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AN INTERIM REPORT OF BRITISH WORK ON JOE

The British atomic energy authorities were alerted at 1130 AM (DST) on Saturday morning September 10, 1949. A conference was held by teletype in the American Embassy in London and the British were informed that a mass of air containing activity was about to pass north of Scotland. It was estimated that the activity would be approximately 1/4 of a disintegration per minute per cubic foot. The British were invited to attempt to collect activity and make independent assesments of its significance.

Two British meteorological flights, with the code names of NOCTURNAL and BISMUTH were in regular operation carrying filters of a type described at the American and British discussion held in September 1948 in Washington. The BISMUTH flights had shown no activity on the 9th of September and the NOCTURNAL flight had shown no activity on the 10th of September. The first flight to collect results from north of Scotland left at 2140 hours on the 10th of September and gave immediate results. Planes were deflected from the BISMUTH flight to north of Scotland, with the result that no BISMUTH flights took place between Saturday, the 10th of September and Wednesday, the 14th of September inclusively. The NOCTURNAL flights were not affected. A summary of all flights to date is given in Appendix I.

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As a matter of interest, if the Americans had not alerted the British the first evidence of activity would have been obtained by the British on the NOCTURNAL flight from Gibraltar on Saturday the 10th of September, and results would not have been obtained before Wednesday the 14th of September, as there is a delay of approximately three to four days in getting the filters from Gibraltar into the laboratory at Harwell.

1. Filter

The filter used for collecting the activity is one of the British standard gas mask filters. The material is made from esparto grass in the form of a cylindrical tube approximately 12 cm in diameter. The filter is mounted in a hollow steel tube, the leading edge of which is shaped to give good aerodynamic properties. This steel tube is bolted onto the wing of an aircraft and usually each aircraft carries a filter on each wing. A wire grid is usually mounted at the front end of the filter to protect it from hail.

The air flow characteristics and the flow efficiency of these filters were calibrated by appropriate tests. Details are given in Appendix II.

2. Counter.

The counter consists of four Geiger counters, each approximately 14 cm long and 1.3 cm in diameter, made of glass 35 mgm/cm^2, and accepts Beta down to 0.3 mev. The four Geigers are used in parallel and are put inside of the filter on some

guard rails so that the geometry is preserved from observation to observation. The counter efficiency is 7.6% and a count of 1 per minute is equivalent to 6.0×10^{-12} curies on the filter. (Area 358 cm^2.)

3. Method of Counting and Elimination of Background

There are three counting units employed, and in one of them is placed the sample filter, in one of the others is placed an unflown filter taken from the same baton as the flown filter. The third counter records counts from an unflown filter which has been preserved and continuously used for counting since observations first began in 1948. The counting time is in every case taken to be sufficient to give a 1% standard error. When a set of readings has been obtained from the three counters, the filters are permuted among the counters and a new set of records taken. By taking averages and permuting again, it is possible to eliminate all statistical fluctuations and variations in counter performance. The results obtained are that the background is 90 counts per minute and the activity of flown filters is expressed in terms of this quantity. The symbol R^1 is used to denote the activity of a filter expressed as a multiple of the background. Thus for example: $R^1 = 1$ means no activity on the filter, but only background; while $R^1 = 2$ means an activity above background exactly equal to the background. The activity collected from the cloud is therefore R^1-1. Values of R^1-1 obtained from filters flown on the various flights are given in Appendix I.

4. Results on Gross Activity

The activity of various filters was measured from day to day with the object of determining the time of origin. By assuming that the activity decreased with time according to an inverse 1.2 power law, it was estimated that the time of origin was between the 26th and 30th of August. There is a slight uncertainty in the exact time of origin and the dates given might need correction of the order of one day if the departures from May and Wigner Law are taken into account. However, the spread in time of the original disturbance has been set widely enough to cover this uncertainty.

NOTE: It is perhaps worth noting that the maximum activity collected by the British filters, for flights of equal duration at similar altitudes, was roughly 20 times that obtained for any of the SANDSTONE tests. The maximum activity in the cloud was on September 11th, and was roughly 0.35 disintegrations per minute per cubic foot of air. This flight was at 20,000 ft. About two-thirds of this activity was found at 30,000 ft on September 11th.

5. Radiochemistry

By applying standard radiochemical techniques, three fission elements have been isolated, namely Barium, Cerium and Iodine. Filter B3 on September the 20th was giving an iodine count of 0.8 ± 0.4 while barium is giving 7.8 ± 3. Further measurements are in progress but all radiochemical results so far obtained are consistent with the time of origin obtained from the gross activity.

6. Auto-radiographs

The first auto-radiographs gave unsuccessful results, but, by increasing the time of exposure to 4 days, positive results have now been obtained. On filter B10, one fairly large particle and 34 extremely small ones have been located. The large particle is giving approximately 10 disintegrations per minute and is therefore about twice the radius of the largest particles collected by the American observers.

7. Activity Versus Particle Size

The evidence so far obtained is that most of the activity collected by the filters is extremely fine and penetrates to some depth in the filter medium. In the case quoted in the last paragraph, only a small percent of the total activity is due to the one large particle and the 34 small ones. Provided that the large particle proves to be authentic, special measurements will be made on it in the hope of measuring the efficiency.

8. Plutonium and Uranium

Information sent by cable and therefore necessarily brief, showed that on September 19th it had been established that the amount of Plutonium on one of the most active filters was less than 3×10^{-12}. The results on Uranium were very unsatisfactory because of the relatively large Uranium concentration in the filter. All that can be said is that the amount of Uranium collected might have been approaching 10^{-7} gms.

It was planned to make two further measurements on alpha emitters. The first was to attempt to get alpha tracks in a photographic film and from standard methods to determine the energy of the alpha

particle. A second method was to concentrate the Uranium from the filter and see if the isotopic ratio 235:238 departed from normal. In neither case has any result yet been reported.

9. This interim report has been written on the evidence existing at Harwell on Saturday, September 17th, supplemented by fragmentary information communicated by secret cable. A proper report of the British work will be written later when the experimental measurements have been more fully digested, and a copy of this report will be forwarded to AFOAT-1.

22 September 1949

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APPENDIX 1

SUMMARY OF BRITISH FLIGHTS, SEPTEMBER 10-16

Filter No.	Plane Type	Take Off Date	Take Off Time	Land Time	Route	Counted Date	Counted Time	Count Excess	Activity ($T-1$)	Remarks
[illegible]	[illegible]	10	2140A	0600A	C	11	1500	110	2.256	
B.3	Hal	10	2330A	0525	C	11	1500	60	0.596	
B.4	Mosq	11	0750	1130	A	11	2100	301	3.342	
B.5	Mosq	[illegible]	1430	2000	A	15		224	2.232	30,000 ft.
B.6	Hal	11	1928	0142	C	12	0900	64	0.735	
[illegible]	Hal	11	1932	0242	C	12	1100	45	0.504	
[illegible]	Mosq	11	0450	[illegible]	B	12	2000	60	0.736	
[illegible]	Hal	12	0925	[illegible]	D	13	0200	42	0.500	
B.10	Mosq	12	[illegible]	2000	B	13	0500	74	0.804	
B.11	Mosq				Round Britain	13	0100	33	0.455	Counted every 10 Min.
B.12	Hal	13	0125	0955	D	13	1630	39	0.413	
B.13	Linc	13	0836	1836	D	14	0230	109	1.133	
B.14	Linc	13	2023	0935	D	14	2000	204	2.216	
[illegible]	[illegible]	14	[illegible]	[illegible]	D	15	[illegible]	350	[illegible]	
[illegible]	Hal	14	1037	1913	F	15	0730	36	0.403	BISMUTH Met Flight
B.17	Mosq	15	1100	1500	Round Britain					Short Flight Round Britain
B.18	Linc	14	0817	1916	D	16	0230	35	0.390	Abortive
B.19	Hal	15	0305	0725	BISMUTH	15	1230	50	0.574	BISMUTH Met Flight
B.20	Linc	14	1700 ?	0230 ?	D					
B.21	Mosq	16	1055	1502	Round Britain					Same as B.17
B.22	Linc	16			D					

~~RESTRICTED DATA~~
~~ATOMIC ENERGY ACT — 1946~~
SPECIFIC ~~RESTRICTED DATA CLEARANCE~~ REQUIRED

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APPENDIX II

Particulate filtering and flow efficiency of Filters

1. Filters normally tested at 3 cu. ft. per minute air flow against a standard methylene blue cloud (90% of particles under 0.5 microns) giving efficiency averaging 99%. Efficiency falls off slightly with increased air flow, but is not expected to fall below 95% at 60. cu. ft. per minute - no measurements available at this speed.

2. Flow through the filter equals 1.764 v litres per second where v is the air speed in the filter entry. The air speed in the filter entry is given by the formula - (where V is the aircraft speed).

$$\tfrac{1}{2}\rho V^2 = \text{Pressure drop} = A\frac{\rho}{\rho_o}v^2 \qquad B\frac{\mu v}{\mu_o}$$

where ρ and ρ_o and μ and μ_o are the density and viscosity of air at the altitude concerned and at sea level. The values of A and B found by experiment are 0.349 and 1.826 respectively. The air flows deduced have been given you in a separate memorandum.