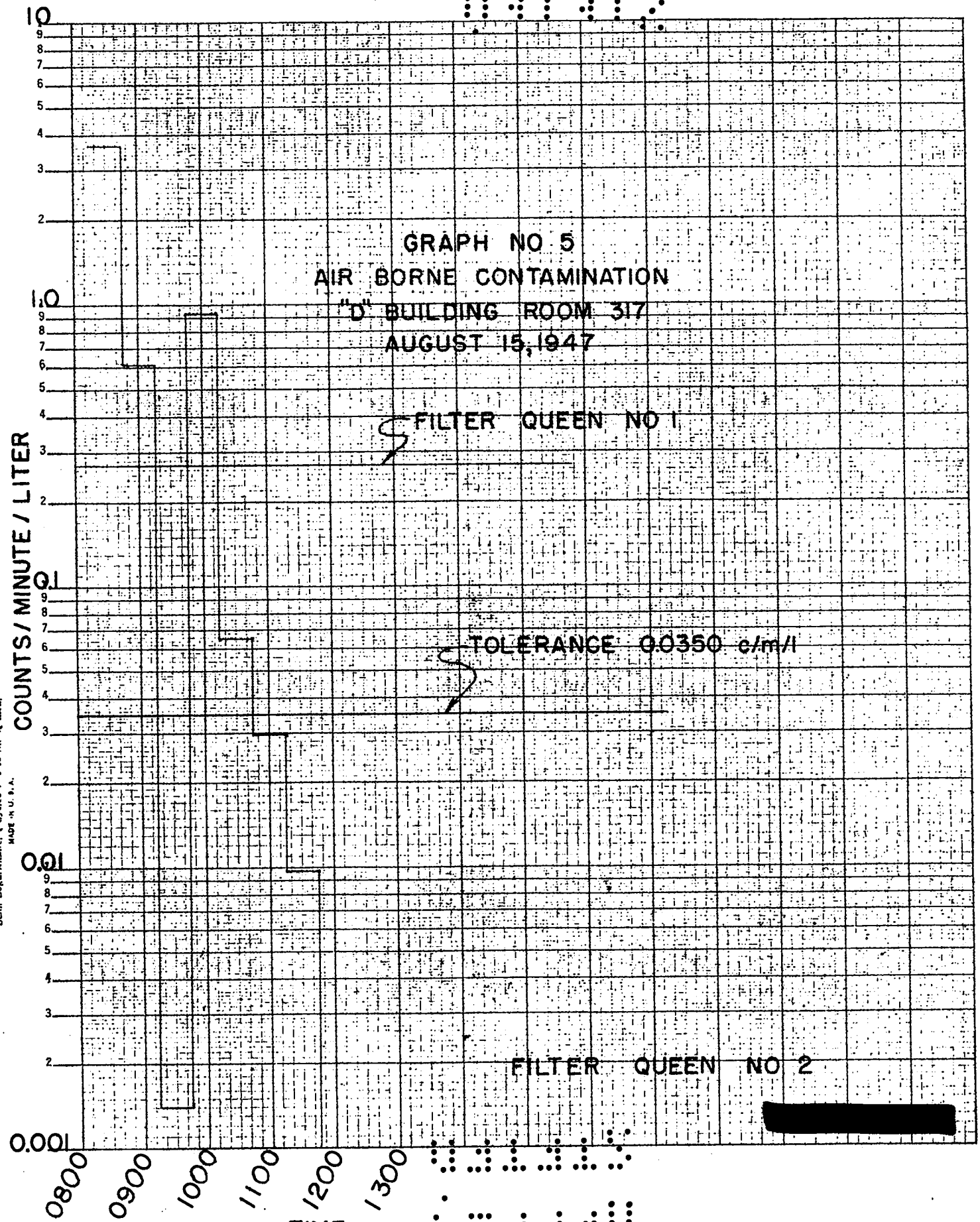
AIR-BORNE CONTAMINATION ROOM 317 D BUILDING, August 15, 1947

Filter Queen No. 1

0800 - 1500	0.2697 Counts per minute per liter

Filter Queen No. 2

0815 - 0845	3.6550	Transfers every 2 minutes from one drybox to another.
0845 - 0915	0.6075	Same except 15 minutes no activity.
0915 - 0945	0.0014	Same except 22 minutes no activity.
0945 - 1015	0.9210	19 transfers between dryboxes.
1015 - 1045	0.0653	7 transfers, no activity for 20 minutes.
1045 - 1115	0.0297	9 transfers.
1115 - 1145	0.0097	20 transfers, same specimen.
1145 - 1315	0.0000	No activity.
1315 - 1510	0.0000	Some clean-up work only.



DATA SHEET ACCOMPANYING GRAPH NO. 6

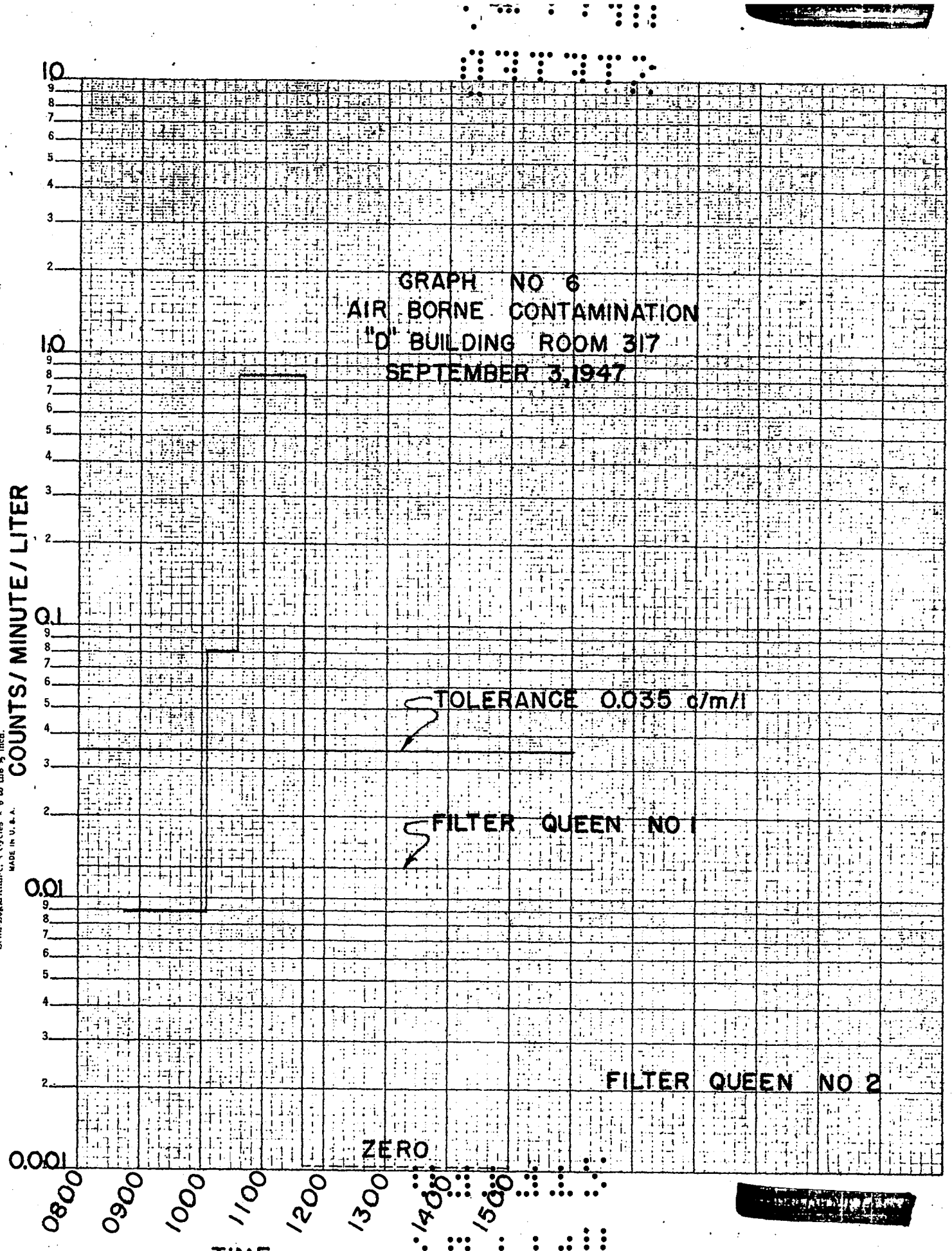
AIR-BORNE CONTAMINATION ROOM 317, D BUILDING, September 3, 1947

Filter Queen No. 1

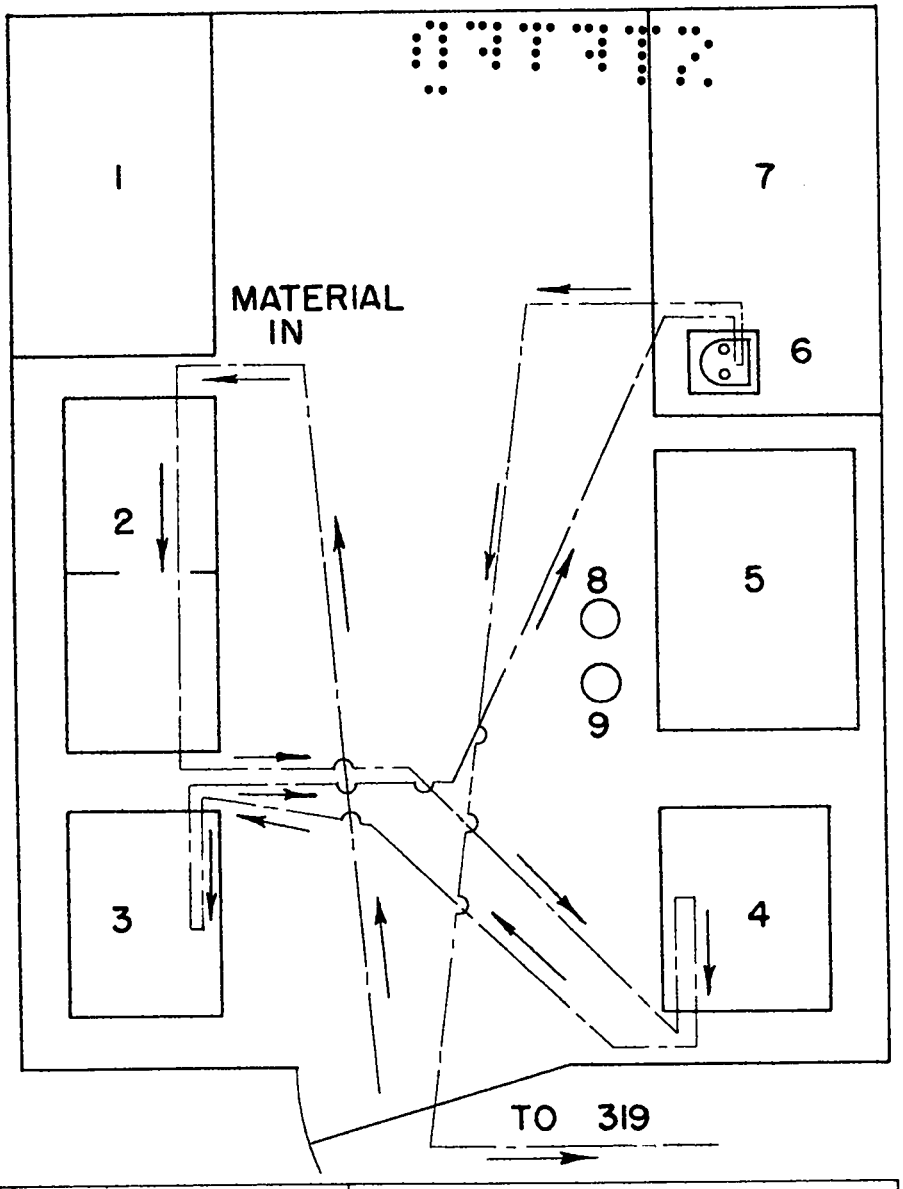
0800 - 1500	0.0131 c/m/L

Filter Queen No. 2

0845 - 1005	0.0089	No work.
1005 - 1035	0.0818	Grinding and cleaning.
1035 - 1135	0.8350	After cleaning - material transferred.
1135 - 1500	0.0000	No activity.



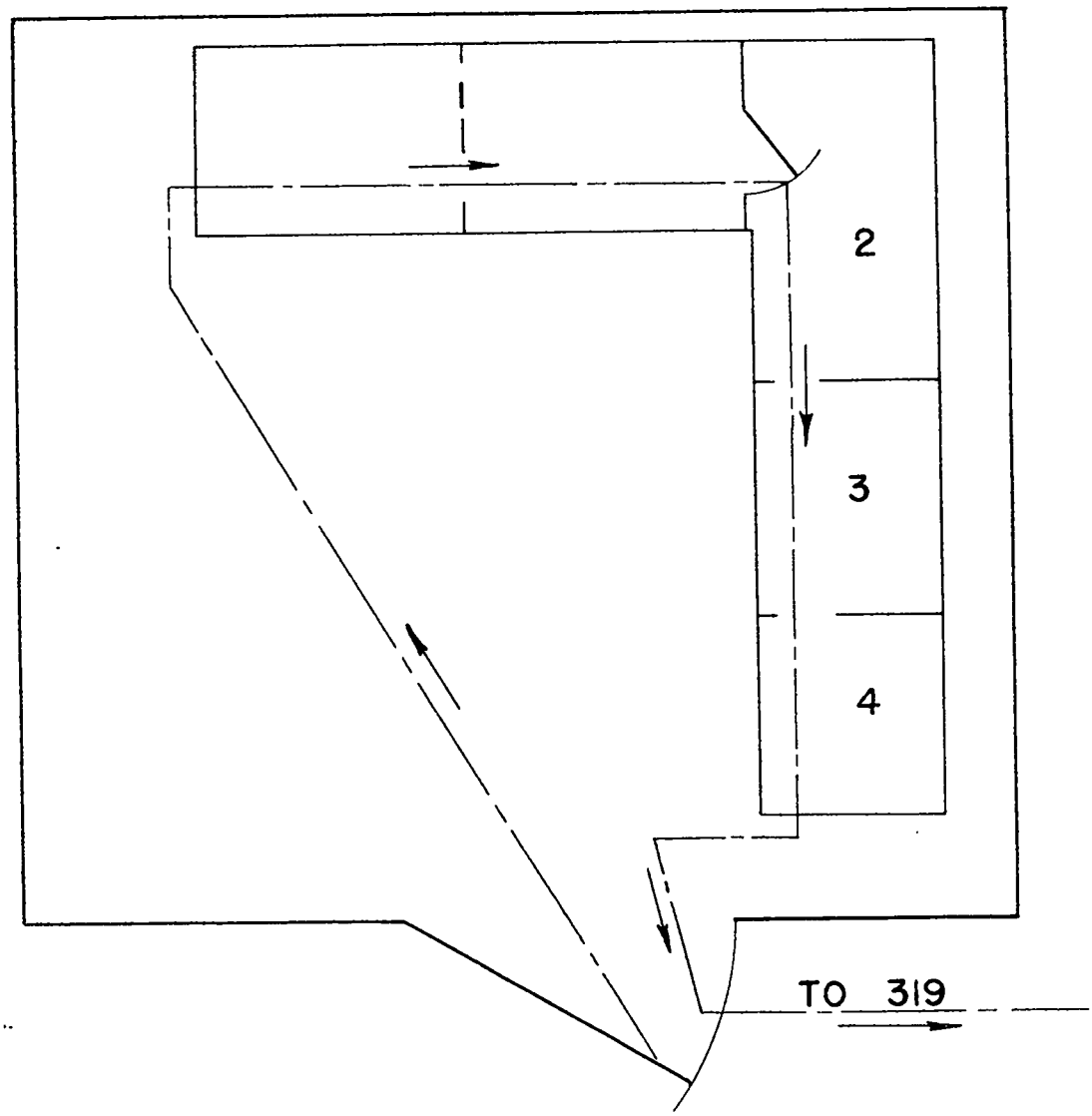
FLOW SHEET -D-317-1



No.	Description	Use
1	Sink	
2	Drycox-Double	Mounting & grinding specimens
3	Drytox-Single	Etching
4	Drytox-Single	Polishing
5	Hood - Open	Room exhaust
6	Microscope	Inspection
7	Table	
8	Filter Queen #1	Air collection-all day run.
9	Filter Queen #2	Air collection-test runs.

[redacted]

IDEAL FLOW SHEET -D-317



No.	Description	Use
1	Drybox-Double	Mounting & grinding specimen
2	Drybox	Polishing
3	Drybox	Etching
4	Drybox	Inspection

UNCLASSIFIED

UNCLASSIFIED