DECLASSIFIED
DNO WHG
Classification Lead
8 Apr 2026

SECRET ATOMIC PRINCIPAL

ARCE CONTROL NUMBER COPY No.
H/137455 004

Reference : SDT/5/77
Copy No. 4 of 4 copies
Page No. 1 of 6 Pages
7 March 1977

BATTLEFIELD DATA FROM NUCLEAR WEAPON

OPTICAL SIGNATURES

[redacted]

This document does not necessarily represent to final views of AWRE or SDT.

AWRE
Aldermaston

AW2010/37
024607
B0381.

DECLASSIFIED
DNO WHG
Classification Lead
8 Apr 2026

BATTLEFIELD DATA FROM NUCLEAR WEAPON OPTICAL SIGNATURES

1. INTRODUCTION

In the battlefield scenario it is important for the battle commanders to be able to assess the likely nuclear contamination from, and the position of, enemy nuclear bursts. Although the latter data can be obtained from optical data, the accuracy is not good and currently greater credibility has been placed on EMP data to fulfil this need. The objective of this note is to analyse UK optical data, estimate various diagnostic parameters with regard to contamination, and compare them with those proposed by the US. With reference to Figure 1, the US have defined the following criteria from their red band measurements (700-900 nmetres) to indicate the likelihood of contamination from a nuclear burst.

$\hat{I}_2/\hat{I}_1$	< 0.6	High explosive device
$\hat{I}_2/\hat{I}_1$	> 0.6 but <3.0	Near surface nuclear burst (contaminating)
$\hat{I}_2/\hat{I}_1$	> 3.0	Airburst (nuclear)
$\hat{T}_2/\check{T}$	> 7.0	Airburst (nuclear)

2. UK DATA

Optical signatures of French nuclear bursts from the Loxwood (1968) and Effort (1970) test series were selected. The criterion for selection was that these events were those most likely to have been contaminating and as a consequence were the largest events detonated. Data from various publications has been obtained to give estimates of device yield, maximum weight and height of burst (see bibliography). The optical signatures were analysed using the UK curve fitting programme. Where possible data from two optical bands centred on 610 and 800 nmetres were used. However, the Loxwood measurements were only made in the 610 nmetres band. Pre-event data samples were used to estimate a zero level for each event and thus allow absolute values of the various intensity peaks to be used.

3. RESULTS

Estimates of the diagnostic parameters may be seen in Table 1. There is one other parameter that could seriously affect these estimates, namely the mass/yield ratio of the device. This ratio is known to have distorted optical signatures when having a value of [redacted]. It was decided that if any French device used in this study had a mass/yield ratio greater than [redacted], the estimated diagnostic parameters would be disregarded. It can be seen from Table 1 that all of the events considered in this analysis were free of this type of distortion.

Considering the UK red band data which lies within the stated US optical band, the events Attic, Blasto and Creature all gave the following:

$\hat{I}_2/\hat{I}_1$	<3.0	(a near ground nuclear burst?)
$\hat{T}_2/\check{T}$	>7.0	(a nuclear airburst)

DECLASSIFIED
DNO WHG
Classification Lead
8 Apr 2026

In the orange band centred on 610 nmetres the following estimates were made:

Operation Loxwood

$\hat{T}_2/\check{T}$	> 7.0	for all events
$\hat{I}_2/\hat{I}_1$	> 7.0	for event Basford
$\hat{I}_2/\hat{I}_1$	< 3.0	for events Ovation and Montbretia

Operation Effort

$\hat{T}_2/\check{T}$	> 7.0	in all cases
$\hat{I}_2/\hat{I}_1$	> 3.0	in all cases

A strict interpretation of the above results would produce a conflicting picture; the red data indicated that the three events of the Effort series were both airbursts and near surface bursts. In the case of the orange data (610 nmetres) no comparison with US data can be made, but as seen in Table 1, events Ovation and Montbretia would certainly merit further investigation on account of their low values of $\hat{I}_2/\hat{I}_1$ ratio compared to those of the other events.

4. DISCUSSION

The UK data was obtained over a path length of 120 nautical miles from ground zero in narrow optical bands (20-30 nmetres) whereas the US data was obtained from a comparatively wide optical band (200 nmetres). The UK data can be assumed to have been affected only by scattering (attenuation), inverse square law and by the conditions of the detonation (height of burst). From this very small data base it would be difficult to refute the US red band criteria. It is also true that the US data base is small. At this time it would be unwise to blindly accept any criteria pending further work on the available optical data. There is a lack of red band UK data from likely contaminating events and further work could only increase confidence in the recognition criteria for nuclear airbursts.

No direct comparison of UK/US criteria can be made in the orange band. However, an inspection of the UK data in Table 1 suggests that some kind of similar threshold values for the ratios may be used to assess likely contamination. In particular the Ovation and Montbretia events stand out and on yield considerations alone, are the events most likely to have been contaminating. The mass/yield ratio for these two events was similar and unlikely to have had any influence on the optical signatures. Since it is known that this signature changes with wavelength, there would be no reason to expect that the same ratio values would result from measurements at different wavelengths.

In the publication "Effects of Nuclear Weapons", some discussion has been given to the relationship of device yield and height of burst. It is of dubious accuracy and states that:

$$H(\text{maximum for local fallout}) \approx 180\ W^{0.4}$$

H is in feet when W is in kilotons.

Values of H have been calculated for the various detonations considered in this note. See Table 1. They show that all of these events were detonated at

DECLASSIFIED
DNO WHG
Classification Lead
8 Apr 2026

heights from which local fallout would have been expected. It is believed that the circumstances of the French test were such that heavy local fallout was unlikely to have occurred.

The SDT review and analysis of all French data, currently in progress, should substantially increase confidence in the UK criteria for airburst (non-contaminating) events in a number of narrow optical bands.

[redacted]

[redacted]

4 March 1977

Bibliography

Effects of Nuclear Weapons pp 77
D. 101803 (SA)
J. 508622 (SAP)
J. 508763 (SAP)

DISTRIBUTION

Copy No.

[redacted]

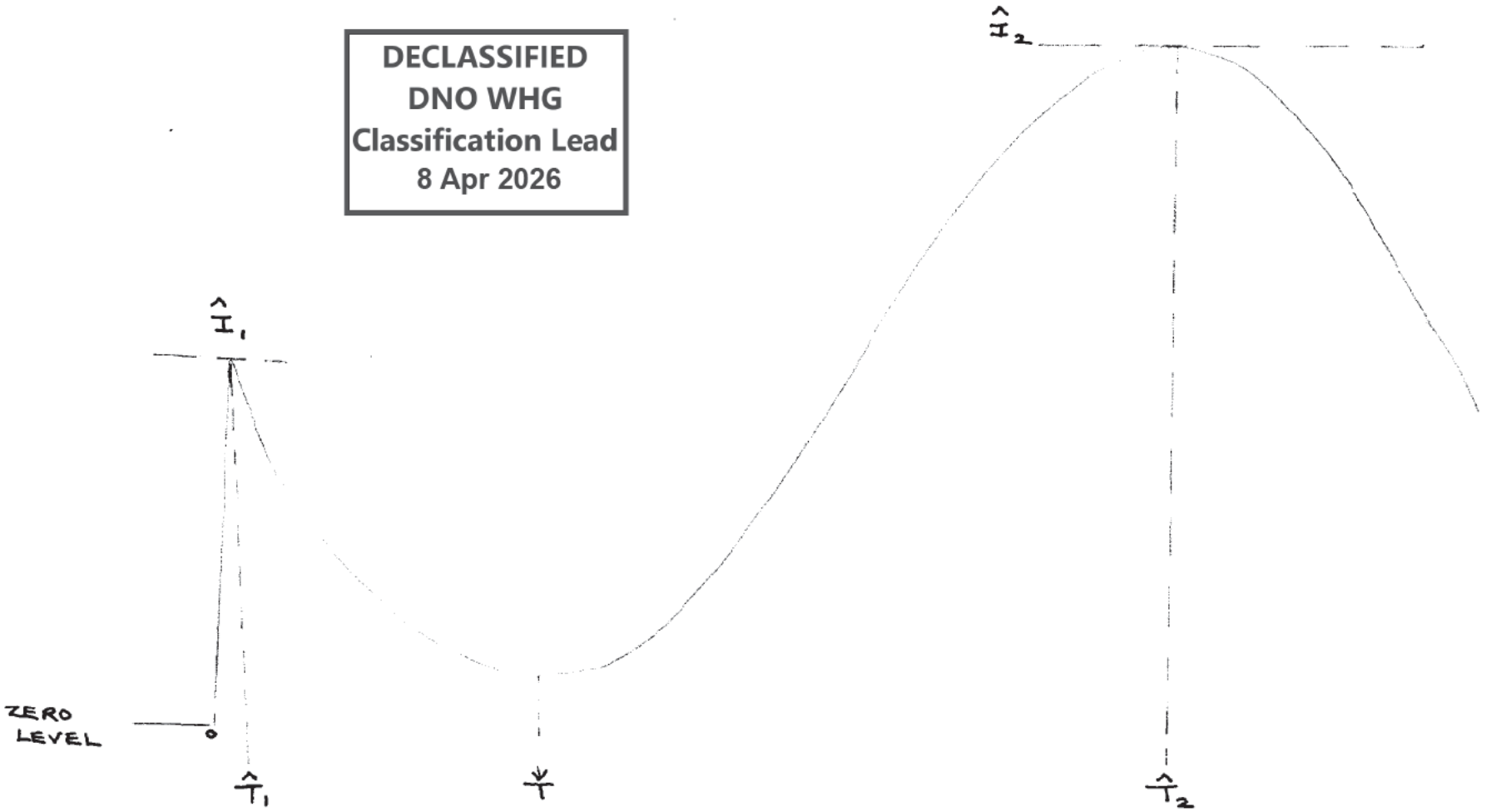
1
2
3
4

DECLASSIFIED
DNO WHG
Classification Lead
8 Apr 2026

Event	Series	Optical Band (n.metres)	Ratio $\hat{T}_2 / \check{T}$	Ratio $\hat{I}_2 / \hat{I}_1$	HOB (feet)	Yield (MT)	Weight of Device (Tonnes)	H (feet)	Mass/Yield (lbs/kT)
Basford	Loxwood	610	[redacted]	[redacted]	1900	[redacted]	[redacted]	2109	[redacted]
Ovation	Loxwood	610			1700			4049	
Montbretia	Loxwood	610			1950			3399	
Attic	Effort	610			1700			2931	
Blast	Effort	610			1600			2953	
Creature	Effort	610			1700			2473	
Attic	Effort	800			See above for Effort series				
Blast	Effort	800							
Creature	Effort	800							

SECRET ATOMIC PRINCIPAL

DECLASSIFIED
DNO WHG
Classification Lead
8 Apr 2026



DIAGRAMMATIC REPRESENTATION OF AN OPTICAL SIGNATURE FROM A NUCLEAR BURST

FIGURE 1