Type T Patch Code (New Document)

For use with Documents with Protective Markings up to and including
CONFIDENTIAL

Document UIN

4 0 0 0 1 8 0

PM 0 0

Caveat 0 0

NOTE: UK EYES ONLY (UKEO)
and other Caveats are
NOT PERMITTED.
Give document special handling.

Prepared By 1 9

Number of Sheets 0 0 7 1

Note: See coding sheet for Protective Marking (PM), Caveat and Prepared By codes.

For use with Documents with Protective Markings up to and including
CONFIDENTIAL

GUARDIAN 27 NOV 1997

Nuclear test 'victims' take Britain to court

Stephen Bates in Brussels

TWO British former servicemen who claim they were subjected to radiation during nuclear tests in the Pacific 40 years ago took their complaints to the European Court of Human Rights yesterday in the latest stage of a long-running attempt to win compensation from the Government.

Accompanied by 50 veterans from Britain, Kenneth McGinley, aged 59, from Paisley, and Edward Egan, 58, from Glasgow, were in Strasbourg to claim the tests had violated their lives and that they had been unable to gain redress through the British courts. Theirs is the key test case brought on behalf of the British Nuclear Test Veterans' Association, which is seeking up to £100,000 compensation for each of the survivors of the tests.

Mr McGinley and Mr Egan were among 22,000 servicemen and at least 1,000 civilians who witnessed the explosion of an 8-megaton nuclear bomb during tests on Christmas Island in winter 1957. They claim that during the tests servicemen were ordered to line up in the open, facing away from the explosions, but were given no protection apart from being ordered to keep their eyes shut for 20 seconds after the blasts.

"The heat was so tremendous I felt it burning my bones and a couple of days later I broke out in a bad rash, like many of the other men who received hospital treatment," Mr McGinley said. He claims the effects of the explosion made him sterile and caused arthritis, kidney and skin problems. Mr Egan, who was a naval rating on a nearby ship, blames the explosion for giving him lung problems.

No records exist of the levels of radiation which the servicemen experienced because monitoring film badges were only issued to the civilians present. Successive British governments have argued that the men were not exposed to harmful levels of radiation because they were too far away. The men and their association claim the exposure of servicemen was deliberate, to see how they would react.

In a further case heard yesterday by the court — before different judges — Lorraine Burns, aged 31, the daughter of a serviceman, claimed her infant leukaemia was the result of the Pacific tests, even though she was not born until eight years later. She claims the Government failed in its duty to inform her father of the risks.

Her claim has already been treated with scepticism by the court, which earlier this year stated there had been no violations of her human rights because there could be no proof that earlier diagnosis would have prevented the disease. But she was given leave to bring proceedings on her own behalf.

Mr McGinley and Mr Egan are complaining that non-disclosure to them of their medical records and other relevant documents deprived them of access to a pension appeals tribunal, which might have compensated them for the illnesses they now suffer. The men say their claims for war pensions were rejected because they could not produce medical records.

The Ministry of Defence says the records do not exist, although the Atomic Weapons Establishment at Aldermaston, Berkshire, has data from contemporary atmospheric tests in the area. Although those records are not public, the Government says they could have been produced for a pensions tribunal.

At an earlier hearing, the court decided that the men's case was admissable under the right to life clause of the European Convention of Human Rights, which the Government is in the process of enacting in British law.

A ruling is expected in the spring.

TIMES 27 NOV 1997

Atomic tests case

Three veterans of British atomic bomb tests in the Pacific and Australia in the 1950s who claim that radiation fallout affected their health took their case to the European Court of Human Rights yesterday. The Ministry of Defence denies any link.

F SIGS 927

(Rev 12/94)

Covering #

FACSIMILE TRANSMISSION COVER SHEET

TRANSMISSION DETAILS		DOCUMENT DETAILS	
Serial No:	Transmission Date: 20/11/97 Time: 16:00	Document Reference: D/ACSA(N)/15/8/5 Total number of pages including this cover sheet:	21
From: [redacted] Tel No: 0171 218 7379	Fax Number: 0171 218 7400	To: [redacted]	Fax Number: 583 9127
Authorised by: Rank, Name and Appointment XXTITLE INITIALS SURNAME		**Transmitted by:** Rank, Name and Tel No	
Signature:		Signature:	

Subject: NUCLEAR TEST VETS

[redacted] asked for some briefing material on Height of Burst and on Weather monitoring.

I am still expecting some input from AWE but have put together the attached. If the AWE material adds/changes what is said in any significant way I will send it or parts of it on Monday.

[redacted]

Covering #

NOTE ON HOB & WEATHER CONDITIONS(WIND DIRECTION)

HEIGHT OF BURST(HOB)

RECORDS

AWE information on HOB is limited but I attach (ANNEX A) the Grapple Z(Rounds 2 & 3) Aircraft & Armaments Group Report. I point you to para 3

> "The ballistic character of this weapon is well known and the ballistic prediction of burst height for a given delay time can be easily made"

The report does explain difficulties in being certain as to the aircraft altitude at time of release and their inability to achieve a required tolerance of +/- 500ft on HOB. A table of predicted and measured HOBs for the precursor and for the live drops is included in this annex, it shows that the RAFs prediction of HOB is close to the AWRE measured figure.

Also attached is the Grapple Z Photograhic Measurements Group Report (ANNEX B). This describes in general terms the camara set up for the determination of Position of Burst.

For Grapple Y I include a summary table of Position of Burst information (ANNEX C).

THE AIRCRAFT & CREW

From the classified official history "The RAF Strategic Nuclear Forces:their origins, roles and development 1946-1969" I first precis:

> The RAF crews were from 49 Sqd. a group specially established for this work which started training for the Grapple tests in Sept 56. Trial drops of inert weapons were conducted in the UK and training continued after they arrived in Christmas Island in March 57 for the initial Grapple tests. Prior to any of the live nuclear drop there were drops of identical weapons but with only a high explosives filling in order to test and demonstrate the whole system. The same group were used for Grapple X, Y & Z drops, the aircrew and aircraft returning to the UK between each operation. The same group had carried out the Buffalo 3 trial.

and quote:

> "The squadron ORB (Operational Record Book) records :
>
> "On the morning of April 28th the Grapple Y nuclear weapon was released visually from Valiant XD824, flown by Sqn Ldr [redacted] and crew. The bomb exploded at its planned height and position, and scientific records obtained therefrom confirm that the squadron once again accuratly fulfilled its committment in regards of this operation"

WIND DIRECTION

The document attached as ANNEX D is a letter from the Met Office to AWE in 1985 containing information they hold on weather conditions in the vicinity of Christmas Island at appropriate times to Grapple X,Y & Z.

It is clear that there was a meteorlogical station on the Island taking weather soundings by balloon and radar and that this information was combined with balloon gathered information obtained by RN & RNZN ships of the Grapple Task Force.

In para 4 of this Annex it records the determination of averaged winds at detonation height, for all shots except Grapple Y these are reported as westerlies. For Grapple Y these averaged winds, were at this low altitude,indicating winds blowing into the north west (towards the island) and for that reason were studied (at the time) in more detail, see para 5. In para 5 it is clear that at the altitude of detonation the winds were taking a more westerly direction parallel with the south west coastline and above that they were west south west in direction.

You may wish to note:

The fire ball/cloud containing a majority of the radioactive material would rise rapidly taking about 10 minutes to reach the tropopause noted to be at 16.3 km (boundry of stratosphere). The importance of this is that once in the stratospheric region the conditions are far more stable and the material is retained at these altitudes for months (typically anything up to 60 months) and circle the globe many times and trickle down as global fall out. Retention of material within the upper troposhere is still counted in terms of weeks. The rate and eventual height of rise is related to yield and therefore wind conditions are far more important in the two low yield (Z 2 & 3) shots. This is probably why the fall out from these two shots was tracked by aircraft (Annex 29 in the Memorial).

Enhanced fall out brought about by rainfall was a risk, this is often referred to as "rainout". Rain most usually arises from clouds up to about 30,000ft(9100m) and once the fire ball/cloud was above this level (as it was very quickly) only the radioactive material in the cloud stem could generate rainout. Wind direction from the rain cloud then had to direct the rain through the a lower altitude radioactive area and from their deposit itself on a inhabited part of the island. In an area of the world such as this with strong and persistant trade winds the probability of the right conditions arising was judged to be low for detonations in the planned places, the time of greatest risk was the three hours after detonation. The greatest worry was fall out from a nuclear explosion arising from an aircraft crash on take off (lower yield /ground burst/close to populated areas).

The bottom line is that T16/93 demonstrates that no significant fall out was found on the island.

ANNEX :- A

[redacted]

GZ/1/AA

Copy No. of Copies
Consisting of 3 Pages

OPERATION GRAPPLE-Z

INTERIM REPORT - ROUNDS 2 AND 3

PART 1. AIRCRAFT AND ARMAMENTS GROUP

Sqn.Ldr. [redacted]

Contents | Page

1.	Group Responsibilities	1
2.	Accommodation	1
3.	Narrative	1
4.	Conclusion	2
Appendix A	Burst Heights.	3

The members of the Group were:-

[redacted] Armt. Dept., R.A.E., Group Leader
" " "
Structures Dept., R.A.E.
" " "
M.E. Dept., R.A.E.
Instr. Dept., R.A.E.

Trials ~~Planning~~ Branch,
AWRE,
Aldermaston, Berks.

October, 1958.

[redacted]

OPERATION GRAPPLE-Z

INTERIM REPORT - ROUNDS 2 AND 3

PART 1. AIRCRAFT AND ARMAMENT GROUP

1. Group Responsibilities

The Group were required to undertake the following duties in connection with the air drop rounds.

1.1 Ballistic advice on the weapon.

1.2 Mechanical advice on weapon vehicle.

1.3 Provision of release units as required and advice on release gear.

1.4 Recording and analysis of aircraft flight conditions by means of auto observer.

1.5 Analysis of weapon release conditions by means of cameras fitted to the dropping aircraft.

1.6 Recording and partial analysis of records made of the aircraft's flight conditions during operational and other sorties.

1.7 Recording and partial analysis of weapon's effect upon the aircraft.

1.8 Scientific examination of the aircraft before and after operations.

1.9 Photographic records, in colour, of the explosion by means of cameras fitted to special Valiant tail cones.

2. Accommodation

The Group assembled on the island by the beginning of August, 1958, and, with members of HM Group, occupied the new building B18 on the airfield. Technical services were provided promptly as required and furniture and some fittings from R.A.E. were installed. The air conditioning and dust free atmosphere of the new building has been a great advantage and the benefits from its use are reflected in the high serviceability of equipment.

3. Narrative

3.1 No records have been lost during operational sorties and all are to be fully analysed at RAE.

3.2 Burst heights, given by Photographic Measurements Group, have shown a spread from 8000 ft. to 9440 ft and this is not considered satisfactory. The reasons for this variation are:-

[redacted]

[redacted]

(1) Variation of release height.

(2) Vertical velocity of aircraft at release.

(3) Small variation in delay times of G.W.H. Units.

(4) Small variations in weapon weights. Of these, (1) and (2) account for the greater part of the variation. (See Appendix A to this paper).

3.3 The ballistic character of this weapon is well known and ballistic prediction of burst height for a given delay time can easily be made. However, determination of accurate release height is not possible owing to the lack of suitable instrumentation.

4. Conclusion

For future trials of this kind, where burst is effected by a time delay, it is suggested that kine theodolites, or other suitable instrumentation, be provided in order to calibrate accurately the aircraft's radio and barometric altimeters, at the correct release height, at the start of each dropping sortie. In addition, it is suggested that during all practice bombing sorties in the UK by the selected pilots, rate of change of height be recorded during the run up. The records to be analysed and made available to the pilots in order that they can practise perfection in this very difficult part of flying technique required for nuclear trials. This could be done by means of a simple auto recorder containing only a slow running cine camera, a clock and a sensitive altimeter. Unless the above provisions are made before a future similar operation burst heights between the limits ± 500 ft cannot be predicted.

[redacted]

GZ/1/AA

Appendix 'A' to Interim Report Operation Grapple-Z Aircraft Armaments Group

Comparison of Corrected Theoretical and Measured Burst Heights

The Theoretical burst height computed for 10260 lb bomb released at 46000 ft at M = 0.76 in a tropical atmosphere typical of Christmas Island from an aircraft in level flight. Time fuse of 53.4 sec assumed. This uncorrected burst height was 8600 ft.

Corrections for small variations in aircraft speed, height, vertical velocity ($\dot{H}$), bomb weight and time fuse were applied to give the corrected theoretical burst height.

Round No.	Release Height (ft)	$\dot{H}$ ft/min	ASI (knots)	Bomb Weight (lb)	Corrected Theoretical Burst Height, (ft)	Measured Burst Height (ft) (PM Group)
F HE 1	46070	0	206	10435	8550	8480
F HE 2	45920	+ 150	205	10021	8730	Not observed
F HE 3	46330	0	206	9588	9120	9070
F Live	46220	+ 450	207	10048	9230	9440
H Inert	45780	0	205	10004	8300	Not measured by PM Group
H HE 1	45520	- 100	202	10235	8000	8000
H HE 2	45610	0	210	10180	8400	8500
H Live	45800	0	205	10360	8450	8660

Release heights, $\dot{H}$, airspeed, etc taken from auto-observer readings.

Annex B

[redacted]

[redacted]

GZ/9/PM

Copy No. of Copies
consisting of 6 Pages

OPERATION GRAPPLE-Z

INTERIM REPORT

PART 9. PHOTOGRAPHIC MEASUREMENTS

[redacted]

Contents

Contents		Page
1.	Group Tasks	1
2.	Methods	1
3.	Round 1 - Pennant	2
4.	Round 2 - Flagpole	3
5.	Round 3 - Halliard	4
6.	Round 4 - Burgee	5
7.	Further Analysis	6

The members of the Group were:-

[redacted] Group Leader
Deputy Group Leader

Trials Planning Branch,
AWRE Aldermaston,
Berks.

November, 1958

[redacted]

[redacted]

[redacted]

GZ/9/PM

1. <u>Group Tasks</u>

PM1 To estimate the yield of all rounds by measurement of the radius-time curve of the fireball.

PM2 To determine the position of burst for the H.E. practice air drops and for the live air drop.

PM3 To photograph the sea at ground zero for the live air drop round

PM4 An additional task for Round 4 was to photograph the weapon in the event of 'delayed' destruction being necessary, and to estimate the yield.

2. <u>Methods</u>

2.1 <u>Task PM1</u>

To estimate the yields of the weapons, high speed cameras were set up at A-Site (693137E 198618N), B-Site (702364E 194728N), K-Site (702450E 188337N) and directed towards the burst. For the balloon rounds the camera alignment was checked visually when the weapon cage was hoisted.

To determine any variation of image size throughout the useful fireball records, due to film movement or flap within the focal plane of the Fastax and Kodak cameras, a series of simple lens/focussing screen "box cameras" were accurately placed in a line at right angles to the line of burst at known distances apart, so that at least three were within the field of view of each high speed camera. The image of the fireball formed on these screens was recorded on the film in the Fastax and Kodak cameras. Measurement, by means of a travelling microscope, of the spaces between these minor images determines any variation of magnification from frame to frame.

To determine the true camera running speeds, time marker pulses were recorded on the film. The camera control and monitoring equipment was provided, installed and operated by CC Group.

2.2 <u>Task PM2</u>

For the two airdrops, Rounds 2 and 3, Position of Burst (P.O.B) cameras (simple lens shutter plate cameras) were placed at A, B and K sites and West Quadrant (693760E, 190468N). For the H.E. drops these sites were manned to vary exposure with time of day. A, B and K site camera shutters were operated at zero by a pulse supplied by CC Group. The West Quadrant camera was operated by hand. For the live round only A, B and K positions were used.

Statics were first taken, i.e. plates exposed to a light placed on a line from each camera to ground zero and as near as possible to ground zero; thereby giving position of burst on plates exposed on airdrops.

[redacted]

[redacted]

[redacted]

Ilford Ordinary plates were used:
½ sec at f.32 being the general exposure for H.E. Rounds,
1 sec at f.22 + neutral density 5·7 filter for the live round.

2.3 Task PM3

A Vinten 300 camera was placed at C-Site on the WM aerial tower and directed towards ground zero. A 1½ in. lens was used at f.8 with ND 1·8 filter and Ilford FP3 film.

The camera was started at -8 sec and was set to run at a speed of 200 fps, calibrated with a 250 c/s time marker.

2.4 Task PM4

For Round 4, to photograph the weapon in case of delayed destruction being necessary, two Fastax cameras were positioned at A-Site, directed to Point P and elevated 2° 5' and visually checked.

The focal length of the lenses was 254 mm. A ND 2·9 filter and f.10 was used on one camera for use in the event of a nuclear explosion occurring. The second camera was set at f.22 without a filter for use in the event of an H.E. explosion occurring.

The cameras were set to run at a nominal 5000 fps calibrated with time marker pulses at 1250 c/s and were started at 55.5 sec after zero, giving a starting time of -2.5 sec to destruction.

3. Round 1 - Pennant

3.1 Camera Data

Site	Camera	Elevation
B-Site	2 Fastax 2 Kodak 1 Vinten 300	5° 16'
K-Site	2 Fastax 1 Kodak	17° 13'

	Kodak	Fastax	Vinten 300
Focal length	63 mm	50 mm	3 in
f No.	10	8	8
Film	Pan F	Pan F	FP3
Filter	ND 2.9	ND 2.9	ND 2·13
Starting time	-1.5 sec	-2 sec	-8 sec
Time marker pulses	625 c/s	1250 c/s	312.5 c/s
Camera speed setting	3000 fps	10000 fps	200 fps

[redacted]

[redacted]

[redacted]

3.2 Results

3.2.1 Fireball Measurements

Three films were analysed; those from Kodak 1, K-Site, and Kodak 2 and Fastax 4 at B-Site. Time markers were almost obliterated by the dark background common to all records at K-Site. For the same reason the useful length of film was rather short and, in the absence of time-zero information from CC Group whose records were similarly spoiled, an appreciable time error may exist in taking the one record. A 'k' of 2.2 was indicated.

Fastax 4 gave a good long record with a 'k' of 2.17 indicated. Using time information from this record to adjust the record of Kodak 2, results in good agreement were obtained.

An air density of 1.16 g/litre was used and is probably only accurate to about 3% as insufficient data were available.

As a first approximation the value of 'k' was taken as 2.17, giving a yield of 23.2 kilotons ±8%

3.2.2 Calibration Lenses

Good images were obtained. The one record analysed (one frame of Fastax 4) gave a focal length of 51.2 mm against the engraved focal length of 51.1 mm.

4. Round 2 - Flagpole

4.1 Camera Data for Task PM1

Site	Cameras	Elevation
A-Site	4 Fastax (2 staggered by $2\frac{1}{2}^{\circ}$) 1 Kodak	10° 54'
B-Site	2 Fastax (staggered by $3\frac{1}{2}^{\circ}$) 2 Kodak 1 Vinten 300	12° 6'
K-Site	2 Fastax (staggered by $2\frac{1}{2}^{\circ}$) 1 Kodak	20° 30' 21° 7'

	Kodak	Fastax	Vinten
Focal length	63 mm	50 mm	3 in
f No.	8	8	8
Film	Pan F	Pan F	FP 3
Filter	ND 2.9	ND 2.9	ND 2·13
Starting time	-2.5 sec	-3 sec	-8 sec
Time marker pulses	625 c/s	1250 c/s	312.5 c/s
Camera speed setting	1500 fps	5000 fps	200 fps

[redacted]

[redacted]

[redacted]

4.2 Results

4.2.1 Fireball Measurement

Five films were analysed on site, those from Kodak 1, 2 and 4 (at K, B and A Sites respectively) and Fastax 1 and 3 (at K and B Sites).

Kodak 4 (A-Site) was so obscured by cloud as to make analysis impossible. This also applied to Fastax 3 (B-Site). Kodak 1 (K-Site) gave a good record and the value of 'k' indicated was 5.10. The fireball on the Fastax 1 record was nearly half cut-off due to the increased height of burst. However, up to about 20 milliseconds the figures obtained gave good agreement with those from Kodak 1.

Kodak 2 (B-Site) was partially obscured by cloud, the main effect being to reduce the density of the fireball image. A 'k' of 5.03 was indicated but this may contain a time error in locating first frame and is probably larger in any event as the outline of the fireball was very faint.

The two values of 'k' gave values for yield of 1.24 and 1.17 megatons respectively, using an air density of 0.870 g/litre, and a mean figure of 1.22 megatons is probably accurate to ± 5%

4.2.2 Calibration Lenses

These produced adequate detail, but no analysis was made on site.

4.2.3 Position of Burst for the Live Round

Only the plates from box cameras at A, B and K Sites were used in estimating position of burst and these indicated:-

135 ft Right of line
270 ft Undershoot } ± 75 ft

with approximate grid co-ordinates of:

696045 E
186380 N

Height of burst was 9440 ft ± 200 ft.

5. Round 3 - Halliard

5.1 Camera Data for Task PM1

Site	Cameras	Elevation
A-Site	4 Fastax (2 staggered by $2\frac{1}{2}^{\circ}$) 1 Kodak	11° 34'
B-Site	2 Fastax (staggered by $3\frac{1}{2}^{\circ}$) 1 Vinten 300	13° 53'
K-Site	2 Fastax (staggered by $2\frac{1}{2}^{\circ}$) 1 Kodak	21° 16'

[redacted]

[redacted]

[redacted]

GZ/9/PM

	Kodak	Fastax	Vinten 300
Focal length	63 mm	50 mm	3 in.
f No.	5.6	5.6	8
Film	Pan F	Pan F	FP 3
Filter	ND 2.9	ND 2.9	ND 2·13
Starting time	-2,5 sec	-3 sec	-8 sec
Time marker pulses	625 c/s	1250 c/s	312.5 c/s
Camera Speed Setting	1500 fps	5000 fps	200 fps

5.2 Results

5.2.1 General

All cameras ran as planned. The P.O.B. plates showed that cloud almost completely obscured the fireball record at K-Site and partly so at B-Site. One Kodak record from each of A and B Sites was processed together with one Fastax record from A-Site.

5.2.2 Fireball Measurement

Three films were analysed, from Kodak 2 (B-Site) and Kodak 4 and Fastax 6 (A-Site). At K-Site the event was almost entirely obscured by cloud. Adjustment of the record of Kodak 4, using time information from Fastax 6, gave a value of 'k' of 4.57. Kodak 2 agreed almost exactly and the best provisional estimate of yield is thus 0.75 Mton.

5.2.3 Position of Burst

Owing to cloud cover at K-Site, high speed records (Kodak 2 and 4) were used in addition to the plates for estimating the position of burst. There also seemed to be a vertical movement of the fireball whilst it was still of sufficient luminosity to record on the plates.

Position of Burst	330 ft Right of line 690 ft undershoot	± 75 ft
Approximate Coordinates	695955 E 186490 N	
Height of burst	8660 ft ± 150 ft	

6. Round 4 - Burgee

6.1 Camera Data for Task PM1

Site	Camera	Elevation
A-Site	2 Fastax 1 Kodak	2° 5'
B-Site	2 Fastax 2 Kodak 1 Vinten 300	5°16'
K-Site	2 Fastax 1 Kodak	17° 13'

[redacted]

[redacted]

[redacted]

GZ/9/PM

	Kodak	Fastax	Vinten 300
Focal length, A-Site	102 mm	254 mm	-
Focal length, B and K Sites	63 mm	50 mm	3 in.
f No.	5.6	6.3	8
Film	Pan F	Pan F	FP 3
Filter	ND 2.9	ND 2.9	ND 2·13
Starting Time	-1.5 sec	-2 sec	-8 sec
Time marker pulses	628 c/s	1250 c/s	312.5 c/s
Camera speed setting	3,000 fps	10,000 fps	200 fps

A-Site was used on this round to supplement K-Site in the event of loss of records by fogging from gamma radiation.

Because of lack of time, the system of simple lens/focussing screen box cameras, used to determine variation of image size from frame to frame, was not erected at A-Site.

The Position of Burst cameras used for the airdrop were operated from A, B and K Sites to determine any great change of weapon position at zero.

6.2 Results

6.2.1 General

All cameras ran as required. One Kodak record from each of A, B and K Sites were processed, together with one Fastax record from B-Site. The record from K-Site was heavily fogged by gamma radiation, but measurements were able to be taken.

6.2.2 Fireball Measurements

Films were analysed from Kodak 1 (K-Site), Kodak 2 and Fastax 3 (B-Site) and Kodak 4 (A-Site). In the absence of theodolites to observe the cargo movement during the pre-burst period, it was assumed that the cargo was over Point P. Movement of up to 20 yards would not be significant at B-Site (and hence A-Site) but would be at K-Site. However, to obtain comparable accuracy at K-Site, cargo movements of less than 10 yards would have to be detected and this is not within the scope of the cameras as situated.

The record of Kodak 2, corrected for time from the information of Fastax 3, gave a 'k' of 2.21. Kodak 4 gave the same value at approximately the same time (20 milliseconds). Using an air density of 1.125 gms/litre the yield was calculated to be 24.5 kton.

The record of Kodak 1 (K-Site) was considerably fogged by radiation, thus giving an indistinct record and only a short, usable length of film. The 'k' indicated was 2.17, corresponding to 22.7 kton yield.

7. Further Analysis

Further work is required to complete the analysis together with calculations of the variations of focal length between frames and true running speed of the films. The films not developed on site were returned to AWRE Aldermaston for analysis.

[redacted]

Annex C

GY/19/POR

OPERATION GRAPPLE-Y

PART 19. BURST POSITION OF HE AND LIVE ROUNDS

Round	Date	A/c No.	Captain	Type of Run	POB Cameras			Quadrant			Plotting Table		Remarks
					Line (ft)	Range (ft)	Height (ft)	Line (ft)	Range (ft)	Height (ft)	Line (ft)	Range (ft)	
GY - HE1	14.4.58	824	[redacted]	Visual	Poor intersection on 2 adjacent cameras				Not taken		700 R	600 +	
GY - HE2	16.4.58	824	[redacted]	Blind	3000 R	10200 +	8600		Not taken		500 R	7900 +	Incorrect settings made in table parallaxes. Release approx. 12 sec late.
					Figures approximate only - poor intersection								
GY - HE3	19.4.58	822	[redacted]	Visual	50 R	150 -	8450	50 R	800 +	8730	50 L	300 +	
GY - HE4	22.4.58	824	[redacted]	Blind	Cloud obscured 3 cameras			800 R	400 -	8000	100 R	450 +	If height bracket assumed the one result from POB cameras gives line and range error less than 1200ft
GY - HE6	25.4.58	824	[redacted]	Blind	200 R	200 +	8100		Not taken		Within 300 ft of target		
GY - W	28.4.58	824	[redacted]	Visual	100 R ± 70	750 + ± 70	7720 ± 200		Not taken		Not taken		Time of Burst: 19.05 07.5 GMT 10.05 07.5 Local (W)

Notes:

1. R = right of Line: L = left of Line
2. + = Range overshoot: - = Range undershoot
3. Position of Burst of Round GY - W expressed in:
   Coordinates: E 596137.6
   N 186089.0
   Lat. and Long. 1° 40' 57½" N ± 1"
   157° 14' 13" W ± 1"

Trials Planning Branch,
A.W.R.E.,
Aldermaston,
Berks.

June, 1958.

ANNEX D

[redacted]

(21)

METEOROLOGICAL OFFICE Met O 9 Room 118
London Road Bracknell Berkshire RG12 2SZ
GPTN 8234
Telex 849801 Telephone 0344 (Bracknell) 420242 ext 2309

[redacted]
AWRE Building [redacted]
Aldermaston
Reading
RG7 4PR

15 NOV 1985
S.F.S.

Please reply to The Director-General
Your reference
SFS/A/26(MET O)
Our reference
D/Met O 9/16/2/3
Date
13th November 1985

WEATHER AND WINDS DURING CHRISTMAS ISLAND NUCLEAR TESTS

1. Thank you for your letter of 2 October 1985. [redacted] has moved to the Met Research Flight, RAE Farnborough and [redacted] is the new AD Met O(SI). We have a considerable amount of meteorological data for Christmas Island for the period of the nuclear weapon tests of 1957-58. There are hourly surface observations (Daily Register of Met Observations, Form 2050, 4 volumes) at 2° 00'N 157° 23'W including rainfall, 6-hourly upper winds and 12-hourly upper temperatures (Upper Air Data, Christmas I, F3458, bound, 2 volumes). In addition, we have the 'recco' reports from the low-level Shackleton and high-level Canberra aircraft, giving detailed cloud and wind information.

2. The rainfall recorded at the above site on the day of each explosion and the next three days is given in Appendix 1. In the 12 hours after each detonation, rain occurred only on 8 November 1957 and 22 August 1958, and then only as light showers, although there is always the possibility that heavy showers fell elsewhere. From August to November the weather is fairly dry, but April is normally wet, and there had been heavy showers earlier in April 1958. Irregular rainfall reports from Air Traffic appear to have been made only in November 1957, not at later tests, and were recorded in pencil in the Daily Register.

3. Appendix 2 lists the upper winds from 900 to 100 mbar measured at Christmas Island up to 24 hours after each explosion, also the heights, temperatures and humidities for the first sounding made afterwards. Soundings often reached 20 mbar, about 26 km.

4. All radio-sonde and radar-wind ascents for the time of the test and up to 24 hours later were examined. The 1, 1.5 and 2 km winds were meaned to obtain the low-level flow for detonation at 2.4 km, and the 1 km wind was used for those at 0.45 km (the only lower wind in the official record is the surface wind at 12 m above ground level, which may not be representative of the higher flow). A graph was plotted of these winds for 0, 6, 12 and 18 hours after each detonation. Directions varied from 082° to 109°, and speeds from 9 to 28 knots, except for the period up to about 9 hours after the test at 1905 GMT on 28 April 1958 when winds were light, and near to being southeasterly (135°). Since the airfield and camp were almost due north-west from the explosion, the winds on this occasion were examined in more detail.

21 cont.

5. The following are details of the ascents 7 hours before and 6 hours after the explosion on 28 April 1958, together with the winds only 1 hour afterwards:

Detonation 19·05Z

	1230Z 28th				2000Z	0100Z 29th			
Press. mbar	Ht m	Wind °/kt	Temp °C	RH %	Wind °/kt	Ht m	Wind °/kt	Temp °C	RH %
1007	surf.	calm	26	95	130/09	surf.	121/08	30	81
900	988	136/10	21	85	130/10	983	124/08	21	93
850	1480	133/09	18	62	140/12	1477	133/07	18	80
800	1997	127/10	15	84	130/13	1995	118/10	16	82
700	3110	109/16	8	76	120/19	3113	118/13	11	32
600	4380	085/33	2	59	080/17	4385	103/15	4	32
500	5837	049/16	-6	49	030/20	5843	043/20	-4	72

The wind-finding ascent at 2000 GMT was extracted from a time-section chart drawn by the Meteorological Office. Each ascent reached 20 mbar (26 km) but high-level values have not been listed here (the tropopause was at 16.3 km, temperature -80°C and the strongest winds were easterly 60 knots near the top of the ascent at 20 mbar).

The surface winds recorded (probably 15-second averages) were:

28.	1755Z	160/08 kt		2200Z	150/08	0200Z	090/08
	1935Z	170/07		2300Z	080/10	0252Z	090/11
	1956Z	130/09		2353Z	070/10	0358Z	100/06
	2057Z	140/08	29.	0058Z	060/09	0459Z	110/06

6. There is a discrepancy between the surface winds reported at 01 GMT at the radio-sonde and surface stations, the latter showing winds backed north of east between 23 and 02 GMT, but the mean surface wind during the 2 hours after the explosion (19-21Z) was 140° 8 kt, from the south-east, during which the mean layer wind at 1, 1.5 and 2 km was about 130° 11 kt with variations in direction of $\pm 10°$. Assuming particles were released at 2.4 km, 22.3 n miles to the south-east of the camp (direction about 142°), it appears that those with fall speeds of about 1/3 m/s could have reached the camp at 2100 GMT (1200 local time). Heavier particles released from the thermonuclear cloud at greater altitudes could have arrived at the camp later.

7. Lighter paticles could only have been deposited at the camp by being washed out in precipitation, and there is no evidence of that, although precipitation reaching the surface in a shower possibly caused by the bomb was observed more than 5 km away at 2057Z (2 hours after detonation), presumably but not definitely to the south-east. Visibility at the hourly observations was always reported as a nominal 40 km. Low cloud cover was 5/8 base 2000-2500 ft at 21Z, becoming 3/8 cumulus, base 2500 ft at 22Z.

8. Upper wind soundings were also made from two ships at 28, 1800Z and 29. 0000Z. HMS 'Ulysses' ('North Ship') was at 3.0°N 155.7°W at midnight, while the Royal New Zealand Navy ship 'Pukaki' ('South Ship') was at 1.5°N 156.0°W. The winds were as follows (°/kt):

(21 cont)

Thousands of feet	North Ship 1800Z	North Ship 0000Z	South Ship 1800Z	South Ship 0000Z
surf.	-	-	-	-
1	140/03	140/08	070/09	090/15
2	140/11	130/10	070/09	090/15
3	140/15	130/13	080/11	100/15
4	130/18	120/13	080/13	100/15
5	130/12	120/13	080/15	110/16
6	130/09	120/09	080/15	110/15
7	130/11	110/09	080/15	120/14
8	130/17	110/07	100/15	120/13
9	130/15	110/08	100/14	120/12
10	120/14	100/06	110/14	120/12
15	080/22	090/13	120/20	110/13
20	040/16	050/21	060/18	050/14

The 'North Ship' shows winds similar to Christmas Island, approximately 130/12 up to 8000 ft but 'South Ship' is well backed at 090/14. Surface observations from the ships have not been found at Bracknell, though some would be plotted on charts.

9. I hope the rainfall and upper wind data given in the appendices, and copies of original data (for 28 April 1958 only), will enable you to check the possibility of radioactive contamination. Please contact me if you require further data.

[redacted]

22

Appendix 1

Rainfall at Christmas Island met station during and after nuclear tests

Local time (V) is 9 hours slow of GMT (Z)

1. 1747Z 8 November 1957

(08.1447-1505Z Light shower (trace))
(1645-1702Z Light shower (o.1 mm))
09.0010-0015Z Light shower (tr)
1548-1645Z Light shower (1.3 mm) Rain at Air Traffic 4.2 mm
1746Z Shower to east
10 No rain
11 0433-0445Z Light shower (tr)

2. 1905Z 28 April 1958 Y

(28.1427-1436Z Moderate shower (0.3 mm))
2057Z Precipitation in sight, more than 5 km from station, reaching surface. Cumulonimbus from bomb
29 No rain
30 1050-1102Z Light shower
1120-1125Z Light shower (tr)
1140-1153Z Moderate shower (2.0 mm) Rainfall 09-12Z 2.0 mm
1540-1605Z Moderate/light shower (0.3 mm)
31 No rain

3. 1800Z 22 August 1958 Z1 25kt Balloon

(22.0935-1020Z Light shower becoming intermittent light rain after 1005Z. Rainfall 09-12Z tr)
1745Z Precipitation in sight, more than 5 km from station, reaching surface, to east and south-east.
1801-1805Z Light shower (tr)
2340-2352Z Light shower (0.3 mm)
23.0810-0813Z Light shower (tr)
1036-1037Z Light shower (tr)
24.0505-0510Z Light shower (tr)
25 No rain

4. 1724Z 2 September 1958 Z2

(02.1255Z Precipitation in sight, more than 5 km from station, reaching surface. Line of large cumulus to south giving a shower.)
03 No rain
04 No rain
05.0125-0128Z Light shower (tr)
1250-1255Z Light shower (tr)
1352-1404Z Light shower (0.2 mm)

5. 1748Z 11 September 1958 Z3

No rain 11th - 14th inclusive

6. 1759Z 23 September 1958 Z 4 25kt Balloon

No rain 23rd - 26th inclusive.

23

Appendix 2

Christmas Island upper air data up to 24 hours after nuclear tests

9X

1. 1747Z 8 November 1957

mbar	12Z 8th °/kt	23Z 8th °/kt	06Z 9th °/kt	12Z 9th °/kt	H m	T °C	RH %	18Z 9th °/kt
~1007	100/08	100/12	091/10	091/08	-	28	74	100/12
900	100/18	094/21	088/23	091/22	988	20	87	094/24
850	094/19	100/22	088/23	091/25	1481	18	73	085/26
800	094/22	103/25	088/22	091/22	2003	18	40	088/25
700	091/24	100/16	112/16	118/13	3132	11	61	127/12
600	100/15	100/12	124/10	118/10	4403	4	50	112/12
500	064/14	082/11	091/13	103/13	5867	-4	49	106/04
400	229/09	271/08	256/08	247/13	7599	-14	43	241/13
300	271/14	115/06	172/07	190/07	9720	-29	61	109/09
250	019/12	034/21	052/18	052/18	10990	-39	-	070/16
200	349/09	007/12	010/15	034/08	12480	-51	-	292/06
150	271/09	295/07	319/10	271/14	14290	-65	-	307/14
100	229/12	238/24	-	283/16	16660	-82	-	289/19

9Y

2. 1905Z 28 April 1958

mbar	12Z 28th °/kt	20Z 28th °/kt	01Z 29th °/kt	H m	T °C	RH %	08Z 29th °/kt	17Z 29th °/kt
~1007	000/00	130/09	121/08	-	30	81	100/08	091/06
900	136/10	130/10	124/08	983	21	93	106/13	085/14
850	133/09	140/12	133/07	1477	18	80	103/13	076/15
800	127/10	130/13	118/10	1995	16	82	103/11	076/16
700	109/16	120/19	118/13	3113	11	32	103/11	076/15
600	085/33	080/17	103/15	4385	4	32	079/14	085/13
500	049/16	030/20	043/20	5843	-4	72	049/22	046/22
400	082/09	070/10	079/12	7570	-13	17	058/13	067/16
300	079/21	080/18	061/16	9690	-29	18	085/20	076/26
250	049/27	080/21	055/17	10980	-38	20	079/19	076/21
200	025/27	030/27	022/22	12480	-51	-	031/11	295/10
150	133/03	240/04	283/05	14290	-64	-	292/08	280/12
100	259/25	280/13	283/22	16680	-77	-	280/19	259/18

23 cont.

GZ1

3. 1800Z 22 August 1958

mbar	19Z 22nd °/kt	H m	T °C	RH %	00Z 23rd °/kt	06Z 23rd °/kt	12Z 23rd °/kt	18Z 23rd °/kt
~1009	121/10	-	27	78	100/12	121/09	121/09	110/07
900	100/24	1010	19	88	106/28	103/24	109/20	Nil
850	091/23	1499	16	86	097/28	097/27	106/22	
800	082/23	2017	16	64	088/26	091/25	094/22	
700	082/23	3138	10	54	082/24	079/24	067/24	
600	073/17	4404	4	22	073/15	091/18	094/17	
500	085/13	5858	-7	18	064/13	067/15	058/18	
400	163/07	7575	-16	11	157/11	172/11	163/12	
300	049/19	9670	-34	11	052/18	064/14	073/15	
250	049/19	10920	-44	-	034/13	343/14	331/13	
200	301/20	12390	-53	-	286/28	301/23	298/17	
150	280/19	14190	-66	-	283/20	292/23	286/26	
100	046/06	16550	-81	-	016/06	280/03	271/08	

GZ2

4. 1724Z 2 September 1958

mbar	12Z 2nd °/kt	18Z 2nd °/kt	H m	T °C	RH %	00Z 3rd °/kt	12Z 3rd °/kt	18Z 3rd °/kt
~1009	121/03	090/07	-	27	74	109/09	000/00	120/07
900	106/22	106/20	1005	20	70	103/21	115/19	Nil
850	085/21	097/20	1496	16	76	100/20	106/21	
800	076/19	088/18	2012	16	54	091/18	097/18	
700	076/20	064/14	3142	11	57	064/15	085/17	
600	070/14	076/11	4409	5	23	082/12	034/14	
500	085/22	076/16	5866	-7	28	079/15	079/15	
400	109/22	115/24	7583	-13	17	112/24	106/25	
300	145/25	109/15	9710	-29	14	091/13	070/12	
250	094/13	076/12	10990	-39	-	106/10	058/20	
200	070/22	058/31	12470	-51	-	067/25	064/25	
150	022/17	034/12	14280	-67	-	085/11	085/07	
100	130/07	139/09	16610	-82	-	349/06	073/07	

23 cont.

5. 1748Z 11 September 1958

9Z3

mbar	12Z 11th °/kt	00Z 12th °/kt	06Z 12th °/kt	12Z 12th °/kt	H m	T °C	RH %	18Z 12th °/kt
~1011	000/00	121/06	121/05	000/00	-	23	91	120/02
900	112/06	127/10	106/14	091/12	1008	20	48	Nil
850	076/05	103/10	070/11	076/12	1504	19	37	
800	073/14	091/12	067/10	082/09	2024	17	28	
700	097/11	091/09	100/07	091/11	3152	11	26	
600	064/15	073/16	100/15	100/16	4417	2	44	
500	115/27	067/13	061/15	055/19	5864	-7	35	
400	094/37	100/39	112/35	109/37	7568	-18	31	
300	097/33	076/32	079/33	079/40	9670	-28	27	
250	094/30	064/38	073/44	067/51	10940	-40	27	
200	061/43	082/47	070/55	052/45	12430	-53	22	
150	073/52	091/44	070/64	076/53	14230	-67	-	
100	109/15	031/13	028/11	076/12	16590	-78	-	

6. 1759Z 23 September 1958

9Z4

mbar	12Z? 23rd °/kt	18Z 23rd m	T °C	RH %	00Z 24th °/kt	12Z 24th °/kt	18Z 24th °/kt
~1011	100/05	-	29	77	109/15	130/07	120/09
900	070/21	1032	19	80	109/20	106/13	Nil
850	067/20	1523	16	87	100/21	091/18	
800	088/18	2039	15	57	097/19	091/25	
700	100/23	3161	9	56	094/20	085/29	
600	097/26	4464	0	67	088/31	076/35	
500	067/28	5955	-6	23	097/28	079/30	
400	076/26	7668	-17	17	097/21	121/18	
300	049/20	9760	-34	15	166/12	178/22	
250	034/17	11010	-43	-	181/21	193/16	
200	004/06	12480	-55	-	208/19	229/17	
150	-	14260	-69	-	199/14	262/10	
100	-	16580	-83	-	271/12	073/11	

UNCLASSIFIED

Unclassified

[redacted]

[redacted] 05/6

S. S. H. P.,
Building [redacted]

4/4/67

Outlying Sampling Programme on Grapple Y and Z

UNCLASSIFIED

The results are briefly summarised below:

1. Honolulu

On Honolulu depositions of the order of 500 $\mu\mu c/m^2$ or more have been detecte almost daily. The level of activity in the rainwater is in the order of 4×10^{-7} $\mu c/ml$.

2. Kwajalein

In Kwajalein when U.S. tests are in progress on the neighbouring islands, th levels of activity fluctuate violently. During Grapple Y the activity in one shower of rain was as high as $1500 \times 10^{-7} \mu c/ml$. From April to September the daily deposition is in the order of 1000 $\mu\mu c/m^2$ with several extremely high depositions. During May the detectable activity would give a γ dose equivalent to 24% of the annual natural background if no correction was introduced for shielding, weathering, etc.

3. Honolulu and Kwajalein are by far the most active stations. On the remainde it is usual for no activity to be detected on the sticky papers and only slight activity to be detected in the air and rainwater samples. There have been occasional exceptions to this.

4. Canton

Canton on 30th April and 2nd May had fallout for Grapple Y in rain to the order of $14 \times 10^{-7} \mu c/ml$. A deposition of the same order occurred on 24/25th September, probably from Pendant.

5. Samoa and Aitutaki

Samoa on 1st August received 10,000 $\mu\mu c/m^2$ and Aitutaki on 3rd August received 15,000 $\mu\mu c/m^2$. These almost certainly arose from U.S. tests. These depositions represent less than 1% of the annual natural background.

6. Malden, Penrhyn and Fiji

In these islands no deposition of note has occurred.

7. Fanning.

On Fanning regular depositions of the order of 300 $\mu\mu c/m^2$ occurred after eac of the Grapple Z shots for two or three days.

8. Christmas

Christmas had if anything less activity deposited on it than any station, the only notable deposition occurred on 10th July when the level was 16,000 $\mu\mu c/m^2$.

9. Fish

No active fish have been found.

UNCLASSIFIED

/10.

[redacted]

UNCLASSIFIED

10. Sr^{90}

No estimation of the Sr^{90} deposited has been made.

11. Summary

It would appear that from all tests in the period April - September 58 the gamma dose delivered in one year as a percentage of the natural background was insignificant at all stations except Kwajalein and Honolulu. The heavy depositions which occurred elsewhere were confined to a few days in each instance and made no significant contribution.

[redacted]

Building [redacted]
A.W.R.E.,
Aldermaston.

13th November, 1958.

Activity of fission products 20y after a fission burst of 1kT

Take 1kT ~ 1.47×10^{23} fissions

$$\text{Activity @ 20y} = \frac{N_o \times 0.693 \times 1.47 \times 10^{23} \times e^{\left(-\frac{0.693 \times 20}{T_{\frac{1}{2}}}\right)}}{100 \times T_{\frac{1}{2}} \times 3.155 \times 10^{7} \times 3.7 \times 10^{10}}$$

3.155×10^7	=	no of secs in a year
3.7×10^{10}	=	dps/ci
$T_{\frac{1}{2}}$	=	half life in years
N_o	=	fission yield %

$$\therefore \text{Activity} = \frac{873\ N}{T_{\frac{1}{2}}} \exp\left(-0.693 \times 20/T_{\frac{1}{2}}\right)$$

	$T_{\frac{1}{2}}$(y)	N_o %	$873\ N/T_{\frac{1}{2}}$	exp	Λ(Ci)	%
Se-79	6.54	0.066	8.8	0.12	1.06	0.31
Kr-85	10.6	0.13	10.7	0.27	2.89	0.84
*Sr-90/Y-90	28.9	2.14	129	0.619	79.9	23.1
Tc-99	2.1×10^5	6.1	0.025	1	0.025	0.007
Ru-106	1.0	4.64	4.05×10^3	10^{-6}	–	
*Sb-125/Te-125m	2.7	0.128	82.7	0.0059	0.49	0.14
*Cs-137/Ba-137m	30	6.83	398	0.63	251	72.5
Pm-147	2.6	2.05	688	0.0048	3.32	0.96
Sm-151	90	0.88	8.54	0.857	7.32	2.1
Eu-154	16	7×10^{-4}	3.8×10^{-2}	0.42	0.016	0.005
Eu-155	1.7	0.25	1.3×10^2	2.9×10^{-4}	0.037	0.011
					346	100

a max because Sr + Cs fractionated ∴ only a few Ci

* Factor of 2 included to allow for daughter activity

The best estimate we can make from aircraft contamination measured in a variety of shots is that surface contamination is about 5.10^{17} fissions per shot per aircraft. It can be shown readily that this would now be about 1 millicurie. In reality, the aircraft were deliberately flown through heavy rain-clouds over the sea and not a great deal would remain to be washed off locally. A fair guess is that at present date the range would be 0.1 to 1 millicurie per aircraft per shot, probably near the former. This suggests a few millicurie of activity in total would be involved, practically all Cs-137/Ba-137m and Sr-90/Y-90. No aircraft engines were decontaminated at Edinburgh field. These are well-known from civil aircraft flights during the period of extensive atmospheric testing in the early 60s to collect substantial amounts of activity and the problem posed by the short exposures in trials would not in any case have represented an unusual hazard after decay.

100-200g Pu max release

AERIAL SURVEY CHART.

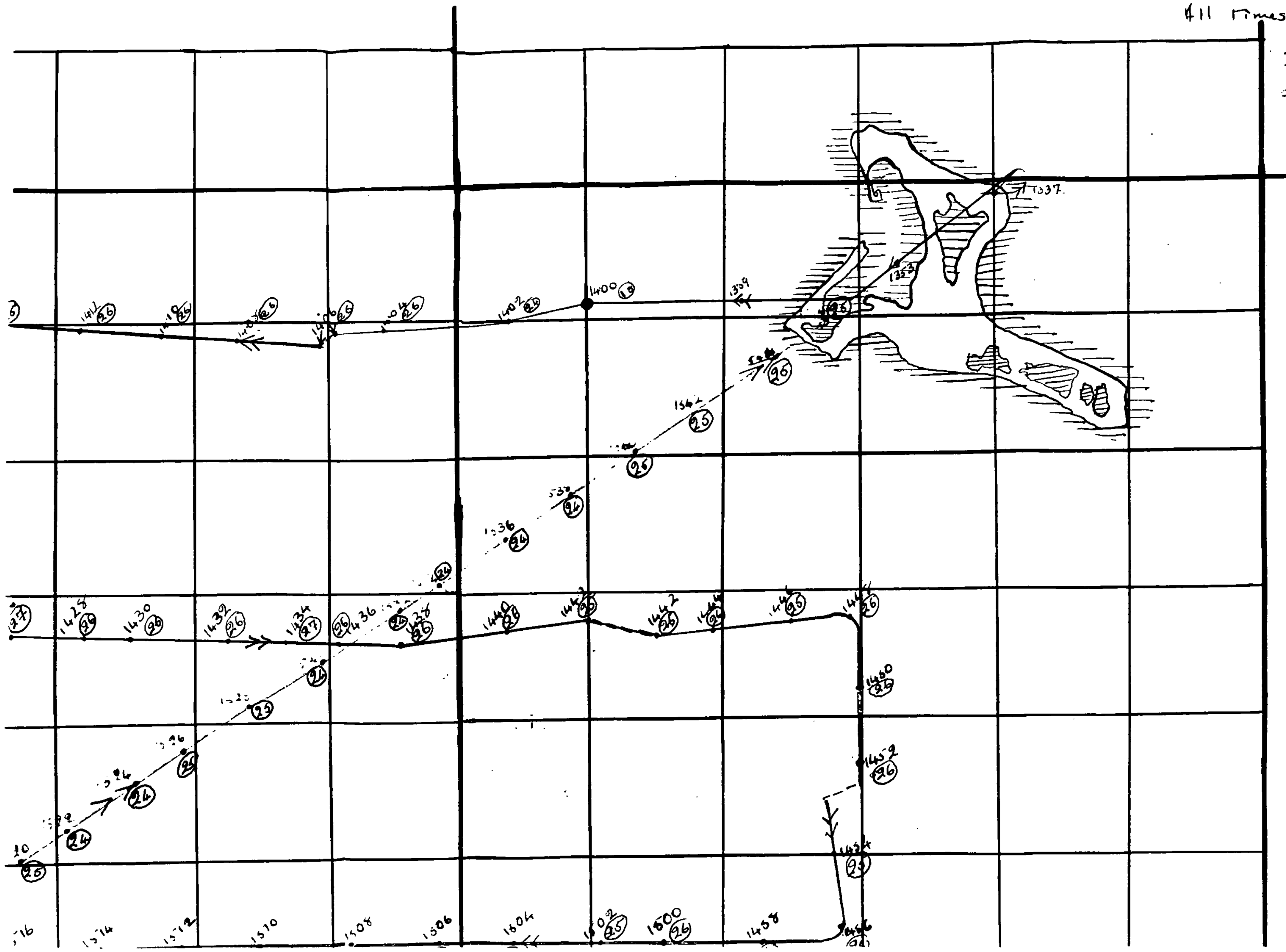
GRAPPLE Y. D.DAY +1

TAKE OFF TIME 1337 local 29/4/

START OF SURVEY 1400 local 01°51'N, 157°50W

SCALE 1:500,000

All times are local

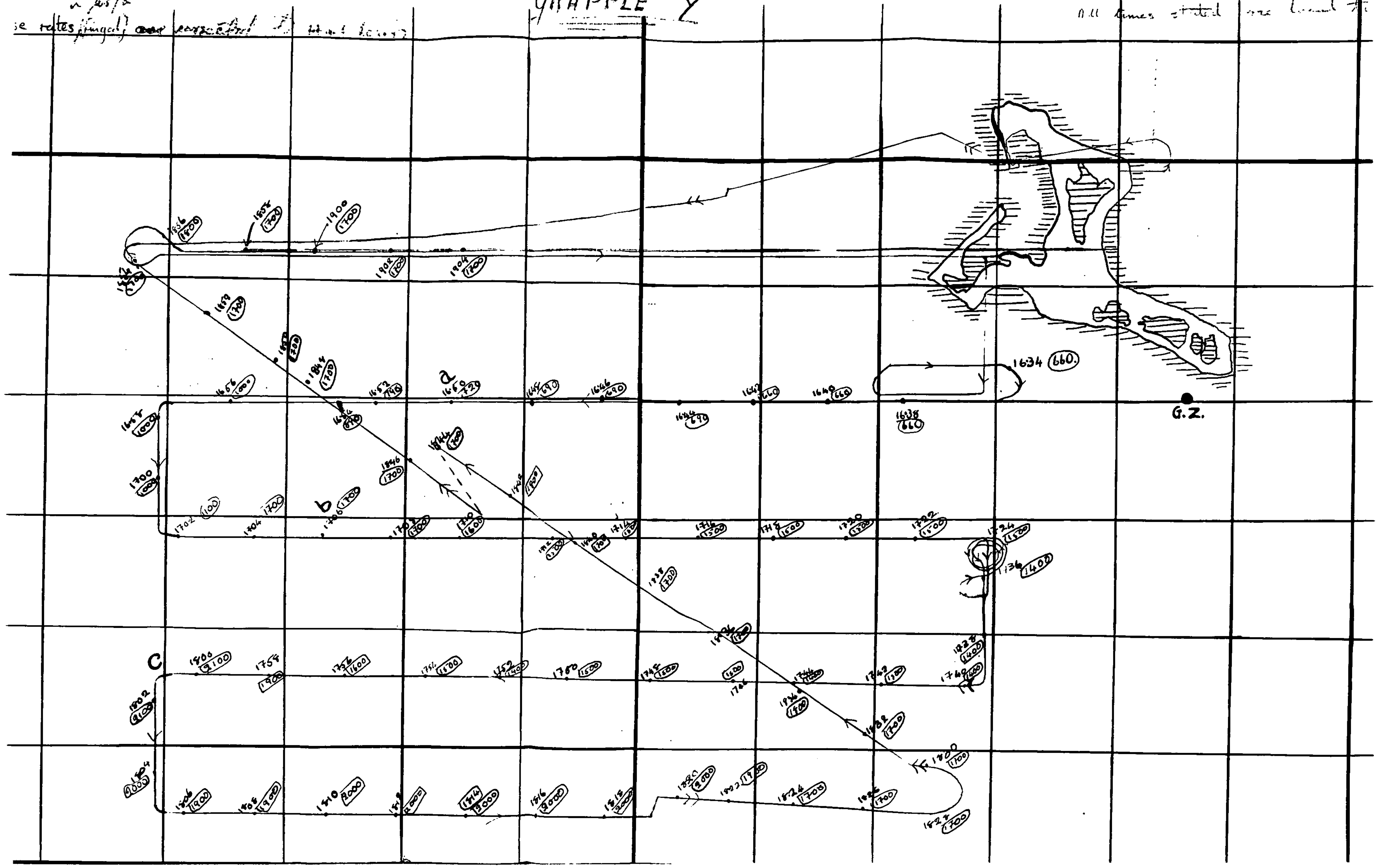


SCALE

Aerial Radiological Survey

GRAPPLE "Y"

Survey made 28-4-58.
Take off 5.29 Local
All times stated are local



ATOMIC WEAPONS ESTABLISHMENT
Aldermaston, Reading RG7 4PR
Telephone 0734 814111
FAX No. 0734 815320
GTN Dialling Code: 1425

Bldg. No. [redacted]
Ext: 7496 (Direct dialling 01189 827 496, direct fax 01189 824 813)
Our Ref: AWE/HPRK/HEG/SN9750
Your Ref:

Date: 19 November 1997

RESTRICTED

[redacted]
Sc(Nuc)2 Room 2261
MoD Main Building
Whitehall
London SW1A 2HB

Dear [redacted]

This is in reply to your fax of 14th November re planning and HOB's at GY and Z.

I enclose copies of all the relevant documents that I can find.

Design of vehicles and fusing for GRAPPLE trial devices was the responsibility of RAE; they might be able to dig out something. Service BD had radar fuses (duplicated for reliability) but they were unreliable and time functioning seems to have been used for all megaton trials. It seems that BD could not use barometric functioning as its maximum speed was too high and compressibility interfered with the barostats. YS had barometric fusing, but it had a different aerodynamic shape to limit maximum airspeed. (YS was of course never dropped at Christmas Island, though it would have been dropped from a Vulcan at GRAPPLE M in 1959 had not the Moratorium intervened). See page 243 of the RAF Strategic Forces history.

NB I think the above para is unclassified!.

Fuses and circuitry were proved by an intensive program of ballistic and HE telemetry trials over several years, at Orfordness, Maralinga and Christmas Island. This program is often forgotten in the shade of the nuclear trials.

The RAF Strategic Nuclear Forces history is now unclassified and has been available to the public for two years via HMSO.

Masses of historical weather data are available from the Met Office (to the public without restriction on repayment as far as I am aware).

I have spoken to [redacted], the senior AWE photographer. He was not at Christmas Island and has no knowledge of techniques. T1/77 (part of this was copied to you earlier, I enclose full text) seems to suggest that HOB was determined by triangulation from fixed cameras. He cannot suggest any other sources. He notes that the high-speed cameras had very narrow fields of view and would have missed the burst altogether had it been more than a few hundred feet out.

To my knowledge all the enclosed are UC but I am marking the package Restricted to cover overall sensitivity.

Regards

[redacted]

Health Effects Group

7496

SN9750

F SIGS 927

(Rev 12/94)

Covering #

FACSIMILE TRANSMISSION COVER SHEET

TRANSMISSION DETAILS		DOCUMENT DETAILS	
Serial No:	Transmission Date: 14/11/97 Time: 16:00	Document Reference: D/ACSA(N)/15/8/5	
		Total number of pages including this cover sheet:	4
From: [redacted] Tel No: 0171 218 7379	Fax Number: 0171 218 7400	To: [redacted] AWE AWE 7496	Fax Number 824813
Authorised by: Rank, Name and Appointment XXTITLE INITIALS SURNAME		Transmitted by: Rank, Name and Tel No	
Signature: [redacted]		Signature:	

Subject: NUCLEAR TEST VETS

[redacted]

Counsel want me to prepare a statement for them, not the court- but to draw on in court if needs be, on HOB Measurement/control and on the Weather/Wind.

I have drafted the attached as a start for your comment and for additions.
For instance:

What can we say about HOB measurement by AWE ?

What can we say/demonstrate about weather conditions acceptable for firing, any documentation to show?

Speak on Monday.

Covering #

DRAFT

NOTE ON HOB & WEATHER CONDITIONS(WIND DIRECTION)

HEIGHT OF BURST(HOB)

The more AWE information that remains is about the device performance and there is not much on how firing at the correct height was achived. However the following points are relevent:

FUZING: [redacted]

There are indications from the reports of one RAF officer made at the time that the fuzing was achived by using two timers initiated by the release of the store from the aircraft, one acting as a backup to the other. This is how current weapons of this type are activated. The aircraft was certainly under radar control and flying at an accurate height would not be a problem.

THE WEAPON

The weapon case used for all the Grapple tests was a standard in service weapon item with known aerodynamic characteristics. The weapon cases had been design for accurate sub-sonic dropping of the in service nuclear weapon called Blue Danube (BD). BD was barometrically fuzed and such fuzing may also have been applied to the Grapple devices as a further backup arrangement.

The BD weapon was detonated at reduced yield by air drop in the Buffalo 3 test in Maralinga (Oct 56). The HOB was set at 500ft and achieved.

THE AIRCRAFT & CREW ?

From the classified official history "The RAF Strategic Nuclear Forces:their origins, roles and development 1946-1969" I first precis:

> The RAF crews were from 49 Sqd. a group specially established for this work which started training for the Grapple tests in Sept 56. Trial drops of inert weapons were conducted in the UK and training continued after they arrived in Christmas Island in March 57 for the initial Grapple tests. Prior to any of the live nuclear drop there were drops of identical weapons but with only a high explosives filling in order to test and demonstrate the whole system. The same group were used for Grapple X, Y & Z drops, the aircrew and aircraft returning to the UK between each operation. The same group had carried out the Buffalo 3 trial.

and quote:

> "The squadron ORB (Operational Record Book) records :
>
> "On the morning of April 28th the Grapple Y nuclear weapon was released visually from Valiant XD824, flown by Sqn Ldr [redacted] and crew. The bomb exploded at its planned height and position, and scientific records obtained therefrom confirm

that the squadron once again accuratly fulfilled its committment in regards of this operation"

MEASURING THE ACHIEVED HOB

Achieving the correct HOB was not only important from a safety point of view but was also from a scientific one. Some of the instruments measuring characteristics of the explosion were focused on the selected point in space, so height as well as position was important. [TONY WHAT CAN YOU ADD ON HOW IT WAS CONFIRMED?]

CONCLUSION

Careful selection and pre use testing of the fuzes employed together with the known characteristic of the weapon and controlled flying would allow for accurate achievment of the required HOB.

EVIDENCE

The attached extracts from reports made at the time show the recorded HOBs for the tests and the precursor trials.[GRAPPLE Y INTERIM REPORT PT 19-GRAPPLE Z INTERIM REPORT PT 23]

[redacted] - You will have these

WIND DIRECTION

The document supplied as Annex M to the original AWE material is attached.[THE LETTER TO [redacted]]

This is a letter from the Met Office to AWE in 1985 containing information they hold on weather conditions in the vicinity of Christmas Island at appropriate times to Grapple X,Y & Z. They explain that they have "a considerable ammount of meteorological data for Christmas Island including rainfall" gathered from a met station on the Island at a postion between the airfield and the main camp. At para 8 they mention that they have the upper wind soundings from the two ships Ulysses to the north, and Pukaki in the south.

Note that the letter ends up by "hoping sufficent information is available to enable AWE to check for the possibility of radioactive contamination."

[redacted] HOW DO WE EXPLAIN THE ACCEPTABILITY OF POST EVENT RAIN Z1 FOR INSTANCE?

[redacted],
C.R.,
Building [redacted]

UNCLASSIFIED

6215
Time Fuzes in Grapple Weapons

I would like to make some comment on [redacted] memorandum of the 15th October, and to explain in more detail what actions are being taken to meet the situation.

Firstly, I would like to correct the impression given in para. 2.2, that in one of the Green Bamboo U.K. test weapons only half of the duplicated firing circuit functioned. This is not so. What actually happened was that one trigger unit failed to function, presumably because of a failure of a time fuze, but the other trigger unit functioned normally and in so doing fired both firing circuits as planned.

Paragraph 2.3 of the memorandum lists information from Maralinga. This differs somewhat from information I have, in that according to my information, in Round 2, which was in fact Round No. 4C5, the port time fuse failed to function and not the starboard one as shown. Thus any inference that failures are associated with any one station in the weapon can be discounted.

The inference to be drawn from paragraph 3 is that the failures and increased time scatter of the time fuzes at Maralinga can in some way be ascribed to the use of I.F.L. and/or the rather low slip temperatures encountered. After examining the situation in some detail, I am forced to the conclusion that this seems to be unlikely for the following reasons.

1. The temperatures quoted were those recorded in free air near the bomb slip when the bomb doors were open. Temperatures as low as this have been recorded several times during the U.K. trials for Buffalo, but in any case these temperatures only exist for the time for which the bomb doors are open. When the doors are shut the temperature is in the region of 20°C.

2. In a flight trial in U.K. the temperature of components mounted near the skin of the bomb have been directly measured. Flying at 45,000 feet for three hours, with bomb bay heating off and opening the bomb doors for short intervals on a drop, produced a minimum component temperature of +10°C. for an outside air temperature of -53°C. Similar trials with bomb bay heating on gave a minimum component temperature of +18°C.

3. The clocks are approved for use by R.A.E. down to a clock temperature of -20°C.

4. The opening in the bomb case required for I.F.L. on Buffalo was to a large extent blocked during flight by the I.F.L. mechanism which projected through the hole, and immediately on release the hole was automatically sealed by a spring loaded door.

5. The time fuzes themselves were well protected from any cold draught from this opening by a thick beam in the skin of the weapon.

Unless the I.F.L. mechanism was in some way giving rise to intense local vibration or other form of disturbance not recorded on the vibration channel of the telemetry system, I am forced to the conclusion that it is unlikely that the presence of the I.F.L. mechanism was associated with the anomalous fuze behaviour at Maralinga although, of course, it cannot be entirely discounted.

I agree entirely with [redacted] that the situation is serious and I have already taken the following actions to meet it.

UNCLASSIFIED

1. I have arranged for the return of all the time fuzes surplus to the trial, some dozen all told. These have already arrived in this country and are being held at Aldermaston pending completion by R.A.E. of a test jig. When this jig is completed, [redacted] will take the fuzes over to Armament Department and witness the tests.

2. I have asked R.A.E. to design fixtures to enable another pair of time fuzes to be mounted in on the Grapple weapons making four in all, so that they operate quite independently of the original pair. A suitable design for Green Bamboo, Orange Herald (S) and Orange Herald (L) has already been completed and I have formally asked R.A.E. to proceed at top priority. A design for Green Granite and Blue Board is being worked on now. The additional fuzes have also been ordered.

3. As much protection from the shock from the exploders as possible is being given to the time fuzes and their associated trigger and telemetry circuits in the U.K. Grapple Trials. This should reduce the uncertainty in establishing the exact cause of any future failures.

As you may know, there has been some controversy in the past between ourselves and R.A.E. on the policy of 'one-shot' devices. They favour the use of 'one-shot' systems in armament, that is systems which cannot be tested before use, whilst I feel that systems which can be tested before use are much to be preferred for our applications. In this case the time fuzes are 'one-shot' devices although I have on several occasions asked R.A.E. to consider making them re-settable for our purpose. The great difficulty with 'one-shot' devices is that one has no idea whether their condition has deteriorated during transport and storage and it does seem possible that some occurrence during transport to Australia may have accounted for the behaviour of the Maralinga fuzes. As the design stands at the moment it is not possible even to check the circuit after connecting the fuze to the weapon, but following repeated representations, R.A.E. have now agreed to amend the design and fuzes incorporating facilities for testing the circuit after connection are expected shortly.

In brief, the cause of the failures is being investigated as quickly and thoroughly as possible and action is being taken to alleviate the effects of any incurable unreliability.

[redacted]

S.L./W.E.

Building [redacted]
Ext. 7219

18th October, 1956

[redacted]

Copy No. 2 of 6 Copies

UNCLASSIFIED

From :- R.A.F./A.W.R.E., Aldermaston.

To :- Distribution as below :

Date :- 10th December, 1956.

Ref :- RAF/AWRE/TS.1260.

'F' Series Trials

1. A requirement has arisen for flight trials of two Grapple weapons with explosive fillings as distinct from the usual inert rounds. This matter was discussed between [redacted] during the latter's recent visit to Headquarters, Bomber Command.

2. Two flights are required, one for each weapon, simulating as far as possible, the conditions to and from the target area at Grapple: the weapons will not be released in the air. The purpose of the tests is as follows :-

(a) to determine that the safety systems for these Grapple weapons operate mechanically in a satisfactory manner during flight.

(b) to confirm the results of the mechanical and vibration tests on the two weapons which have already been carried out on ground rigs.

3. The specification of the stores is as follows :-

(a) Vehicles will be standard Blue Danube externally but weighing 10,000lbs.

(b) Warheads will contain 1308 lbs and 476 lbs of RDX/TNT respectively.

(c) Warheads will not contain any R/A materials, Firing Systems or any means of initiating the explosive.

(d) Weapons will be cleared for flight by R.A.E. (Mechanical Aspect) and by A.W.R.E. (Explosives Aspect).

4. These flights trials will form an insurance against possible delays during Grapple, and it is most desirable that they should take place: obviously any minor snags can be far more readily cleared up in this country. It would be appreciated if your approval for these two flights could be given and appropriate instructions issued to the Squadron concerned, subject of course, to the production of appropriate clearance certificates by the R.A.E. and A.W.R.E.

[redacted]

Sen. R.A.F. Representative

Building [redacted]
Aldermaston.

Distribution :

Headquarters, Bomber Command, High Wycombe, Bucks. (For the attention of [redacted]

[redacted]

File.

UNCLASSIFIED

Grapple - Y. Firing Conditions and Aircraft Safety

1. The following conditions have formed the basis of aircraft safety considerations by AWRE.

(i) The expected yield is 2 - 2½ MT.

(ii) A reasonable upper limit to the yield is 4 - 5 MT.

(iii) The burst height will be raised 1,000 ft to 8,5000 ft ± 1,000

(iv) The aircraft dropping height will be raised 1,000 ft to 46,000 ft.

(v) The chance of premature operation of the firing circuit after arming is of the order of 1 in 20,000. The earliest arming timing will be at 13,000 ft.

(vi) Firing will, for other reasons, not take place when cloud cover below the burst is more than 2/8.

2. Neglecting air attenuation the thermal dose to the aircraft from a burst at 8,500 ft can be taken as 10 cals/cm^2 per 1 MT. The permitted level of thermal dose to the aircraft is 45 cals/cm^2; this is stated as possibly causing slight damage but not preventing the aircraft from returning to base. Thus for the expected yield and the upper limit of yield the aircraft should not receive more than about 45 cals/cm^2 from a burst at the chosen height.

3. If a premature occurs at the maximum possible height, 13,000 ft, then the dose to the aircraft from the expected yield is about 30 cals/cm^2.

4. If a combination of an unlikely premature and an unexpected high yield occurs then a dose of 45 cals/cm^2 is received for the following combinations very approximately.

Premature Burst Height Ft.	13,000	12,000	10,000	9,000
Yield MT	3	3½	4	4½

However the chance of a premature and a high yield is less than the chance of a crash on take-off or landing and it is recommended that the risk of this combination of circumstances be accepted.

DD/AWRE.
17.12.57.
DD/WRC/296/57.

Copy 1 [redacted]
2 D.G.A.W.
3 Controller of Aircraft MOS
[redacted]

GRNP 66

C/NO 0607

20194 IX(a)

472

A.W.R.E.,
Christmas Island.

18th June, 1957.

UNCLASSIFIED

[redacted]

Scientific Director.

C/NO 607

Hazards of Megaton Tests

Introduction

Consider a megaton airburst about 1-2 miles off the S.E. point of Christmas Island. Ground Zero is then some 21-22 nautical miles from the airfield, 23-24 nautical miles from Main Camp, 26 nautical miles from London and 28-29 nautical miles from the N.W. point. We thus consider distances of 20, 25 and 30 nautical miles. Yields are assumed to be 1 MT and 3 MT.

Air Blast

The free air overpressure in p.s.i. is obtained from Capabilities Fig. 6 as follows:-

Distance (n.miles)	Yield	1 MT	3MT
20		0.21	0.32
25		0.16	0.25
30		0.13	0.20

On the surface, the effect of ground reflection is roughly to double the overpressures. Strictly the effect is rather more complicated and should be derived from height of burst curves, but the available data does not extend to such low overpressures. Simple doubling gives one a reasonable grasp of the magnitude of the surface blast pressures.

The only blast damage data in Capabilities which extends to such low pressures is on Fig. 97 which includes data on light damage to parked helicopters, transport and liaison aircraft (military aircraft are usually much tougher targets). The range in nautical miles for such light damage is given in the following table:-

Height of burst (ft.)	Yield	1 MT	3 MT
8000		16	22
20000		19	25

Light damage is only defined as not preventing immediate operational use of the aircraft, and presumably includes for example a certain amount of panel dishing. One would expect that aircraft are at least as strong as the structures erected on Christmas Island by the Grapple Task Force. The distances quoted in the previous table must thus roughly apply for light damage to wooden and aluminium clad buildings, that is, probably a few roofs damaged if not removed, windows broken, wall panels cracked. Tents would presumably be blown down at the same distances.

As a check, we note that a Shackleton suffered light damage at 26 nautical miles from Orange Herald. The "Effects of Atomic Weapons" quotes light damage to houses extending out to 8 miles from a 20 KT weapon, corresponding to 26 nautical miles from a 1 MT explosion.

It must however be remembered that Warrior experienced a much reduced blast pressure from both Short Granite and Orange Herald, almost certainly because of blast refraction. For example, the measured peak pressure of 0.075 p.s.i. from Orange Herald was only about 25% of the value to be expected in a uniform atmospher.

Such an effect of refraction had been qualitatively predicted, but the existing theory does not allow me to make any sort of quantitative estimate. It is thus not entirely satisfactory to rely on refraction for a safety factor, although I think it likely that in most cases it will significantly reduce the surface pressure.

Thermal Radiation

Assuming a thermal yield of one third the total yield, the thermal dose in calories/cm^2 is given from Capabilities Fig. 20 as follows:-

Distance (n.miles)	Yield	1 MT	3 MT
[illegible]		0.9	2.8
25		0.6	1.8
30		0.4	1.2

Reflection from overhead cloud cover could increase the thermal dose by perhaps 50%, but in most cases clouds would tend to reduce the dose received on the average. For example, clouds appear to have reduced the thermal dose as measured at Malden by about a factor of 3 for Orange Herald. Nevertheless one can hardly base safety considerations on cloud shielding.

Various data on thermal target response are quoted in Capabilities. Fig. 64 gives the threshold energy for first degree burns (skin reddening) as 3 cals/cm^2 for a yield in the 1-3 MT range. From Fig. 115 we deduce that newspaper would be ignited by a thermal dose greater than about 7 cals/cm^2 from a megaton burst; this indicates the fire risk from inflammable litter. Fig. 108 indicates that natural vegetation is liable to be ignited by a megaton thermal dose around 6-7 cals/cm^2.

A 1 MT airburst would give a dose of 6 cals/cm^2 at a range of about 8 nautical miles, and so vegetation fires would seem likely to occur throughout the S.E. arm of the island. It might be necessary to take precautions against a Westward spread of the fires in the prevailing Easterly surface winds, and delay firing in the fairly rare event of a marked Southerly surface wind.

Conclusions

The present rough discussion has focussed attention on two aspects of megaton target response, blast and thermal radiation, which we believe are the only effects that matter at the longer ranges - in the absence of course of fall-out. Our orders of magnitude would indicate that 1 MT should not produce significant damage at 20 nautical miles range, and the same is probably true for 3 MT, but here the margin of safety is quite small.

Unless we rely on blast refraction, we must assume that some blast damage is likely, probably quite slight for 1 MT but becoming more serious with 3 MT. Precautions to protect aircraft should be taken and some strengthening of buildings seems indicated; tent walls should be opened; pe rsonnel should be protected from possible structural debris.

Thermal radiation does not appear to be as serious a hazard as I had earlier stated, largely because the increased time of delivery with larger yield weapons increases the critical dose. There would appear to be no obvious thermal hazard at 20 or more nautical miles from the burst, but personnel should be protected against the risk of damaged skin and sunburn.

In my opinion, the blast and thermal hazards of the assumed 1 MT airburst are just about acceptably small, but I would regard the risks from a 3 MT airburst as uncomfortably high. One would have very little hesitation in accepting such risks at an advanced control centre as at Maralinga or a mobile floating base such as Narvik, but I should not regard the 3 MT explosion as reasonable at a main base - the factor of safety is too low - there is no adequate allowance for unforeseen eventualities.

Finally there is the danger from fall-out from an accidental near surface or surface burst. This will necessitate restrictions on the permissible wind structure, the degree of restriction depending on the expected maximum accidental yield. If one imposed the extreme restriction that the mean wind to all relevant levels should have no Southerly component, the available wind statistics indicate that firing would only be possible on less than 10% of occasions.

[redacted]

CINO 0665

1ap 595

691

MINUTE SHEET

[redacted]
S.S.P.T.,
Building [redacted]

UNCLASSIFIED

GRAP 695

Aiming Accuracy on Live Grapple Trials

The aiming accuracy of weapons dropped on live trials in the Pacific is often the subject of discussion on site between ourselves and the R.A.F., and it has occurred to me that you should have a note on the present situation.

The R.A.F. have stated that they will guarantee that 50% of the weapons dropped will fall within a circle of 400 yards radius. This is more accurately interpreted for an air burst as within a horizontal circle of 400 yards radius with its centre above the specified ground zero. I am told that the statistics of all the weapons dropped on Grapple, including a large number of small practice bombs confirm the R.A.F. claim.

There are various factors which affect the application of this evidence to an actual live trial. For instance many practice rounds were dropped under worse aiming conditions than would be tolerated for a live trial, on the other hand nervous tension on the live trial may adversely affect the aiming accuracy and it is impracticable to assess these effects. I believe, however, that they can be ignored for our purpose and this is borne out by the fact that all four live rounds have been within a 500 yard radius.

If we now consider the accuracy requirements demanded by the A.W.R.E. measurements we need only concentrate on the close-in high speed gamma measurement. Everything else will cover a field of view so wide that comparatively gross errors can be tolerated. The gamma intensity measurement is very sensitive to positional error which in this case could be a large percentage of the total range, and the problem is overcome by using at least duplicate sets of equipment with different sensitivity settings. In order to arrive at suitable settings the gamma measurement team need some guidance on the range of positional errors they are supposed to cover and this must be a compromise based on our knowledge of the likely aiming accuracy and on the equipment performance.

In the present circumstances I have advised [redacted] that he should work to the same conditions that I agreed with [redacted] on earlier Grapple Trials, namely:-

1. An error in any horizontal direction of less than 400 yards should not affect the gamma information.

2. An error in any horizontal direction between 400 and 1,000 yards may lead to progressive worsening in the accuracy of the measurement.

3. An error in any horizontal direction of greater than 1,000 yards may lead to total loss of the high speed gamma information.

The effect of the expected variation in burst height is much less severe and I have told [redacted] that he should work to 8,500 feet with a tolerance of ± 500 feet.

[redacted]
S.L.T.

Room 109,
Building [redacted]

3rd March, 1958.

UNCLASSIFIED

c.c [redacted]

(1921) Wt22971/4445
9,52 1,100,000
JC&SLtd
Gp736/209
(REGIMINT)
CODE 5-34-0

[OVER

CWO 0113

I.1. Gen

260

UNCLASSIFIED

[redacted]
C.R.,
Building [redacted]

6190

TIME FUSES IN GRAPPLE WEAPONS

1. FLYING TRIALS TESTS ON TIME FUSES

The intention is to fire the Grapple weapons from time fuses preset to give a burst height of 8,000 feet when the weapon is released from 45,000 feet. These units are fitted in pairs such that the operation of either will fire the weapon, and they are provided as complete and tested units by R.A.E. The performance testing of these units naturally forms a part of the dropping trials programme now under way at Orfordness which is intended to prove that the performance of the Grapple weapons is satisfactory. In addition the opportunity has been taken to fit a pair of time fuses to each of the Buffalo weapons that have been dropped both in this country and overseas, in order to increase the statistical trials information on these units. It should be noted that the Buffalo rounds are fired by radar fuses and the time fuses are therefore set to function earlier without being connected to the firing circuit, so that full information of their operation is transmitted before any damage from firing results.

The performance of the time fuses on the four trials in Australia has just been confirmed and must give rise to a certain amount of concern.

2. RESULTS OF TRIALS

2.1. U.K. Trials for Buffalo

Ten weapons were dropped at Orfordness, and each carried two time fuses, whose performance was uniformly very good. The measured times of operation of each unit are tabulated below.

W/H Fuse - Times in Seconds

Weapon Ser. Nos.		From Record	From R.A.E.	Differences
"A"	Port (Upper)	42.47	42.518	-.05
	Stbd. (Lower)	42.57	42.508	+.07
"B"	" "	42.55	42.512	+.04
	" "	42.56	42.517	+.04
"C"	" "	42.58	42.486	+.09
	" "	42.46	42.449	+.01
"D"	" "	42.52	42.504	+.02
	" "	42.59	42.507	+.07
"E"	" "	42.59	42.518	+.08
	" "	42.50	42.518	-.02
"F"	" "	42.41	42.503	-.09
	" "	42.41	42.484	-.07
"G"	" "	42.52	42.515	.00
	" "	42.52	42.502	+.02
"H"	" "	42.54	42.504	+.04
	" "	42.53	42.513	+.03
"J"	" "	42.46	42.512	-.05
	" "	42.49	42.515	-.03
"K"	" "	42.48	42.50	-.02
	" "	42.50	42.50	.00

. Times from R.A.E. are the preset times supplied with the units.

2.2. U.K. Grapple Trials

So far there have been six dropping trials using Green Bamboo test weapons and each was fired by time fuses and the burst heights were all close to 8,000 feet. However on one round, only one half of the duplicated firing circuit functioned and a time fuse failure is suspected, although the failure could be on the firing circuit. The weapon components and telemetry equipment are subject to damage from the detonators at firing and it is difficult to be certain of the exact cause of failure.

2.3. Buffalo Trials in Australia.

Four separate trials have now been made in Australia and each weapon carried two time fuses. Since these fuses operate before firing there can be no ambiguity about their operation. The results are as follows:-

			Time of Operation	Error
Round 1	(Instrumentation round)	Port	42.55 secs.	+.05 secs.
		Starboard	42.58	+.08
Round 2	(H.E. round)	Port	42.29	-.21
		Starboard	Did not operate	
Round 3	(H.E. round)	Port	42.65	+.15
		Starboard	Did not operate	
Round 4	(Live round)	Port	42.78	+.28
		Starboard	42.60	+.10

These trials revealed two complete failures out of eight fuses and abnormally large time errors on the remaining fuses in rounds 2, 3 and 4.

3. DISCUSSION

The implication of these time fuse failures so near to the Grapple live trials are of course extremely serious. S.L./W.E. has already ensured that R.A.E. are working on the problem but whatever happens there will be only restricted opportunity to build up enough statistical evidence to restore complete confidence in these units.

It may be that the Australian failures are related to particular conditions on the Buffalo trial. Pinkerton has reported that temperatures in the heated bomb bay are below freezing point and in addition, there was an opening left in the ballistic casing on rounds 2, 3 and 4, because In Flight Loading was used on the live round. The combination of low temperature and the presence of this aperture may be significant. The opening is not required on Grapple rounds. R.A.E. have a representative at Maralinga and will no doubt have communicated the possibility to Farnborough.

If temperature is significant it must be remembered that these Australian trials are only at 30,000 feet, whereas Grapple aircraft will fly at 45,000 feet. In addition temperatures over the Pacific will be 10 - 15°C. lower than corresponding temperatures in this country at the higher altitude.

[redacted]

Group Leader
Flying Trials.

Room 109,
Building [redacted]

15th October, 1956.

[redacted]

A0194 XIIC C1/3 0237

413

ROYAL [redacted]

Dept. of Physical Research, Admiralty.

Tel.: WHItehall 9444

Ex. [redacted]

Your Ref.:

Our Ref.: DPR/WWJ/16A/57

QUEEN ANNE'S MANSIONS, ST. JAMES'S PARK, LONDON, S.W.I.

UNCLASSIFIED

11th March, 1957

[redacted]
S.W.P.,
Atomic Weapons Research Establishment,
Aldermaston,
Berks.

Dear [redacted]

Herewith for retention is a copy of the note which I sent to D.C.(R. & D.), as requested by you.

All good wishes for your trip.

Yours sincerely,

[redacted]

[redacted]

Wave Formation as a result of Accidental Surface Burst near Christmas Island

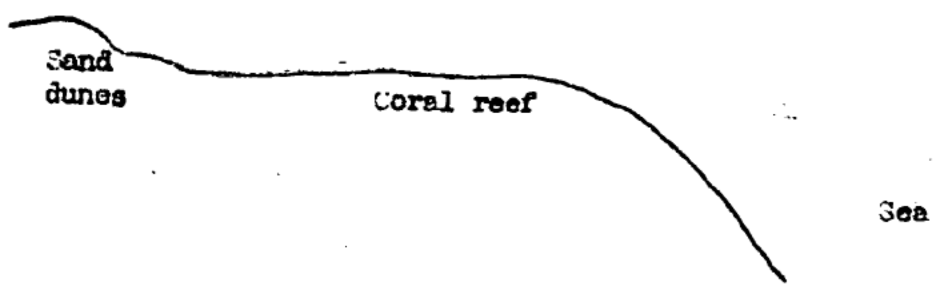
In pursuance of DRP(AES)M(56)2 conclusion (13), consideration has been given to the consequences of an accidental surface burst of the nuclear weapon soon after take off. Land bursts were not considered, and the case thought to be typical, and worthy of a quantitative estimate was a surface burst about a mile off the Northern shore of the Island. (Long. 157°20'W), north of the take-off runway.

Discussions were held at A.W.R.E. with [redacted] and with [redacted] resulting in four yields being used in the calculation of wave height, wave length, and number of waves in wave-train. The typical effective yields were 1, 10, 100 and 250 kilotons, and the above quantities were calculated using the best available data.

The next problem was to determine what effect these wave-trains would have after arriving at the shore of Christmas Island. Charts and soundings of relevant areas were obtained, and the problem was discussed with the National Institute of Oceanography. Only the derived figures for wave-height etc. were passed to N.I.O. without any reference to the corresponding yields. It is thought that the wave-height figures are an overestimate - possibly by a factor as large as four.

Hydrography

The prevailing winds, waves and currents approach the shore from an Easterly direction, and this ensures that there is no gently sloping sand beach as on the West coast of the island, but that the coral reef would rise steeply out of deep water as the soundings do in fact indicate.



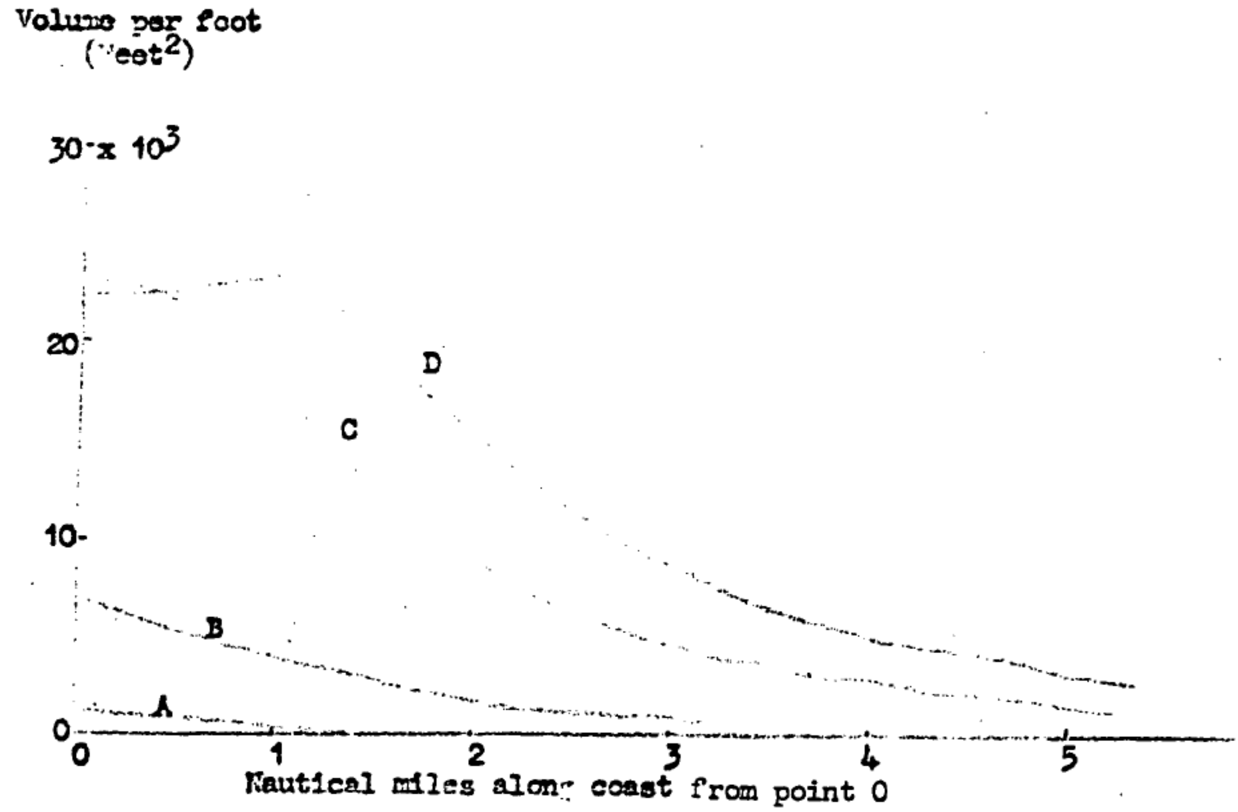
Wave trains

The derived (rounded) data is tabulated under the four yields referred to above. All figures are for a distance of one mile from the surface burst.

	A	B	C	D
Yield	1 Kt.	10 Kt.	100 Kt.	250 Kt.
Maximum Wave height (Feet) h_m	± 6	± 20	± 60	± 100
Average Wave Length (Feet)	675	1200	2150	2700
No. of Waves of height > 1/5 h_m	12	7	4	3

Flooding by Waves

The only published work at all relevant to this situation is in a report of the Inst. of Eng. Research, Berkeley, Calif., by [redacted] entitled "Flow over reefs and structures by wave action" (I.E.R. Series No. 3, Issue 361, 1954); this gives data for the volume of water thrown on to the reef per foot of reef for various wave steepnesses and heights of reef above sea level, obtained entirely from model tests. Taking the dimensions of waves in Table, and allowing reasonable values for the heights of the given number of subsidiary waves, estimates were thus obtained for the total volume of water thrown on to the reef per foot of reef, at various distances along it, and the results are plotted as curves in the Figure.



(Volume of water thrown on to reef
from wave systems tabulated above)

Allowances were made for the decrease of wave height with distance from the source, and the changing angle of approach of the waves. The figures assume the height of the reef above m.s.l. to be such as to take the maximum volume of water. This height would be about 1/5 of the wave height; any other reef height would give lower figures, but the difference in water volume between that height and zero is only about 10%.

It may appear surprising that there is very little difference in cases C and D. This is because the largest wave in case D is much steeper than in case C, and so it breaks earlier and loses more energy.

It would be impossible to calculate exactly how this water will behave once on the reef. In cases C and D, which are the only possibly dangerous ones, the successive waves will arrive at intervals of over 20 sec. so that by the time the largest arrives, the water from the first subsidiary waves will have already spread over the reef to the land, and some water will be pouring back into the sea. Any initial net forward momentum will soon be lost by friction and turbulence and by meeting the returning water. If the land is high enough to prevent flooding, therefore, the general effect will be for the successive bulks of water to build up a head of water over the reef. To obtain a rough idea of how high this head may be,

UNCLASSIFIED

one can divide the volume per foot by a typical width. Aerial photographs held at the Hydrographic Office show that the width of the reef in this part of the coast is fairly constant at about 350 ft., and one can allow a further 150 ft. for the sand beach etc. Assuming that about half the water has time to flow back into the sea, percolate into the sand, and spread laterally, before danger occurs, then dividing the figures for volume per foot by 1000 feet would give roughly the height of land that could be considered safe from flooding.

The point on the shore nearest to the explosion will be called O and it appears from the chart that land in this region is "up to 20 ft." high, so there is evidently some danger within a mile or two from O for the two largest wave systems. This would most obviously affect the airfield, unless on particularly high ground, but the "main camp", being 3 nautical miles West of O, may be fairly safe. Wave systems A and B would cause no serious trouble.

For C and D there would be at least 2 minutes interval between hearing an explosion and the arrival of the water at the land, and longer for A. and B. Any water coming over the land will of course flow into the lagoons and soon subside.

Ordinary wind waves in the neighbourhood, calculated from the quoted prevailing wind force of 3-4, would rarely exceed $\pm 1\frac{1}{2}$ ft., with mean wave-length 230 ft., and are therefore of no consequence. The nearest island, "Fanning", being over 150 miles away, the wave heights caused by explosions near Christmas Island would cause no danger.

Summary

The volume of water per foot of coast is shown diagrammatically in the figure. It can be seen that, for yields 1 Kt. and 10 Kt., the danger from serious flooding of airfield and main camp areas is negligible. For the yields 100 Kt. and 250 Kt. there is a danger up to about two miles along the coast from the point nearest the explosion. However, this is not the only danger, because the thermal hazard is serious out to some three miles for the 100 Kt. case, and five miles for the 250 Kt. case. The instantaneous gamma dose would be mid-lethal up to about a mile from the burst in the same two cases, and brick buildings would be destroyed by blast out to distances of one, to one and a half miles from the explosion.

Conclusion

It is considered, by A.W.R.E., that the effective yield of an accidental surface burst is most unlikely to exceed 10 Kt. Under these conditions, the danger to the installations on Christmas Island due to flooding has been shown to be negligible for a surface burst a mile from the shore. Should the yield reach the most unexpected value of 250 Kt. there is risk of serious flooding for several miles along the coast near to the explosion, but this risk is overshadowed by the thermal dose received over the same area.

C/No 0354

[redacted]

UNCLASSIFIED [redacted]

58

721

Low Altitude Aircraft Contamination from the Planned burst at Grapple-Y

by

[redacted]

1. Introduction

Because of the height at which the Grapple-Y explosion is planned to take place, it is quite certain that the resulting fallout will not cause serious illness, or even a significant proportion of cases of sickness, among persons exposed to it. There are, however, two related problems for which numerical estimates of the upper limit of contamination are of interest. The first of these concerns the survey by aircraft that is to be made, some hours after burst, in an attempt to detect sea-borne contamination: the second concerns the air search of the danger area that is to be made, after the burst, to locate any ships that may have penetrated to the area. This note gives a summary of some contamination calculations relevant to these operations.

2. The Density of Airborne Contamination

2.1 In both operations, aircraft may fly through regions where radioactive material is falling. It is to be emphasised that this is not what is meant by the phrase "flying through the radioactive cloud". The cloud from the planned airburst will have its lowest parts at about 60,000 feet altitude: beneath the cloud the falling radioactive particles will produce a region of extremely dilute radioactivity; and it is this region of dilute airborne radioactivity that we consider first.

We are interested in estimating the maximum possible density of airborne contamination at the lower altitudes in this region. Hence we neglect the dispersing effect of the wind, and assume that the stabilised cloud remains a coherent entity at rest, while contaminated particles fall from its centre. In this way, for a cloud of radius 20 n.m., we find that the maximum density of airborne contamination within a few thousand feet of the sea surface is about 4×10^{-9} curies per cubic metre, and occurs at about $9\frac{1}{2}$ hours after burst.

At this point the problem separates into two parts, viz. the effect on the aircrew, and the later effect on the ground crew as they work on the aircraft.

2.2 Dealing with the aircrew first, we compare the above volume density of airborne contamination with the maximum permissible level quoted in section 2.2. 1 (b) (ii) (b) of "Radiological Safety Regulations for Christmas Island (March 1958)". In our units this latter level, for a time of $9\frac{1}{2}$ hours, is 3.2×10^{-7} curies per cubic metre. Thus there is no possibility of the aircrew being subjected to more than about 1 per cent of the permitted level. Recalling that the dispersing effect of wind has been neglected, we conclude that the actual level encountered by the aircrew will be considerably less than 1 per cent of the permitted level.

2.3 Turning to the effect on the ground crew, this clearly depends on the amount of contamination that adheres to the aircraft as it traverses the region. To estimate the largest possible value, we assume that all the contamination swept up in a flight of length 40 n.m adheres to the aircraft.

The surface density of contamination is found to be about 4×10^{-3} one-hour curies per sq. metre, which compares with 32×10^{-3} one-hour curies per sq. metre (at $9\frac{1}{2}$ hours) for level A. Thus, for a 40 n.m traverse, the adhering contamination cannot possibly exceed one-eighth of level A. Recalling the assumptions, that the radioactive material suffers no dispersion by wind and that all the material in the path of the aircraft adheres to it, we conclude that the actual hazard to the groundcrew in practice is much less than one-eighth of the completely non-hazardous level A.

/3. Rainout

3. Rainout

The above estimates make no allowance for rainout of contamination. As it is difficult to be precise on this aspect we can only be prudent. Aircraft should not fly in any region in which the following conditions exist simultaneously, viz.

(1) Rain is falling:

(2) Any part of the nominal stem, in the height band 10,000 feet to 30,000 feet, is in the region; this to be judged from the actual constant level trajectories in in that height band.

In passing, it may be remarked that the constant level trajectories in the height band 10,000 feet to 30,000 feet define the only part of the nominal prohibited Area that there would seem to be any point in searching after the explosion. This is not necessarily the region in which search should be made for sea-borne contamination resulting from gravitational fallout.

3/4 CINC 0417 UNCLASSIFIED 770

From: [redacted], C.B., D.S.O., R.A.F.,

0194 XXIX (1)
FYT 10

Headquarters Task Force Grapple.
Air Ministry,
Whitehall Gardens,
London S.W.1

SSPT | Yu... | 28.

GRA/104/6/Org

2nd July, 1958

My dear [redacted]

We discussed two aspects of health physics yesterday and I think it appropriate to record our views.

Film Badges

Should film badges be issued to those serving at Christmas Island? It has not been thought necessary to issue film badges to date. Since radio-activity and contamination at the Island may occur only in certain areas the policy has been to define these areas and control entry and exit thereto, admitting only personnel both service and civilian (A.W.R.E.) whose duty necessitates their working in these areas. These personnel have been given appropriate medical examinations (blood count) and are provided with film badges.

The remainder of the Island is not subject to contamination or radio-activity. However, as a wise insurance policy, counts are taken in all areas to ensure that backgrounds remain within limits. In lay language the count could be regarded as a communal film badge.

As we are now, for the first time, about to undertake balloon supported firings at Christmas Island, health physics for all at the Island comes under fresh examination in view of the possible differences between this type of firing and the high altitude air burst from the general radio-activity and contamination aspect. First thoughts suggest issue of film badges to all personnel. Further examination, however, indicates the wisdom of this policy to be questionable to say the least. If all personnel are to be issued with film badges, natives, both female and children, civilian merchant navy men in merchant ships and those in a similar category at the Island will have to be included. The administrative task (which of course must be met if essential) is considerable bearing in mind that the badge has to be issued, a record kept and the badge rechecked subsequent to examination for contamination after the holder has left the Island. Issue of badges at this stage may well provoke anxiety. What right have we to subject native populations and civilians to the possibility of contamination which, however remote, the issue of a badge to individuals would suggest is a likely possibility? Why should our present system of controlled areas not be extended to cover the requirements of balloon supported firings? Would this be adequate and safe?

First consideration of a film badge issue was provoked by the lego-medical aspect of disability claims. A case is now about to start and there may be some difficulty in disproving such claims. We discussed all this at some length at our meeting yesterday and our conclusion was that it would not be necessary for a general issue of film badges for Grapple Z, and that the present system of controlled areas would be safe and should continue. The Task Force will take the necessary steps to ensure that such areas are clearly

../marked....

[redacted]
S.S.T.D.,
A.W.R.E.,
Aldermaston,
Berks.

UNCLASSIFIED

0194XXIX(2)
ENT .10

UNCLASSIFIED

marked in appropriate languages, controlled and defined in orders and that such orders are frequently repeated. Finally, all personnel who may have to enter these controlled areas are to be examined and issued with a personal film badge.

Blood Counts

At the moment the vast majority of service personnel at Christmas Island are not medically examined (blood counts) either prior to or after serving on the Island. However, contamination levels have been calculated on the assumption that all serving at the Island could be regarded as occupational workers and this category of personnel at Aldermaston have medical tests (blood count). Those at the Island, other than A.W.R.E., however, do not.

We discussed this matter at length and were of the opinion that measures should be put into effect at the earliest opportunity to ensure that all service personnel going to Christmas Island from now on were subject to medical examination (blood count). We also thought that medical test facilities should be set up at the Island immediately so that all personnel could be examined prior to the first Grapple Z firing. I have today put these two points verbally to [redacted] and [redacted] of the H & R Medical Branch, Air Ministry. They are not in favour of instituting a universal medical examination (blood count) and consider that our present system of controlled areas is adequate. They do believe, however, that it would be a wise precaution to institute a medical examination (blood count) for those Army and other personnel who are required to take part in rehabilitation work after balloon firings at the southeast end.

I would be grateful if you would confirm or otherwise the points I have made above as far as our meeting yesterday was concerned. I will then write to the H & R department asking them to confirm their advice on the medical examination (blood count) aspect for service personnel, and ask them to provide facilities for examination of those we propose to employ on rehabilitation. If the War Office and Admiralty accept the R.A.F. view, and I will put it to them, then I think we will be clear to go ahead.

Yours

[redacted]

UNCLASSIFIED

My Copy

NOTE FOR FILE [15/8/5]

ECHR [redacted] & CO - CONCERNS OVER DOCUMENTS SUPPLIED

1. The lawyer for the Applicants has accused the Government [letter to the ECHR 24/10/97] of misleading the Court in that answers to questions put by the Commission in May 1995 are through material provided in the recent Government Memorial to the Court, shown to be apparently untrue. We believe we have a reasoned defence against this claim and I set out the situation here for the record.

2. In May 1995 prior to deciding whether an oral hearing was necessary the Commission (ECHR) put a number of questions to each side. The question put, the answer to which is causing the difficulty, was:

> "to indicate whether it is possible that, classified documents include records of the radiation levels recorded after the relevant detonations and/or of any monitoring or treatment of the applicants after these detonations.
>
> If not, given that the government do not dispute that the applicants were involved in the nuclear testing in 1958, why were there no contemporaneous records kept of such radiation levels and of the effects on the subjects of the tests.
>
> If so, what is the reason for withholding from the applicants (as distinct from public scrutiny) monitoring and medical records relevant to the applicants?"

3. The answer was worked on by Sc(Nuc)2 [15/8/5B E69] and this concentrated on the environmental monitoring , working on the fact, I presume, that the prompt effects were not material to the case, which of course the Applicants have some difficulty with. The answer supplied by the FCO via PL/LS was:

> "<u>Classified documents do not contain the records referred to in the Commissions question</u>. Records of environmental radiation monitoring at Christmas Island and elsewhere are not currently classified. No information has been withheld from the applicants as there was, and is no reason to do so.
>
> Exposure records exist for the personnel considered likely to have been exposed as described in the answer to the Commissions second question."

The FCO appear to have added the leading sentence for it does not appear in [redacted] letter to them! It is this statement that is now causing the difficulty.

4. In preparing the Memorial this summer we supplied some declassified extracts from classified Grapple Reports which showed, in limited form, some of the prompt effects and reported on some aspects of fallout. Their lawyer was quick to spot the new material and to point the ECHR to the UK again being "reluctant and lacking in candour" in the 1995 response to questions and to now being "scandalously underhand".

5. The argument that supports our assertion that the statement made in 1995 was fair & reasonable is:

It was always our view that it was clear from the YIELD figures available since 1993 and even earlier generalised yield data that there was no risk from PROMPT effects at the main populated sites on the Island. The subject of FALLOUT had been addressed in AWE Report T16/93 (Environmental Monitoring at Christmas Island 1957-58) and this showed no levels of concern.

References 20 thro. 24 of our Memorial are some of the documents referenced in T16/93 that show what environmental monitoring was carried out, none of these have never been classified. T16/93 (without these references) demonstrates that there was no contamination from FALLOUT in the populated areas of the Island and provides in tables and in graphs the records of the measurements taken.

References 26 thro. 29 in the Memorial are new material AND THESE WERE CLASSIFIED IN 1995. They are extracts from classified documents and released for the first time in the memorial. They however add nothing to the FALLOUT data in T16/93 as they record material collected from the same sources used to compile T16/93 , in fact some of the tables in T16/93 are clearly taken from these references.

As far as PROMPT effects go Ref 28 in particular shows measurements taken at close range in order to determine weapon performance but also demonstrates that the PROMPT RADIATION effects (for Grapple Y the largest shot by far) were of short range and there would have been nothing to measure at the populated sites.

These documents (26 thro. 29) do not provide new or additional records of radiation levels relevant to effects on participants, they only demonstrate that at the populated sites there was no PROMPT RADIATION effects and that FALLOUT was as shown in T16/93.

6. There are some difficulties :

T16/93 does not reference the documents 26 thro 29 and you cannot find all the material in T16/93 from its own references (I now realise). It is believed that one of T16/93s references was being produced by [redacted] but never completed.

[redacted]

10/11/97

echrmen-5

DOCUMENT

GROUP

SEPARATOR SHEET

My Copy
echrmom-3

From: [redacted] Sc(NUc)2a
Rm 2261

MINISTRY OF DEFENCE
Main Building, Whitehall, London SW1A 2HB

Telephone (Direct dial) 0171 218 7379
(Switchboard) 0171 218 9000
(Fax) 0171 218 7400

[redacted]
Deputy Legal Advisor
FCO

Copy
[redacted]
1 Hare Court

Your reference

Our reference
D/ACSA(N)/15/8/3
Date
5/11/97

ECHR [redacted] & CO - [redacted] CONCERNS OVER DOCUMENTS SUPPLIED

1. The question put by the Commission was I understand:

> "to indicate whether it is possible that, classified documents include records of the radiation levels recorded after the relevant detonations and/or of any monitoring or treatment of the applicants after these detonations.
>
> If not, given that the government do not dispute that the applicants were involved in the nuclear testing in 1958, why were there no contemporaneous records kept of such radiation levels and of the effects on the subjects of the tests.
>
> If so, what is the reason for withholding from the applicants (as distinct from public scrutiny) monitoring and medical records relevant to the applicants?"

The answer supplied was:

> "Classified documents do not contain the records referred to in the Commissions question. Records of environmental radiation monitoring at Christmas Island and elsewhere are not currently classified. No information has been withheld from the applicants as there was, and is no reason to do so.
>
> Exposure records exist for the personnel considered likely to have been exposed as described in the answer to the Commissions second question."

2. Explanation:

There are two ways of getting irradiated at atmospheric tests, from the yield dependent PROMPT effects and from FALLOUT (governed by yield, height of burst and weather conditions).

It was always our view that it was clear from the YIELD figures available since 1993 and even earlier generalised yield data that there was no risk from PROMPT effects at the main populated sites on the Island. The subject of FALLOUT had been addressed in AWE Report T16/93 and this showed no levels of concern.

References 20 thro. 24 of our Memorial are some of the documents referenced in T16/93 that show what was carried out, none of these have never been classified. T16/93 (without these references) demonstrates that there was no contamination from FALLOUT in the populated areas of the Island and provides in tables and in graphs the records of the measurements taken.

References 26 thro. 29 are new material. They are extracts from classified documents and released for the first time in the memorial. They add nothing to the FALLOUT data in T16/93 as they record material collected from the same sources used to compile T16/93.

As far as PROMPT effects go Ref 28 in particular shows measurements taken at close range in order to determine weapon performance but also demonstrates that the PROMPT RADIATION effects (for Grapple Y the largest shot by far) were of short range and there would have been nothing to measure at the populated sites.

These documents (26 thro. 29) do not provide new or additional records of radiation levels relevant to effects on participants, they only demonstrate that at the populated sites there was no PROMPT RADIATION effects and that FALLOUT was as shown in T16/93.

3. I expect you will have noted that [redacted] complaint that the NRPB Ref. 31 document is based on information in the material of the references discussed above is nonsense. The wording in para 3.14 of the Memorial demonstrates the generality of the work. There is no direct link between NRPB report at Annex 31 and Annexes 20 thro. 24 and 26 thro. 29.

4. I note in researching these points that in our Memorial at para 1.91 we say that the yields were made public in the Australian Royal Commission Report, only the tests in Australia are dealt with in this report I do not see any information on the Grapple shots there? The information in the public domain at that time was probable as shown in the NRPB 1988 report Table 3.1.

[redacted]