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DEPARTMENT OF ATOMIC ENERGY

ATOMIC WEAPONS RESEARCH ESTABLISHMENT

REPORT No. T 18/54

OPERATION HURRICANE GROUP REPORTS

(PART 43)

Report on Trial Carried Out for Ministry of Food

G. R. Stanbury
(Scientific Adviser's Branch, Home Office)

Approved subject to corrections
R.M. Jones
18/5/54

[redacted]

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Department of Atomic Energy

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CIVIL DEFENCE GROUP

Report on Trial Carried Out for Ministry of Food

G. R. Stanbury
(Scientific Adviser's Branch, Home Office)

Received on 24th March, 1954.

[redacted]

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1. Introduction

In time of war many conditions contribute to the necessity for storing food temporarily in the open on the dockside. Large stocks of food are also kept in dock buildings nearby, which might be damaged by blast in such a way as to expose the contents to the weather, or to the various effects of any subsequent Atomic Bomb attack. For this reason the Ministry of Food wanted to know what would happen to such stocks if an Atomic Bomb were exploded nearby as in this trial, particularly from the point of view of estimating what proportion of the food might be recovered and made fit for human consumption.

Although in this particular trial the atomic bomb was exploded inside a ship, it was considered that the conditions produced would be generally similar to those resulting from a bomb dropped from the air and exploding very close to, or on the surface of, the shallow water typical of most harbours in this country, a possibility which has been anxiously engaging Civil Defence for some time.

In a more general way the Ministry of Food are interested in the detailed effects of atomic blast on structures and on the possibility of fire, but this information will become available from other aspects of the trial and is outside the scope of this specific experiment dealing with food in the open.

2. Equipment and Procedure

The Scientific Adviser's Division of the Ministry of Food proposed that three dumps of food should be set up in different parts of Trimouille, the contents of each dump being as shown in Table 1.

It will be noted that the various packages are those normally used for ship freight, but that in some instances different materials have been used so as to make it possible to evaluate their fire risk and their resistance to the penetration of radioactive contamination in comparison with the more orthodox materials.

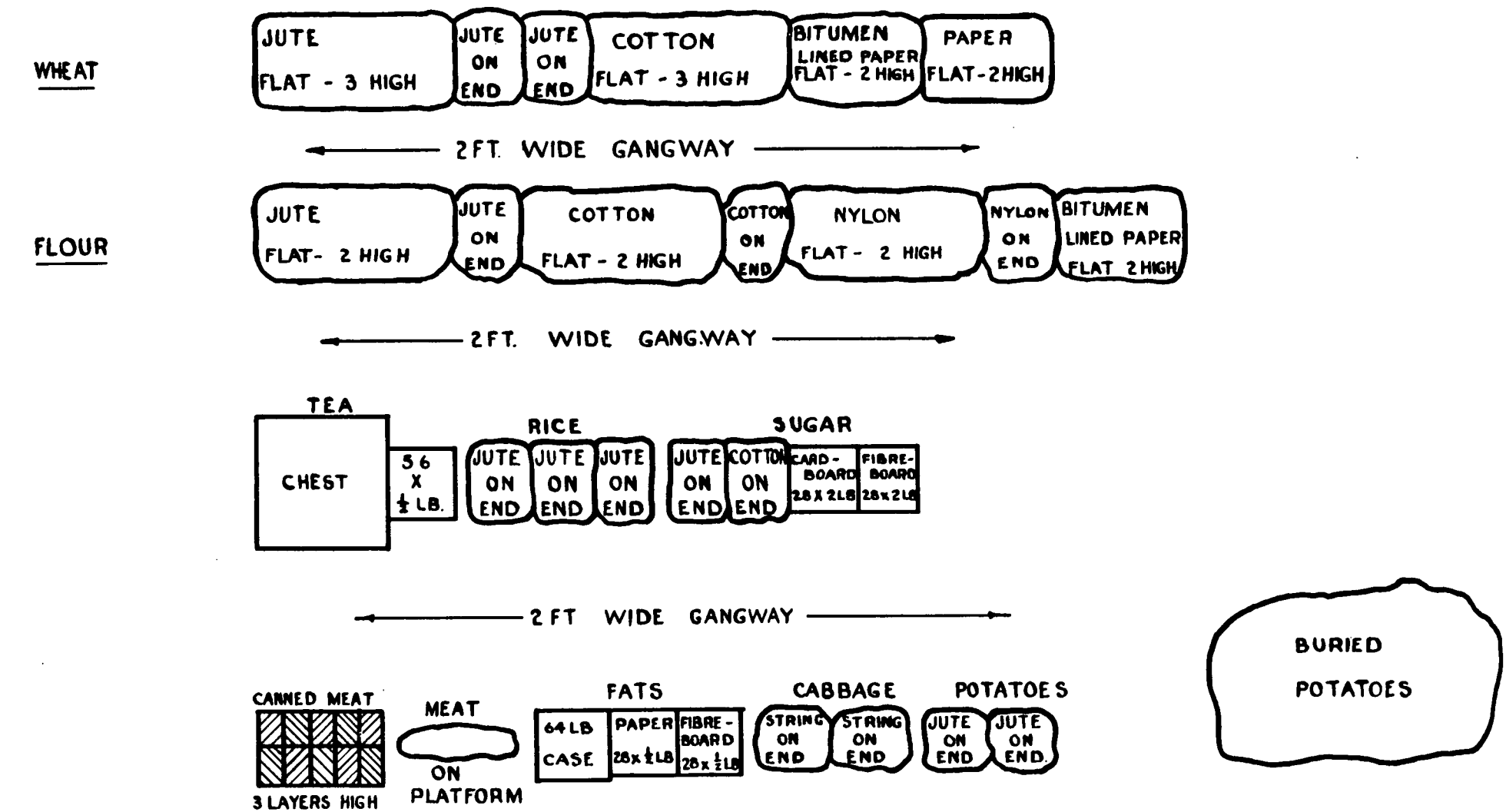
It was agreed with the Technical Director to place one dump, T.C.13, as close as convenient to T.V. so as to simulate a food dump on the open dock exposed to the full effects of the explosion.

TABLE 1

Commodity	Weight	Container
Flour	3 x 140 lb. bags 3 x 140 lb. bags 3 x 140 lb. bags 2 x 56 lb. bags	Finely woven jute Cotton Nylon 5 ply paper, bitumen lined
Wheat	5 x 180 lb. sacks 3 x 180 lb. sacks 2 x 56 lb. bags 2 x 56 lb. bags	Jute Cotton Paper, 5 ply, bitumen lined Paper, no lining
Carcase Meat	1 Carcase of Mutton Total weight 50 lb.	Wrapped in Cotton
Sugar	1 x 160 lb. sack 1 x 160 lb. sack 1 x 56 lb. case containing 28 x 2 lb. cartons 28 x 2 lb. cartons	Jute Cotton Fibreboard Cardboard, unwrapped
Tea	1 x 120 lb. chest 56 x ½ lb. packets	Plywood - metal foil lined Paper, no outer wrapping
Canned Meat	24 x 6 lb. tins (360 lb. gross)	
Fats	1 x 64 lb. cases 28 x ½ lb. packs 28 x ½ lb. packs	Wood - paper lined Paper - exposed Paper inner - fibreboard outer
Rice	2 x 114 lb. bags 1 x 114 lb. bags	Jute Cotton
Potatoes Cabbage	2 x 1 cwt. 2 cwt. 1 cwt (2 x 56 lb.)	Jute sacks Buried in soil String bags

The sites were first levelled with a bulldozer over an area of about 10 yd. × 20 yd., although in the case of the hockey pitch the work of levelling had already been done. The levelled sand was then covered with "bitesse" - a standard army road surfacing material of bitumanised hessian - and then lightly sanded. An area of 5 yd. × 10 yd. in the centre of this was then covered with the steel shuttering which had been used in the erection of the M.O.W. concrete cubicles; this provided a good clean level fire-proof surface for the dump.

The food was arranged in four parallel lines perpendicular to the direct line from T.V. as shown in Photographs Nos.:- 99, 100, 101 and 102. A 2 ft. wide lane was left between each line for access, and the food was laid out in each line according to the following plan:-


WHEAT
JUTE
FLAT - 3 HIGH
JUTE ON END
JUTE ON END
COTTON
FLAT - 3 HIGH
BITUMEN LINED PAPER
FLAT - 2 HIGH
PAPER
FLAT - 2 HIGH
2 FT. WIDE GANGWAY
FLOUR
JUTE
FLAT - 2 HIGH
JUTE ON END
COTTON
FLAT - 2 HIGH
COTTON ON END
NYLON
FLAT - 2 HIGH
NYLON ON END
BITUMEN LINED PAPER
FLAT 2 HIGH
2 FT. WIDE GANGWAY
TEA
CHEST
56 X ½ LB.
RICE
JUTE ON END
JUTE ON END
JUTE ON END
SUGAR
JUTE ON END
COTTON ON END
CARD-BOARD 28 X 2 LB
FIBRE-BOARD 28 x 2 LB
2 FT WIDE GANGWAY
CANNED MEAT
3 LAYERS HIGH
MEAT
ON PLATFORM
FATS
64 LB CASE
PAPER 28 x ½ LB
FIBRE-BOARD 28 x ½ LB
CABBAGE
STRING ON END
STRING ON END
POTATOES
JUTE ON END
JUTE ON END.
BURIED
POTATOES

The food was collected at the Naval Victualling Store at Freemantle and sent up by S.S. Kybern to Monte Bello, where it arrived on 15th September. The dry goods were taken ashore immediately and stored in a Nissen hut at Gladstone Beach. The perishable goods were put into refrigeration or other suitable storage on H.M.S. Zeebrugge and not transferred to Trimouille until the day before the first proposed D-1 day. All the food was distributed into position on the afternoon of this day, but owing to the fact that D-1 was subsequently postponed for one day, the food was actually in the open for about $2\frac{1}{2}$ days prior to the explosion. Owing to the very hot sunny weather at the time, the food was somewhat adversely affected by this rather long exposure; the cabbage became completely dehydrated and quite inedible, the butter - even in wooden cases - melted and seeped away, and the carcases of mutton thawed out, were attacked by swarms of flies, and soon began to decay. In these respects the conditions were not at all comparable with those in this country but it was the best that could be done under the circumstances.

After the explosion, sorties were made to the dumps on the following occasions, about an hour only being available at each site for investigation.

T.C 13	16th October 1952	D+13 by Land Rover from T.1.
T.C 14	7th October 1952	D+4 by Land Rover from T.1.
T.C 15	17th October 1952	D+14 by Land Rover from Gladstone Beach.

Photographs were taken, a general damage assessment made, and the local background gamma radiation measured.

Samples were also taken from some of the lots for subsequent measurement of beta activity. Originally a special sampling tool had been made for this purpose, but it was difficult to avoid contaminating the tool and transferring active material from one sample to another. It was found more satisfactory as well as quicker and more convenient to slit the package open with a knife and extract the sample with a dessert spoon, the food not in direct contact with the spoon then being transferred to a clean bag made of polythene sheet; this bag was then sealed with "lassovic" ready for removal. It was of course impossible to make any measurements of contamination on the spot owing to the high local gamma radiation flux.

3. Results

3.1 T.C.13

3.1.1 Radioactivity

Measured gamma ray dose rate on D+13	0.1 r./hr.
Estimated gamma ray dose rate 1 hr. after explosion	100 r./hr.

The contamination on the ground was not noticeable to the eye as elsewhere, and it is probable that some proportion of the activity came from gamma ray emitters at a distance.

The beta activity of the sampled lots is reported separately.

3.1.2 Blast

Damage by blast was considerable.

The 7 lb. tins of meat were scattered up to a distance of 25 yd..

The chest of tea was thrown 25 yd., clear of the platform of steel shuttering.

Sacks of food were thrown various distances as shown in Photographs Nos:- 103, 104, 105 and 106 the maximum being about 15 yd.. Several of the sacks were ripped open.

Several of the steel shutters were picked up from round the edge and thrown about, and the bitesse underneath was ripped up and pieces of it found wrapped round other nearby objects.

The whole area was covered with a layer of dirt and sand from the surroundings, and it was almost impossible to identify any of the markings on the sacks.

3.1.3 Fire

Most of the vegetation round about the dump had been destroyed by fire and only charred tufts were left. From a study of other parts of the island it appeared that this vegetation was not ignited by the heat flash. At equivalent distances to the south of T.2 Camp there were certainly exposed areas which were not fired. The vegetation itself was extremely dry and friable and, once ignited, the fire would easily have spread, and it is presumed that the initial fires were started by red hot pieces of metal from T.V., since these were found in various places subsequently. This would account for the somewhat random nature of the fire effects.

At first sight the dump did not appear to have suffered any fire damage since there was a considerable cleared area around it, but closer inspection revealed the following:-

(a) The carcase of mutton originally in the front line had been blown clear of the back of the platform and all that was left of it was a few charred bones. Nearby were the charred remains of one of the sacks of food. (see Photograph No.103).

(b) The tea chest which was thrown clear of the platform on to the vegetation at the back was completely destroyed by fire with all its contents. All that was left was the twisted remains of the metal edging of the chest (see Photograph No.107). The vegetation all around it was burnt up.

(c) Eight of the sacks of food were thrown completely clear of the platform on to the scrub as shown particularly in Photograph No. 106 and these were all burnt to some extent. In some cases a few ashes only were left, while in others the sack and contents were only half destroyed. Two other sacks had small areas of the covering burnt off. One sack just clear of the near edge of the platform and close to the burnt out carcase of mutton was partly destroyed by fire, but all those which remained on the platform were unaffected.

The inference seems to be that it was only those parts of the dump which were blown clear of the platform on to the scrub which were fired. They were possibly split open by the blast and this rendered them more vulnerable to the fire spreading over the scrub.

3.1.4 General

There were no flies about and no obvious signs of any other forms of animal life. Certainly there was no evidence that rats had been anywhere near the dump after the explosion.

The potatoes which had been buried were moist when dug up and were quite free of any radioactive contamination.

3.2 T.C.14

3.2.1 Radioactivity

Measured gamma ray dose rate on D+4 < 0.5 mr./hr..

There was no visual fall-out in this area and it seems reasonable to infer that since the activity even on the first day was so low that the fall-out had been negligible, the small measured dose rate coming from the general effects of heavier contamination to the north, from contamination of the water in the lagoon and possibly from some very slight neutron induced activity in the ground.

Samples of food were taken for beta measurement but it was found on return to H.5 that there was no measurable activity and the samples were subsequently destroyed.

3.2.2 Blast and Fire

There was no disturbance of any of the lots in this dump by blast and no damage at all by fire.

3.2.3 General

The butter had melted in the heat of the sun and seeped out of the boxes.

The potatoes and cabbage in bags were badly dried up, but the potatoes which had been buried were quite moist and edible.

The outer layer of sugar (about 1 in. deep) in each of the sugar bags was very hard. Probably this was due to the heavy dew soaking through the covers, dissolving the outer layer of sugar, and then hardening up again to a solid crust under the subsequent action of the hot sun.

The carcase of mutton was in an advanced state of decay and covered with flies.

There was much evidence of rats, most of the sacks having been eaten into somewhere apparently since the explosion. One dead rat was found.

The general impression was that apart from the meat, butter and exposed vegetables, a large proportion of this dump could have been used for human consumption.

3.3 T.C.15

3.3.1 Radioactivity

Measured gamma ray dose rate on D+14 0.2 to 0.25 r./hr..

Estimated gamma ray dose rate

1 hr. after explosion about 250 r./hr.

This site is shown after the explosion in Photograph No. 108.

In this region there had been very heavy fall-out of radioactive material in the form of black inky rain which had evidently come down from the cloud from the direction of the explosion but at an angle to the ground of about 45°. As a result, the front and top faces of all the lots in this dump were heavily marked with black spots of active material while the back faces were quite clean. This was most marked in the case of the chest of tea shown in Photograph No. 109. The top and front were heavily spotted with black spots, whilst on the sides the contamination shows black streak marks crossing the plywood surface at an average angle of about 45° (N.B. The two large black blobs were caused by the painting out of trade names).

When the top of the chest was opened up the inside surfaces of the plywood were quite clean. Also when the sacks were cut open and turned back there was no visible contamination on the insides of any of the covers.

The beta activity of the sampled lots is reported separately.

3.3.2 Blast and Fire

There was no disturbance of any of the lots in this dump by blast as can be seen by Photograph No. 108 taken after the explosion.

There was no damage by fire.

3.3.3 General

There was no evidence at all of any damage caused by rats or other animals either before or after the explosion and there were no flies about when the examination was made. This dump was situated in the middle of the hockey pitch which was surrounded by a low wall of sandbags and to this extent it may have been partly inaccessible to rats, but it seems hardly possible that this alone can have been responsible for the complete immunity of the dumps for 14 days. It is probable that most of the rats had either died off or had been driven away since the accumulated external dose in this area in two weeks would have been of the order of 1,000 roentgens; moreover the area for some distance around had not been set on fire so that the vegetation itself was still there but was covered with dust and black spots of radioactive contamination which would have caused additional harm if taken internally.

4. Penetration of Radioactive Fall-Out into Food Packages (Based on Measurements Made by Mr. R. A. Kendall, of the Ministry of Supply)

4.1 Method of Measurement

The counts were carried out by exposing the food samples to an endwindow beta counter in a metal tray 5 cm. in diameter and 1 cm. in depth. This container was filled level with the edge in each case, thus constituting a "thick" source; at any rate it was several mean free paths deep for the beta particles emitted at the time of counting. This eliminates the necessity of weighing and preparing aliquot samples for counting in every case, since a comparison of counting rates observed with the above technique gives a rough comparison of activity per gram of sample.

In order to determine the absolute activity, a sample of sugar showing about average activity was returned to the United Kingdom for an accurate count. Here it was dissolved and filtered, and an aliquot part of the solution deposited on a thick aluminium tray and counted at a defined geometry. No significant increase over background was observed, indicating that all the contaminant was insoluble. The filter paper was then counted with a thick aluminium backing, and the count corrected for geometry and backscatter. No attempt was made to dissolve the fission products. This observation was made on D+52.

4.2 Results

All the activities are given in Table 2 for D+52 and estimated for D+1 using the $T^{-1.2}$ decay law for mixed fission products. Allowing for the number of counts taken, the uncertainty of the assumption regarding thick source counting of materials of varying density, and the error in the absolute determination of activity, it is estimated that the error in the activities quoted is within $\pm$ 30 per cent.

TABLE 2

Beta activity of samples of food from dumps at T.C.13 and T.C.15

SITE	ESTIMATED GROUND CONTAMINATION D+1	NO.	SAMPLE		ACTIVITIES IN MICRO-CURIES PER GRAM.		REMARKS
			FOOD	PACKAGING	D + 52	D + 1	
T.C.13	20 micro--curies per sq. cm.	2	Flour	Nylon sack	5×10^{-4}	6×10^{-2}	
		3	Wheat	Jute sack	2×10^{-4}	2.4×10^{-2}	
		4	Sugar	Jute sack	0.9×10^{-4}	1.1×10^{-2}	
		5	Sugar	Cotton sack	30×10^{-4}	36×10^{-2}	(Split (open (sack
		7	Flour	Nylon sack	90×10^{-4}	108×10^{-2}	
		8	Sugar	Cardboard	30×10^{-4}	36×10^{-2}	
		9	Sugar	Fibreboard	0.8×10^{-4}	1×10^{-2}	
		10	Flour	(bitumen (lined	7×10^{-4}	8.4×10^{-2}	
		11	Wheat	(Paper bags	4×10^{-4}	4.8×10^{-2}	
		12	Wheat	Paper bags	1×10^{-4}	1.2×10^{-2}	
		13	Tea	Paper packets	3×10^{-4}	3.6×10^{-2}	
T.C.15	50 micro--curies per sq. cm.	14	Wheat	Jute sack	8×10^{-3}	10×10^{-1}	
		15	Wheat	Cotton sack	20×10^{-3}	24×10^{-1}	
		16	Wheat	(bitumen (lined (Paper bags	2×10^{-3}	2.4×10^{-1}	
		17	Wheat	Paper bags	0.4×10^{-3}	0.48×10^{-1}	
		18	Flour	Jute sack	40×10^{-3}	48×10^{-1}	
		19	Flour	Cotton sack	9×10^{-3}	11×10^{-1}	
		20	Flour	Nylon sack	50×10^{-3}	60×10^{-1}	
		21	Flour	(bitumen (lined (Paper bags	2×10^{-3}	2.4×10^{-1}	
		22	Tea	Paper packets	0.4×10^{-3}	0.48×10^{-1}	
		23	Rice	Jute sack	3×10^{-3}	3.6×10^{-1}	
		24	Rice	Cotton sack	40×10^{-3}	48×10^{-1}	
		25	Sugar	Jute sack	8×10^{-3}	10×10^{-1}	
		26	Sugar	Cotton sack	3×10^{-3}	3.6×10^{-1}	
		27	Tea	Chest	1×10^{-3}	1.2×10^{-1}	
		28	Sugar	Cardboard	4×10^{-3}	4.8×10^{-1}	
		29	Sugar	Fibreboard	5×10^{-3}	6×10^{-1}	

5. Discussion and Results

In general the activity in the samples from T.C.15 was about 10 times higher than in those from T.C.13 although the ground contamination was only $2\frac{1}{2}$ times higher. This is understandable since at T.C.13 the contamination could not be seen and had evidently not been deposited wet; at T.C.15 on the other hand the appearance at the dump - as already described - indicated that the contamination had come down as a light inky rain in which form it would more readily have penetrated the covers especially those which were porous like the woven sacks.

The sampling at T.C.13 was not as satisfactory as at T.C.15 owing to the very extensive disturbance of the dump by blast, e.g. it was sometimes difficult to decide which side of a bag had been uppermost. For this reason the samples from T.C.15 are more useful for comparing the degree of protection afforded by each type of cover. At T.C.15, despite the large variation from sample to sample, it is evident that the penetration through the woven materials was about 10 times greater than through the more impervious covers such as paper and plywood.

Even in the worst case, however, most of the activity was kept out. This can be seen from the approximate figures collected in Table 3 which compare the activity on the covers with that in the layer, about 1 cm. thick, immediately beneath from which the samples were taken.

TABLE 3

SITE	ACTIVITY ON THE COVER $\mu c./cm.^2$	ACTIVITY BENEATH THE COVER			
		MAXIMUM		MINIMUM	
		$\mu c./g.$*	Proportion of activity on surface	$\mu c./g.$	Proportion of activity on surface
T.C.13	20	1	0.05	0.01	0.0005
T.C.15	50	5	0.1	0.5	0.01

*Since the density of most of the foodstuffs was about 1 g./c.c. these figures can be directly compared.

It will be seen that in the worst case of the woven sacks at T.C.15 only $\frac{1}{10}$ of the activity deposited on the surface found its way into the layer just underneath. Since the average depths of the sacks laid flat was about 50 cm. the average activity over the whole - even in the worst case measured - would only have been about 0.1 $\mu c./g.$ and this would have applied only to the top sack in the pile at the time the contamination was deposited.

If there had been really heavy rain at the time it is possible that penetration through the covers would have been much more serious.

It is interesting to compare this with figures given in the F.C.D.A. Civil Defence Technical Bulletin TB-11-8, December 1952 in which it is stated that the permissible emergency level of radioactivity in water and food for consumption over a period of 10 days is 0.9 μc./c.c. which is of the same order as that found in the worst case at T.C.15 in the exposed sacks. It would seem, therefore, that even under these extremely severe contamination conditions the risk to food supplies would not be serious. Since most of the activity would remain on the covers the handling and disposal of these would present difficulties.

6. Conclusions

Even under the severe conditions of radioactive contamination which arose in this test, a very high proportion of the food exposed in dumps such as those tested would be fit for human consumption. Special care would have to be taken in the handling and disposal of the covers.

7. Acknowledgments

The C.D. team wish to acknowledge the assistance rendered by Brig. A. W. Wardell, the C.D. Adviser to the Australian Government in the conduct of this trial, and by Mr. R. Kendall of AWRE, Ministry of Supply, in measuring the radioactivity of the samples.

Photograph No.99 Ref.F.1167

Food Dump at TC13 - facing the sea.

Photograph No.100 Ref.F.1169

Food dump at TC13 - facing inland.

[redacted]

Photograph No.101 Ref.F.1166

Food dump at TC13 - facing North.

Photograph No.102 Ref.F.1168

Food dump at TC13 - facing South.
Note mounted gas masks (site G.M.5)
on the extreme left of the picture.

Photograph No.103 Ref.F.1529

Food dump at TC13 after the explosion - facing the sea. (Note burnt out carcase of mutton).

Photograph No.104 Ref.F.1528

Food dump at TC13 after the explosion - facing inland.

Photograph No.105

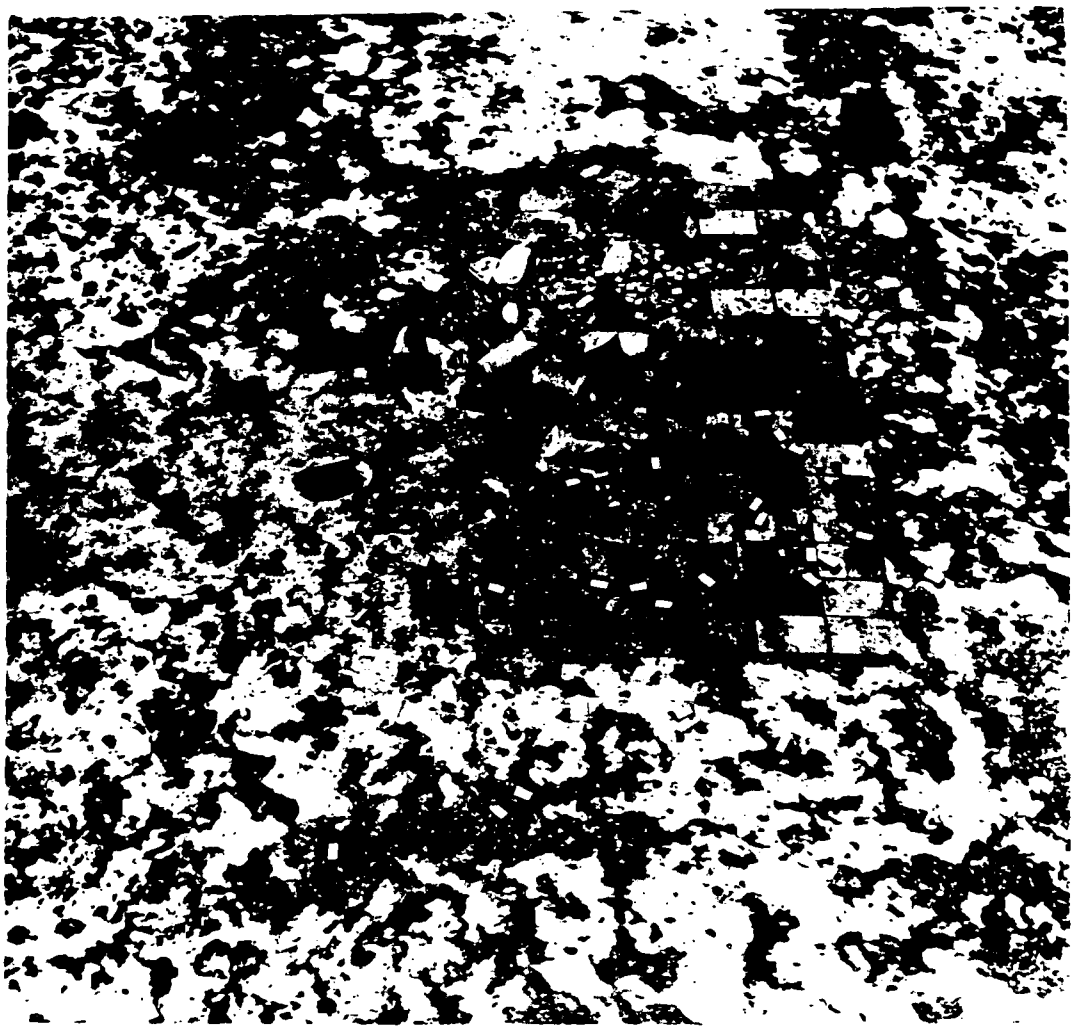
[redacted]

Ref.P.1530

Food dump at TC13 after the explosion - facing North.

Photograph No.106

Ref.P.149

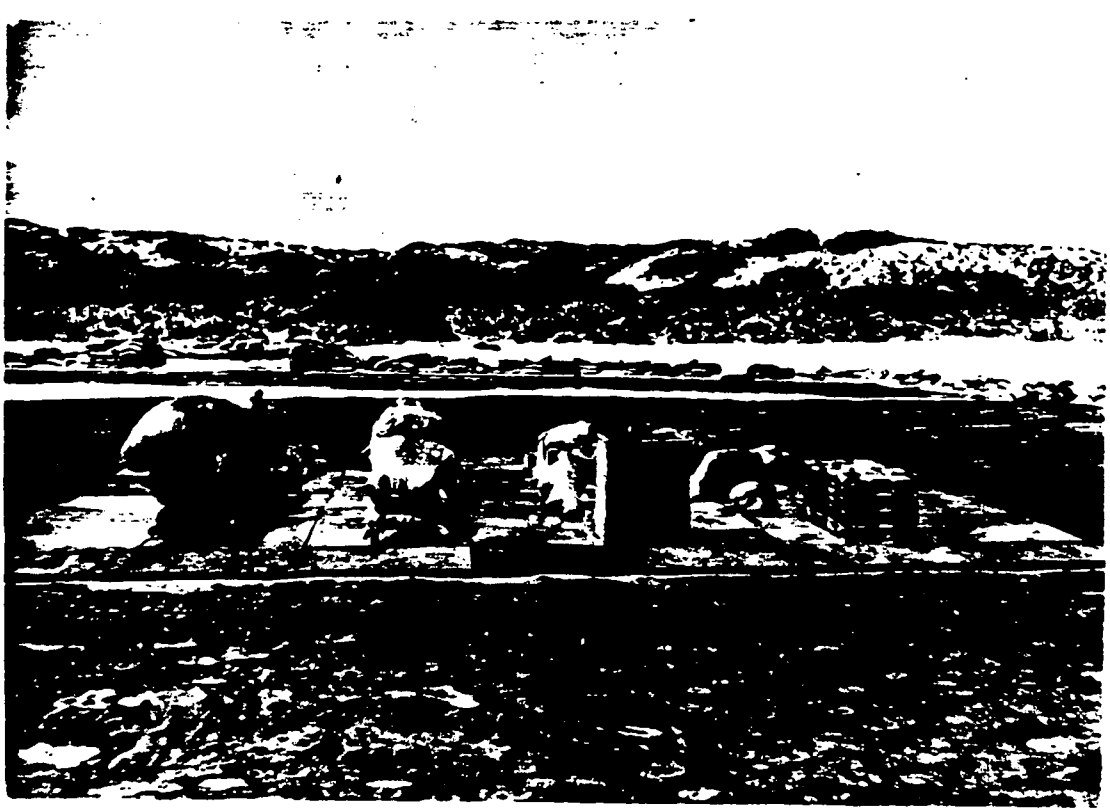


Food dump at TC13 after the explosion - from the air.

Photograph No.107 Ref.F.1540

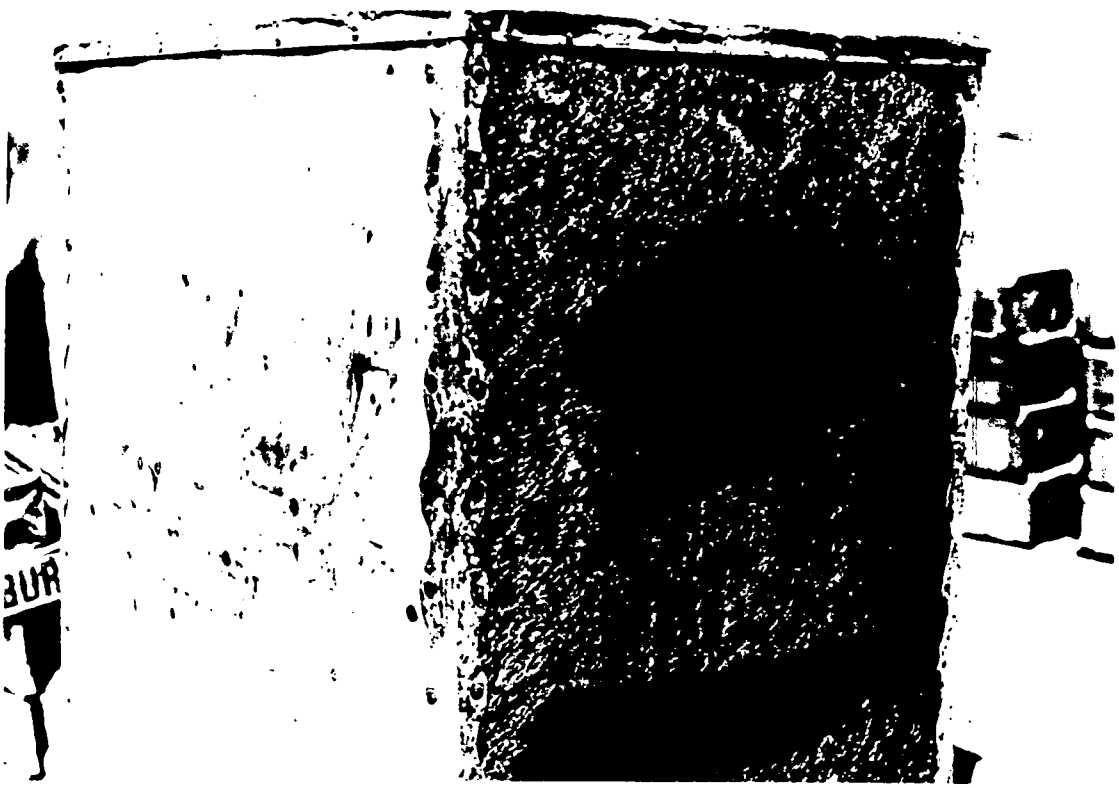
Burnt out tea chest from food dump at TC13.

Photograph No.108 Ref.F.1522



Food dump at TC15 after the explosion.

Photograph No.109 Ref.F.1524



Tea chest streaked with black fallout at TC14.