EG&G
B-2063

RAE

EDGERTON, GERMESHAUSEN & GRIER, INC.

FIREBALL CALCULATIONS
SHOT HUMBOLDT
OPERATION HARDTACK PHASE II
PROJECT 15.1

DISTRIBUTION STATEMENT A APPLIES
PER NTPR REVIEW.

Robert L. Hagen DATE 4/25/96

REPORT NO. B-2063
4 MARCH 1960

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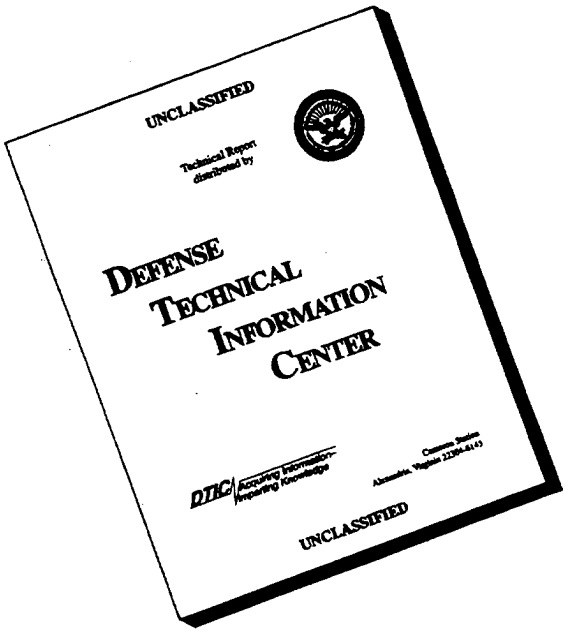

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ISST

29 May 1996

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OCD/MR. BILL BUSH

SUBJECT: Documents for DTIC System

There is no record of your office receiving the following reports:

EGG-B-2064 (4 March 1960)
Fireball Calculations Shot
Wrangell Operation Hardtack
Phase II, Project 15.1

EGG-B-2063 (4 March 1960)
Fireball Calculations Shot Humboldt
Operation Hardtack Phase II
Project 15.1

Both documents are now approved for public release.

Therefore, we are transmitting copies for inclusion into the DTIC system, if not found there.

Ardith Jarrett

ARDITH JARRETT
Chief, Technical Support

Enclosure:
A/S

FIREBALL CALCULATIONS

SHOT HUMBOLDT

OPERATION HARDTACK, PHASE II

PROJECT 15.1

Report No. B-2063
4 March 1960

Prepared by J. E. Campbell
J. E. Campbell

Approved by D. F. Seacord, Jr.
D. F. Seacord, Jr.

EDGERTON, GERMESHAUSEN & GRIER, INC.
Boston, Mass. Santa Barbara, Calif. Las Vegas, Nev.

FIREBALL CALCULATIONS - SHOT HUMBOLDT

1.0 INTRODUCTION

Shot Humboldt was a thirty-foot tower shot sponsored by LRL and detonated on 29 October 1958 in Area T-3V of the Nevada Test Site at 0645 PST.

The fireball yield was 3.3 tons ± 0.3 ton.

2.0 CAMERA INSTRUMENTATION AND OPERATION

Photographic coverage of fireball growth was provided by four high-speed Eastman cameras, two each at Station 3-357 (Transportainer No. 3) and Station 3-358 (White Truck No. 2). Two Rapatronic cameras were located at each of these stations to record early fireball growth. In addition, a 15,000 frame-per-second EG&G Framing camera was used, located at Station 3-358 (6 x 6 No. 1). All cameras produced good records of this low-yield tower shot.

Station locations together with burst location are shown in Figure 1. Figure 2 is a summary of the survey data.

3.0 RESULTS

Application of phi-comparison (EG&G Report No. B-1869) indicates a yield of 3.3 tons ± 0.3 ton for Shot Humboldt.

An air density of 1.097 grams per liter was used in the yield calculations, based on a pressure of 885 millibars, a temperature of 7.4°C, and a relative humidity of 46% at the height of the device at shot time.

The following table shows the comparison shots and the Humboldt yield obtained by the phi-comparison.

Comparison Shot	Humboldt Yield (Tons)
Air Drop	
Osage	3.35
Ranger A	3.17
Buster B	3.20
Wasp	3.41
Wasp[1]	3.41
Ranger E	3.25
Balloon	
Rushmore	3.51
Hidalgo	3.36
Lea	3.46
Tower	
Post	3.26
UK-3	3.25
Chaves	3.53
Hornet	3.33
Moth	3.19
Quay	3.24
	$\overline{W}$ = 3.3 tons

Diameter vs time and phi vs time plots are shown in Figs. 3 and 4.

The following data sheets are included for each film:

a) Photo Plan and Photo Loading Chart

b) Camera Data and Calculation Sheet

c) Diameter Measurement Sheet

d) E-102 Print-Out Sheet of D, t, and ϕ

The zero-frame times of the Eastman and Framing camera records were determined by comparison with the Rapatronic diameter-time data.

Appendix A contains photographic examples of the Humboldt fireball.

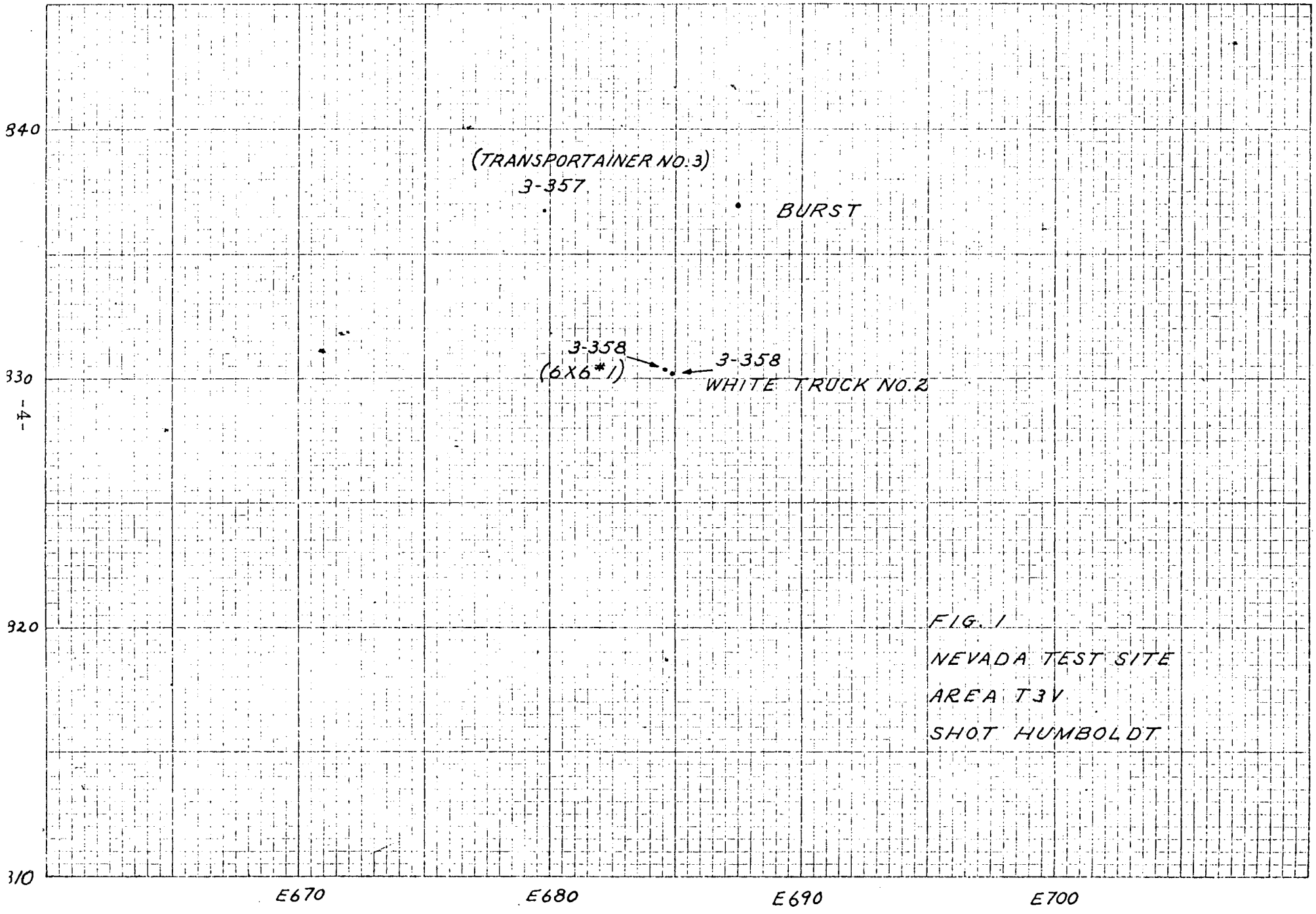


FIG. 2

HUMBOLDT

DATE 10/29/58

SURVEY DATA

GZ STA. T3V

STA.	COORDINATES			FROM PHOTO STA.			DIST. HOR.		TANGENTS		ANGLES	
	N	E	Z	ΔN	ΔE	ΔZ	FT.	M.	ΔN/ΔE	ΔZ/DIST.	BRG	TILT
T3V	836984	687378	4054*									
TRANS'P'TAINER #3 3-357	836766	679706	4046	+218	+7672	+8	7675.1	2339.4	35.1927	0.00104	88°22'	0°04'
White Truck No.2 3-358	830358	684829	3997	+6626	+2549	+57	7099.4	2163.9	.3847	0.00803	21°03'	0°28'
3-358 6x6 #1	830366	684801	3997	+6618	+2577	+57	7102.0	2164.7	.3894	0.00803	21°17'	0°28'
	BEARING ANGLES REPRESENT TRUE AZIMUTH FROM PHOTO STA. TO GROUND ZERO.											
	TILT ANGLES ARE MEASURED FROM THE PHOTO STATION TO SHOT CAB OR AIR ZERO											
*	INCLUDES 30 FEET, HEIGHT OF TOWER.											

FORM E17(1-55 500) NAME ANALYSIS EDGERTON, GERMESHAUSEN & GRIER INC.

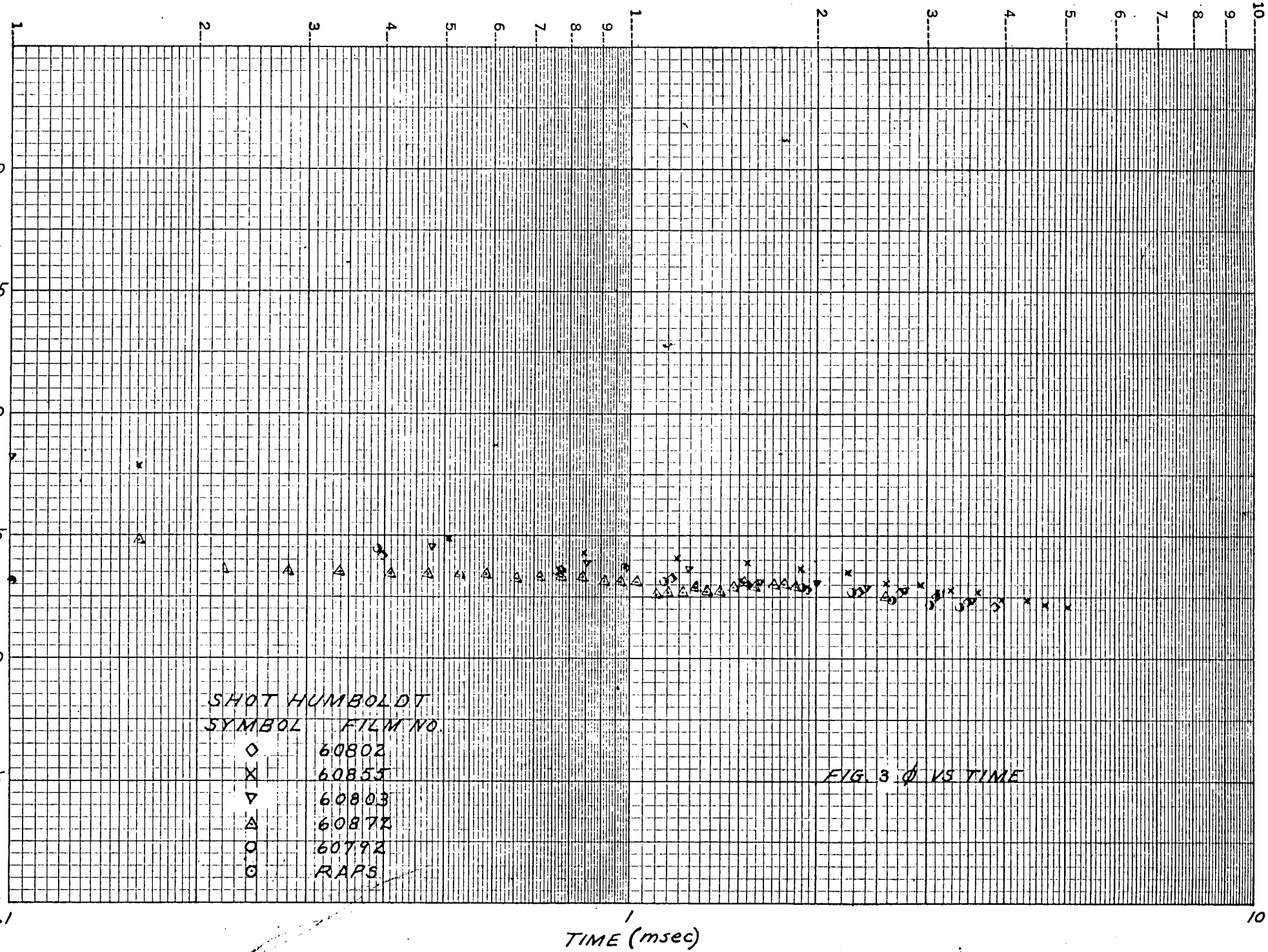


FIG. 3 φ VS TIME

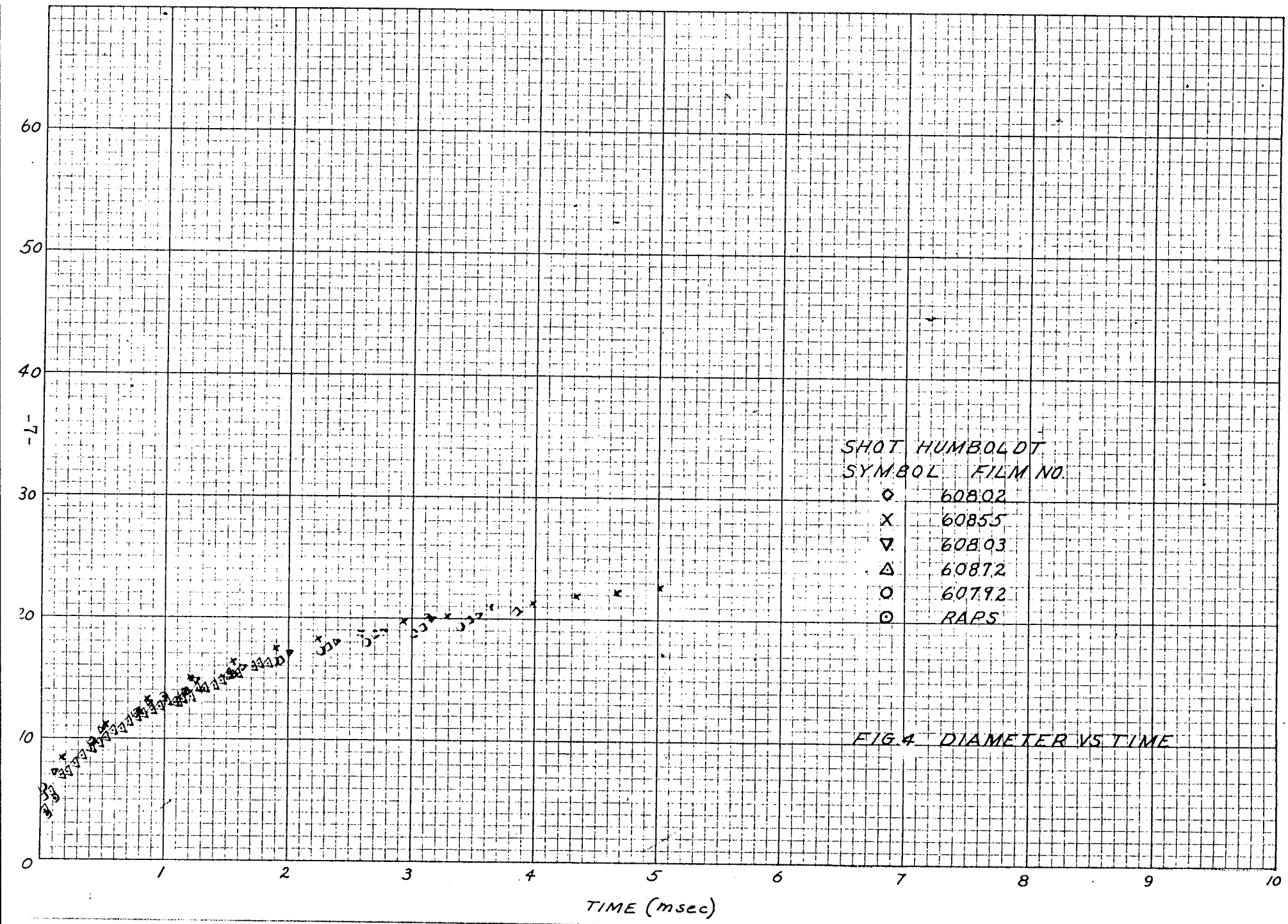


FIG 4 DIAMETER VS TIME

Table I

Hardtack Phase II, Humboldt
Fireball Camera Distribution

Station	Camera	Qualitative Functioning
3-357 Transportainer No. 3	E-33	Record
	E-1	Record
	R-34	Record
	R-30	Record
3-358 White Truck No. 2	E-11	Record
	E-5	Record
	XR-3	Record
	R-4	Record
3-358 6 x 6 No. 1	Framing	Record

Table II

Hardtack Phase II, Humboldt
Average Diameter vs Time

Time (m sec)	Diameter (meters)
0.5	10.5
1.0	13.5
1.5	15.5
2.0	17.0
2.5	18.5
3.0	19.5
3.5	20.0
4.0	21.0

Table III

Hardtack Phase II, Humboldt

Rapatronic Summary

Station	Film No.	Camera No.	Horizontal Range (m)	F. L. (mm)	Diameter (m)	Time (ms)
3-357	60851	R-34	2339.3	479.03	13.67	0.99
	60852	R-30	2339.3	479.30	3.75	0.05
3-358	60794	XR-3	2163.9	476.76	5.21	0.10
	60795	R-4	2163.9	477.82	20.17	3.15

STATION NO. 3-358
STATION TYPE 6x6 #1
DISTANCE GZ 7102.0 ft
DISTANCE OBJECT 7102.3 ft

PHOTO PLAN

BRG 21°17'

EVENT HUMBOLDT
GZ STA. T3V
DATE 10/29/58
POSTED

	STATION	GZ	DIFF.	TILT
N	830 366	836 984	6 618	GZ 0°13'
E	684 801	687 378	2 577	OBJ 0°28'
Z	3 997	4 054*	57	

CAMERA			LENS			FIELD TARGET H/V	AIMING			POWER			MARKER		DELAY	FILM	PURPOSE	REMARKS
NO.	NOM SPD.	RACK POS.	FOC. MM	S/N	FILTER		OBJECT	H	V	VOLTS	SHUT RHEO.	TIME ON/OFF	TYPE	S/N				
FR	16,000	=	10 in.		ND·5 W-12		F.B	0°00'	0°29'	115 AC 24 DC	MAX	-1/+1	200	1	=		15.1	
-10-																		

REMARKS *INCLUDES 30 ft, height of Tower

FINAL

PHOTO LOADING CHART

STATION 3-358 6x6 #1 EVENT HUMBOLDT DATE 10/29/58

FILM					CAMERA			LENS		EXPOSURE			REMARKS
TYPE	EMULS. NO.	SIZE	HOLDER	PERF. NO.	NO.	RACK POS.	NOM. SPD.	FOC. MM	FILTER	APER	SHUTTER RHEO.	W/M^2	
MF		35x11	CASSETTE	60,872	FR #2	=	16,000	10 in.	ND.5 W-12	f9.0	MAX	1×10^5	

DATE FILM LOADED _____ DATE CAMERA LOADED _____ DATE EXPOSED _____

REMARKS _____

FINAL

FORM E-40

EDGERTON, GERMESHAUSEN & GRIER, INC.

PHOTO PLAN

TATION NO. 3-358
TATION TYPE WHITE TRUCK No. 2
ISTANCE GZ 7099.4 ft
ISTANCE OBJECT 7100.0 ft

STATION	G Z	DIFF.
N 830 358	836 984	6626
E 684 829	687 378	2549
Z 3 997	4 054*	57

BRG 21°03'
TILT GZ 0°13' OBJ 0°28'

EVENT HUMBOLDT
GZ STA. T 3V
DATE 10/29/58
POSTED 10/31/58

CAMERA NO.	CAMERA NOM SPD.	CAMERA RACK POS.	LENS FOC. MM	LENS S/N	LENS FILTER	FIELD TARGET H/V	AIMING OBJECT	AIMING H	AIMING V	POWER VOLTS	POWER SHUT RHEO.	POWER TIME ON/OFF	MARKER TYPE	MARKER S/N	DELAY μs	FILM	PURPOSE	REMARKS
E-11	2500	C-1	305	784691	ND-1 W-12	.210 .165	F.B	0°00'	+0°29'	120 DC	40/80	-1.5/+1.5	200	60	=	MF	15.1	
E-5	2500	C-2	254	876312	W-12	.250 .196	F.B	0°00'	+0°45'	120 DC	40/80	-1.5/+1.5	200	10	=	MF	15.1	
XR-3	4μs COIL	A-1	480	774695	ND-1	.740 .740	F.B.	0°00'	+0°16'	115 AC 24 DC	BULB	=	FM	5	100	RP	15.1	100 μsec delay
R-4	40μs COIL	A-2	480	773952	=	.740 .740	F.B.	0°00'	+0°09'	115 AC 24 DC	BULB	=	FM	5	3000	RP	15.1	3000 μsec delay
30 SP	64	L C-3	18.5	11026	=	4.150 2.590	DOC.	0°00'	+8°29'	24 DC	133°	-5/+30	=	=	=	D KDC	15.1	
110 SP	64	R C-3	18.5	12297	=	4.150 2.590	DOC.	0°00'	+8°30'	24 DC	133°	-5/+30	=	=	=	D KDC	15.1	
						ACTUAL RAP DELAYS												
						XR-3	97.4 μsec + 2 μsec half coil delay											
						R-4	3127.6 μsec + 20 μsec half coil delay											

REMARKS * INCLUDES 30 ft, HEIGHT OF TOWER

FINAL

PHOTO LOADING CHART

STATION 3-358 WHITE TRUCK NO. 2 EVENT HUMBOLDT DATE 10/29/58

FILM					CAMERA			LENS		EXPOSURE			REMARKS
TYPE	EMULS. NO.	SIZE	HOLDER	PERF. NO.	NO.	RACK POS.	NOM. SPD.	FOC. MM	FILTER	APER.	SHUTTER RHEO.	W/M²	
MF		16-100	H.S. REEL	60792	E-11	C-1	2500	305	ND-1 + W-12	f 9.0	40/80		
MF		16-100	H.S. REEL	60855	E-5	C-2	2500	254	W-12	f 5.0	40/80		
RP		2¼-3¼	RAP HOLDER	60794	XR-3	A-1	4 μs COIL	480	ND-1	f 11.0	BULB	3×10^6	100 μs DELAY
RP		2¼-3¼	RAP HOLDER	60795	R-4	A-2	40 μs COIL	480	=	f 11.0	BULB	3×10^5	3000 μs DELAY
D KDC		16-50	U-MAG	60796	30 GSP	C-3	64	18.5	=	f 3.2	133°	WESTON 300	
D KDC		16-50	U-MAG	60797	110 GSP	C-3	64	18.5	=	f 4.5	133°	WESTON 600	
					ACTUAL RAP DELAYS								
					XR-3	97.4 μsec		+ 2 μsec half coil delay					
					R-4	312	7.6 μsec	+ 20 μsec half coil delay					

DATE FILM LOADED _____ DATE CAMERA LOADED _____ DATE EXPOSED _____

REMARKS _____

FINAL

FORM E-40

EDGERTON, GERMESHAUSEN & GRIER, INC.

STATION NO. 3-357

STATION TYPE TRANSPORTAINER No. 3

DISTANCE GZ 7675.1 ft

DISTANCE OBJECT 7675.3 ft

PHOTO PLAN

BRG 88° 22'

EVENT HUMBOLDT

GZ STA. T3V

DATE 10/29/58

POSTED 10/31/58

	STATION	GZ	DIFF.	TILT
N	836 766	836 984	218	GZ −0° 10'
E	679 706	687 378	7672	OBJ 0° 4'
Z	4 046	4 054*	8	

CAMERA			LENS			FIELD TARGET H/V	AIMING			POWER			MARKER		DELAY μs	FILM	PURPOSE	REMARKS
NO.	NOM SPD.	RACK POS.	FOC. MM	S/N	FILTER		OBJECT	H	V	VOLTS	SHUT RHEO.	TIME ON/OFF	TYPE	S/N				
E-33	2500	B-2	305	784702	ND-1 W-12	.225 .175	F.B.	0°00'	+0°27'	120DC	40/80	−1.5/+1.5	200	4	=	MF	15.1	
E-1	2500	B-1	500	C73377	W-12	.225 .175	F.B.	0°00'	−0°4'	120DC	40/80	−1.5/+1.5	200	2	=	MF	15.1	
M-2	100	A-1	50	MA4481	W-12	3.800 2.450	CLOUD	0°00'	+7°48'	120DC	170°	−5/+30	200	4	=	FX	15.1	
R-34	40μs COIL	A-2	480	773948	=	.800 .800	F.B.	0°00'	+0°27'	115AC 24DC	BULB	=	FM	11	1000 μs	RP	15.1	1000 μsec delay
R-30	4μs COIL	A-3	480	773953	ND-1	.800 .800	F.B.	0°00'	+0°2'	115AC 24DC	BULB	=	FM	11	50	RP	15.1	50 μsec delay
60 GSP	64	L A-1	25	69261	=	3.195 1.960	DOC.	0°00'	+7°58'	24DC	133°	−5/+30	=	=	=	D KDC	15.1	
128 GSP	64	R A-1	18.5	12318	=	4.485 2.800	DOC.	0°00'	+0°24'	24DC	133°	−5/+30	=	=	=	D KDC	15.1	
						ACTUAL RAP DELAYS												
						R-34	968.4 μsec + 20 μsec half coil delay											
						R-30	53.9 μsec + 2 μsec half coil delay											

REMARKS * INCLUDES 30 ft HEIGHT OF TOWER

FINAL

FORM 8-40 A

EDGERTON, GERMESHAUSEN & GRIER, INC.

PHOTO LOADING CHART

STATION 3-357 TRANSPORTAINER NO.3 EVENT HUMBOLDT DATE 10/29/58

FILM					CAMERA			LENS		EXPOSURE			REMARKS
TYPE	EMULS. NO.	SIZE	HOLDER	PERF. NO.	NO.	RACK POS.	NOM. SPD.	FOC. MM	FILTER	APER.	SHUTTER RHEO.	W/M²	
MF		16-100	H.S. REEL	60802	E-33	B-2	2500	305	ND-1 + W-12	f8.0	40/80	3×10^5	
MF		16-100	H.S. REEL	60803	E-1	B-1	2500	500	W-12	f6.3	40/80	2×10^4	
FX		35-200	MIT MAG	60850	M-2	A-1	100	50	W-12	f4.0	170°	WESTON 400	FAST PROCESS
RP		2¼-3¼	RAP HOLDER	60851	R 34	A-2	40μs Coil	480	=	f11.0	BULB	3×10^5	1000μsec delay
RP		2¼-3¼	RAP HOLDER	60852	R 30	A-3	4μs Coil	480	ND-1	f11.0	BULB	1.5×10^7	50μsec delay
D KDC		16-50	U-MAG	60806	60 GSP	A-1	64	25	=	f4.0	133°	WESTON 500	
D KDC		16-50	U-MAG	60807	128 GSP	A-1	64	18.5	=	f5.6	133°	WESTON 800	
					ACTUAL RAP DELAYS								
					R-34	968.4 μsec +		20 μsec		half coil delay.			
					R-30	53.9 μsec +		2 μsec		half coil delay			

DATE FILM LOADED _____ DATE CAMERA LOADED _____ DATE EXPOSED _____

REMARKS _____

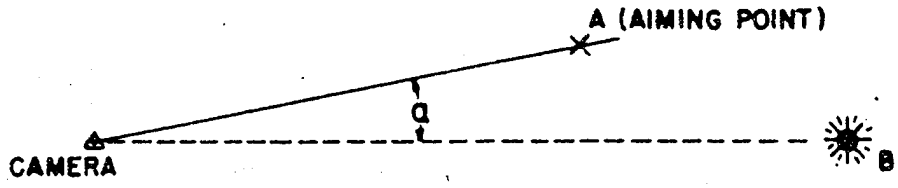
FINAL

FORM E-40

EDGERTON, GERMESHAUSEN & GRIER, INC.

CAMERA DATA & CALCULATIONS

FILM NO. 60794	STATION NO. WHITE TRUCK NO. 2 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. XR-3	EQ. AP.		DATE: 12/1/58



HORIZONTAL PROJECTION

A. $R^{0}/_{A} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

$\alpha =$ 0°00′	$\beta =$ 0°45′	$H_B =$ 4054 ft
$\cos\alpha =$ 1.00000	$\cos\beta =$ 0.999914	$H_C =$ 3997 ft
$CB_h =$ 2163.9 m	$\sin\beta =$ 0.013090	$\Delta H =$ 57 ft = 17.4 m
$CB_h \cos\alpha \cos\beta =$ 2163.7 m	$\Delta H \sin\beta =$ 0.23 m	$R^{0}/_{A} =$ 2163.93 m

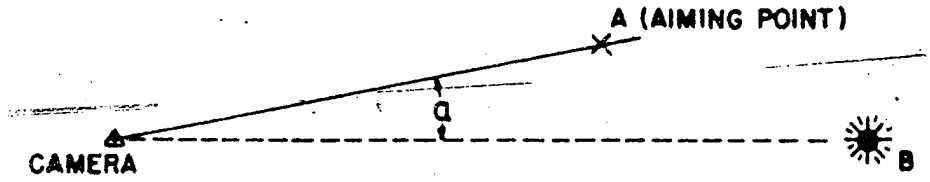
B. FOCAL LENGTH 476.76 mm (774695)

C. MAGNIFICATION FACTOR (meters/in.) 115.29

D. ZERO TIME CORRECTION 0.10 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60795	STATION NO. WHITE TRUCK NO. 2 3-358	TEST HUMBOLDT	CALCULATED BY: JE
CAMERA NO. R-4	EQ. AP.		DATE: 12/1/58



A. $R^{\circ}/_{A} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0° 00'	β = 0°45'	H_B = 4054 ft
cos α = 1.00000	cos β = 0.999914	H_C = 3997 ft
CB_h = 2163.9 m	sin β = 0.013090	ΔH = 57 ft = 17.4 m
$CB_h \cos\alpha \cos\beta$ = 2163.7 m	$\Delta H \sin\beta$ = 0.23 m	$R^{\circ}/_{A}$ = 2163.93 m

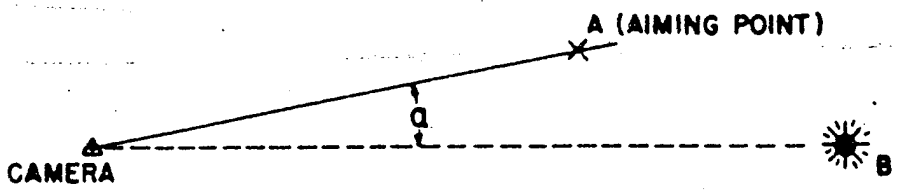
B. FOCAL LENGTH 477.82 mm (773952)

C. MAGNIFICATION FACTOR (meters/in.) 115.03

D. ZERO TIME CORRECTION 3.15 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60851	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. R-34	EQ. AP.		DATE: 12/1/58



HORIZONTAL PROJECTION

A. $R^{0}/_{A} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0°00′	β = 0°27′	H_B = 4054 ft
cos α = 1.00000	cos β = 0.99997	H_C = 4046 ft
CB_h = 2339.4 m	sin β = 0.00785	ΔH = 8 ft = 2.44 m
$CB_h \cos\alpha \cos\beta$ = 2339.3 m	$\Delta H \sin\beta$ = 0.00 m	$R^{0}/_{A}$ = 2339.3 m

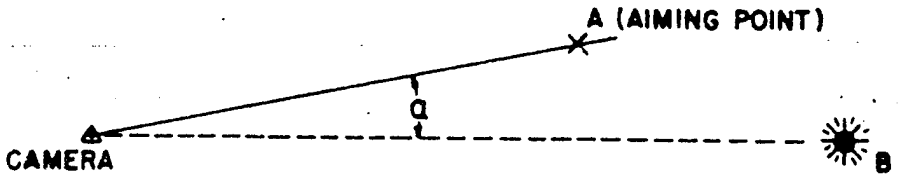
B. FOCAL LENGTH 479.03 mm (773948)

C. MAGNIFICATION FACTOR (meters/in.) 124.04

D. ZERO TIME CORRECTION 0.99 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60852	STATION NO. 3-357 TRANSDYNAMIC No. 3	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. R-30	EQ. AP.		DATE: 12/1/58



HORIZONTAL PROJECTION

A. $R^{O}/_{A} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0° 00′	β = 0° 27′	H_B = 4054 ft
$\cos\alpha$ = 1.00000	$\cos\beta$ = 0.99997	H_C = 4046 ft
CB_h = 2339.4 m	$\sin\beta$ = 0.00785	ΔH = 8 ft = 2.44 m
$CB_h \cos\alpha \cos\beta$ = 2339.3 m	$\Delta H \sin\beta$ = 0.00 m	$R^{O}/_{A}$ = 2339.3 m

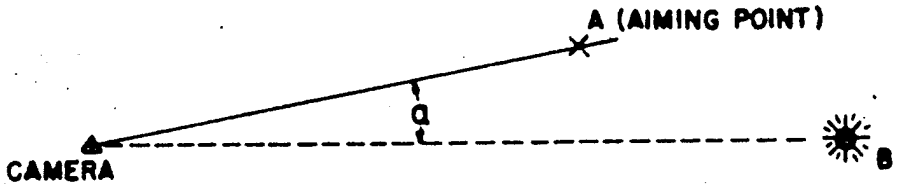
B. FOCAL LENGTH 479.30 mm (773953)

C. MAGNIFICATION FACTOR (meters/in.) 123.97

D. ZERO TIME CORRECTION 0.05 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60855	STATION NO. WHITE TRUCK NO 2 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-5	EQ. AP.		DATE: 10/29/58



HORIZONTAL PROJECTION

A. $R_{A}^{0} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0° 00'	β = 0° 45'	H_B = 4054 ft
$\cos\alpha$ = 1.00000	$\cos\beta$ = 0.999914	H_C = 3997 ft
CB_h = 2163.9 m	$\sin\beta$ = 0.013090	ΔH = 57 ft = 17.4 m
$CB_h \cos\alpha \cos\beta$ = 2163.7 m	$\Delta H \sin\beta$ = 0.23 m	R_{A}^{0} = 2163.93 m

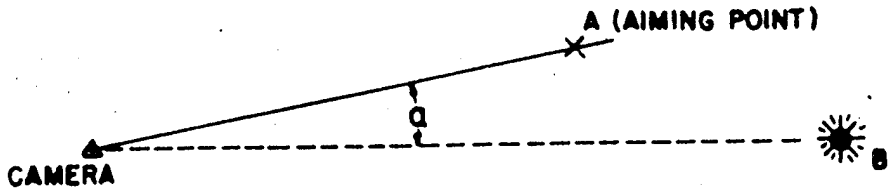
B. FOCAL LENGTH 250.2 mm (876312)

C. MAGNIFICATION FACTOR (meters/in.) 219.68

D. ZERO TIME CORRECTION 0.16 msec

CAMERA DATA & CALCULATIONS

FILM NO. 60855	STATION NO. WHITE TRUCK NO 2 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-5	EQ. AP.		DATE: 10/29/58



HORIZONTAL PROJECTION

A. $R\%_A = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0° 00'	β = 0°45'	H_B = 4054 ft
$\cos\alpha$ = 1.00000	$\cos\beta$ = 0.999914	H_C = 3997 ft
CB_h = 2163.9 m	$\sin\beta$ = 0.013090	ΔH = 57 ft = 17.4 m
$CB_h \cos\alpha \cos\beta$ = 2163.7 m	$\Delta H \sin\beta$ = 0.23 m	$R\%_A$ = 2163.93 m

B. FOCAL LENGTH 250.2 mm (876312)

C. MAGNIFICATION FACTOR (meters/in.) 219.68

D. ZERO TIME CORRECTION 0.16 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT FILM NO. 60855

Fr. No.	Mag.	D_1	D_2	D_3	D_{avg} (m)	FLEXOWRITER D_{avg} (m) xxx.xx	FLEXOWRITER t (ms)
0	29.00	0111	0114		8.53		0.16
1		0147	0151		11.29		0.51
2		0173	0180		13.38		0.85
3		0197	0200		15.05		1.20
4		0214	0221		16.49		1.55
5		0230	0233		17.55		1.90
6		0239	0249		18.50		2.25
7		0248	0254		19.03		2.59
8		0258	0266		19.86		2.94
9		0268	0271		20.43		3.29
10		0276	0280		21.07		3.64
11		0284	0282		21.45		3.99
12		0288	0294		22.06		4.35
13		0294	0300		22.51		4.68
14		0298	0305		22.85		5.03

READ BY GGO JEC TYPED BY

DATE 10/29/58 DATE

REMARKS:

FIREBALL CALCULATIONS

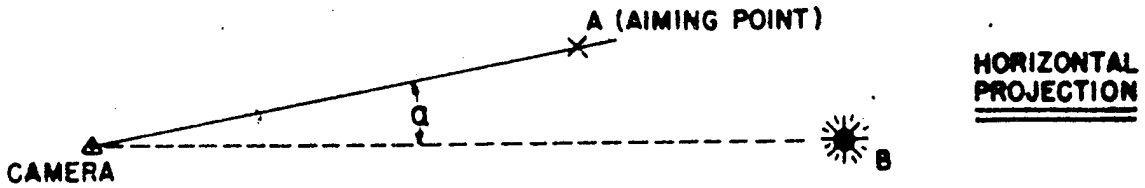
SHOT HUMBOLDT FILM NO. 60855

DATE

D	t	ln D	Int	$t^{2/5}$	ϕ
9.53	.15	2.147 66	1.83250 -	.480463	17.753
11.99	.51	2.483 84	.67335 -	.763922	14779
13.38	.85	2.593 77	.16245 -	.937085	14278
15.05	1.20	2.711 45	.18225	1.075626	13991
16.49	1.55	2.802 83	.43833	1.191642	13838
17.55	1.90	2.865 11	.64187	1.292721	13576
18.50	2.25	2.917 80	.81086	1.383128	13375
19.03	2.59	2.946 04	.95158	1.463210	13005
19.86	2.94	2.988 70	1.07937	1.537933	12901
20.43	3.29	3.016 99	1.19090	1.610207	12687
21.07	3.64	3.047 82	1.29204	1.676084	12566
21.45	3.99	3.065 68	1.38386	1.739412	12331
22.06	4.35	3.093 71	1.47024	1.800558	12251
22.51	4.68	3.113 90	1.54733	1.853981	12141
22.25	5.03	3.100 29	1.61542	1.908217	11974

CAMERA DATA & CALCULATIONS

FILM NO. 60802	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-33	EQ. AP.		DATE: 12/1/58



A. $R^{0}/_{A} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0° 00′	β = 0° 27′	H_B = 4054 ft
cos α = 1.00000	cos β = 0.99997	H_C = 4046 ft
CB_h = 2339.4 m	sin β = 0.00785	ΔH = 8 ft = 2.44 m
$CB_h \cos\alpha \cos\beta$ = 2339.3 m	$\Delta H \sin\beta$ = 0.00 m	$R^{0}/_{A}$ = 2339.3 m

B. FOCAL LENGTH 306.9 mm (784702)

C. MAGNIFICATION FACTOR (meters/in.) 193.6

D. ZERO TIME CORRECTION 0.01 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT FILM NO. 60802

Fr. No.	Mag.	D_1	D_2	D_3	D_{avg} (m)	FLEXOWRITER D_{avg} (m) xxx.xx	FLEXOWRITER t (ms)
0	48.15	0129	0131		5.23		0.01
1		0247	0240		9.79		0.40
2		0308	0304		12.30		0.78
3		0211	0208		14.04		1.17
4		0231	0228		15.38		1.55
5		0247	0247		16.55		1.94
6		0264	0264		17.69		2.33
7		0279	0281		18.76		2.71
8		0291	0291		19.50		3.10
9		0300	0301		20.13		3.48
10		0307	0308		20.60		3.87

READ BY LW JEC TYPED BY

DATE 10/29/58 DATE

REMARKS:

FIREBALL CALCULATIONS

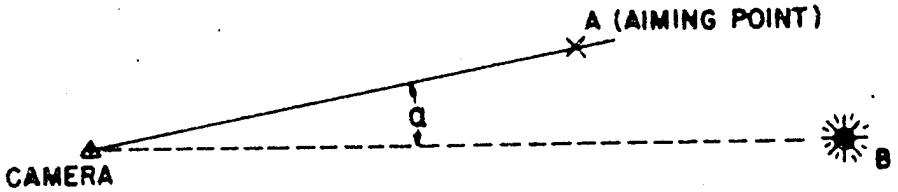
SHOT HUMBOLDT FILM NO. 60802

DATE

D	t	ln D	ln t	$t^{2/5}$	ϕ
5.23	.01	1.654 39	4.605 09 -	.1 590 64	32.8 79
9 79	40	2 281 33	916 21 -	6 931 64	14 1 23
12 30	78	2 509 55	248 44 -	9 053 99	13 5 85
14 04	1 17	2 641 95	15693	10 647 84	13 1 85
15 38	1 55	2 733 14	43833	11 916 42	12 9 06
16 55	1 94	2 806 46	66269	13 035 33	12 6 96
17 69	2 33	2 873 05	84579	14 025 88	12 6 12
18 75	2 71	2 931 75	996 88	14 899 65	12 5 90
19 50	3 10	2 970 42	1 131 39	15 723 27	12 4 01
20 13	3 48	3 002 20	1 24707	16 467 95	12 2 23
20 60	3 87	3 025 27	1 35332	17 182 93	11 9 88

CAMERA DATA & CALCULATIONS

FILM NO. 60803	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-1	EQ. AP.		DATE: 12/1/58



HORIZONTAL PROJECTION

A. $R^{\circ}/_{A} = CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

α = 0° 00′	β = −0° 4′	H_B = 4054 ft
$\cos\alpha$ = 1.00000	$\cos\beta$ = 1.00000	H_C = 4046 ft
CB_h = 2339.4 m	$\sin\beta$ = 0.00116	ΔH = 8 ft = 2.44 m
$CB_h \cos\alpha \cos\beta$ = 2339.4 m	$\Delta H \sin\beta$ = 0.00 m	$R^{\circ}/_{A}$ = 2339.4 m

B. FOCAL LENGTH 541.6 mm (C73377)

C. MAGNIFICATION FACTOR (meters/in.) 109.7

D. ZERO TIME CORRECTION 0.10 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT FILM NO. 60803

Fr. No.	Mag.	D_1	D_2	D_3	D_{avg} (m)	FLEXOWRITER D_{avg} (m) xxx.xx	FLEXOWRITER t (ms)
0	28.90	0191	0191		7.26		0.10
1		0282	0286		10.79		0.48
2	19.23	0228	0230		13.05		0.86
3		0258	0263		14.85		1.25
4		0278	0282		15.96		1.63
5		0301	0301		17.16		2.01
6	9.66	0161	0160		18.23		2.40
7		0169	0167		19.08		2.78
8		0177	0176		20.05		3.17
9		0182	0179		20.50		3.55

READ BY plw rh TYPED BY

DATE 10/29/58 DATE

REMARKS:

FIREBALL CALCULATIONS

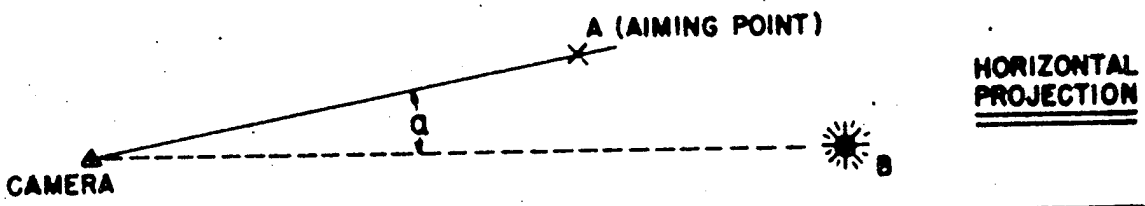
SHOT HUMBOLDT FILM NO. 6 0803

DATE

D	t	ln D	Int	$t^{2/5}$	ϕ
7.26	.10	1.98234	2.30251 -	.398119	18235
10 79	48	2 378 56	73394 -	7 45590	14471
13 05	86	2 568 78	15075 -	9 41480	13861
14 85	1.25	2 698 07	22310	10 93345	13582
15 96	1 63	2 770 16	48865	12 15873	13126
17 16	2 01	2 842 65	69812	13 22137	12978
18 23	2 40	2 903 11	87539	14 19290	12844
19 08	2 78	2 948 66	1 02239	15 05247	12675
20 05	3 17	2 998 22	1 15373	15 86440	12638
20 50	3 55	3 02040	1 26700	16 59971	12349

CAMERA DATA & CALCULATIONS

30792	STATION NO. WHITE TRUCK NO.2 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
λ E-11	EQ. AP.		DATE: 12/1/58



$= CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

'	β = 0° 29'	H_B = 4054 ft
00000	$\cos\beta$ = 0.99996	H_C = 3997 ft
63.9 m	$\sin\beta$ = 0.00844	ΔH = 57 ft = 17.37 m
$\cos\beta$ = 2163.8 m	$\Delta H \sin\beta$ = 0.1 m	$R^0/_A$ = 2163.9 m

AL LENGTH 305.9 mm (784691)

NIFICATION FACTOR (meters/in.) 179.68

O TIME CORRECTION 0.01 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT FILM NO. 60792

Fr. No.	Mag.	D_1	D_2	D_3	D_{avg} (m)	FLEXOWRITER D_{avg} (m) xxx.xx	FLEXOWRITER t (ms)
0	48.15	0161	0161	0161	6.00		0.01
1		0267	0259	0267	9.86		0.39
2		0328	0326	0330	12.23		0.76
3	28.90	0229	0219	0220	13.85		1.14
4		0253	0245	0241	15.32		1.51
5		0272	0259	0265	16.50		1.89
6		0287	0276	0277	17.42		2.27
7		0298	0290	0288	18.16		2.64
8		0309	0298	0305	18.90		3.02
9		0322	0308	0314	19.57		3.40

READ BY plw jc rh TYPED BY

DATE 10/29/58 DATE

REMARKS:

FIREBALL CALCULATIONS

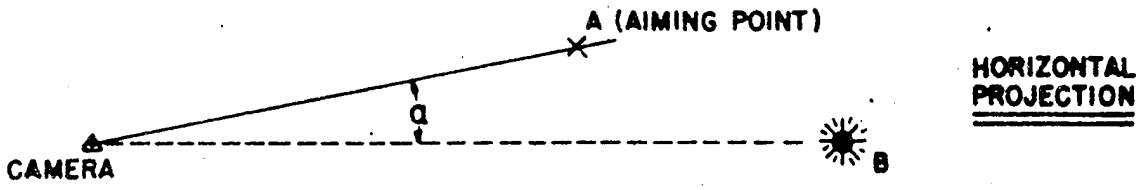
SHOT HUMBOLDT FILM NO. 60792

DATE

b	t	ln D	ln t	$t^{2/3}$	ϕ
6.00	.01	1.79168	4.60509 -	.159064	37.720
9.86	39	2.28844	94153 -	686180	14369
12.23	76	2.50384	.27444 -	896034	13649
13.85	1.14	2.62832	13095	1.053776	13143
15.32	1.51	2.72923	41218	1.179242	12991
16.50	1.89	2.80343	63659	1.289997	12790
17.42	2.27	2.85768	81971	1.388031	12550
18.16	2.64	2.89926	97070	1.474446	12316
18.90	3.02	2.93918	1.10523	1.555961	12146
19.57	3.40	2.97400	1.22381	1.631539	11994

CAMERA DATA & CALCULATIONS

0872	STATION NO. 3-358 (6×6 #1)	TEST HUMBOLDT	CALCULATED BY: JEC
. FRAMING	EQ. AP.		DATE: 1/29/60



HORIZONTAL PROJECTION

: $CB_h \cos\alpha \cos\beta + (H_B - H_C) \sin\beta$

0'	β = 0° 29'	H_B = 4054 ft
10000	$\cos\beta$ = 0.99996	H_C = 3997 ft
4.7 m	$\sin\beta$ = 0.00844	ΔH = 57 ft = 17.37 m
$\cos\beta$ = 2164.6 m	$\Delta H \sin\beta$ = 0.1 m	$R^0/_A$ = 2164.7 m

L LENGTH

IFICATION FACTOR (meters/in.)

TIME CORRECTION 0.03 msec 1/2 fr

DIAMETER MEASUREMENTS

SHOT HUMBOLDT FILM NO. 60872

Fr. No.	Mag.	D_1	D_2	D_3	D_{avg} (m)	FLEXOWRITER D_{avg} (m) xxx.xx	FLEXOWRITER t (ms)
0	48.34	0092	0099		4.16		0.03
1		0128	0131		5.72		0.09
2		0157	0161		7.13		0.16
3		0168	0167		7.46		0.22
4		0182	0188		8.14		0.28
5		0195	0201		8.80		0.34
6		0208	0214		9.41		0.41
7		0222	0229		9.91		0.47
8		0233	0237		10.39		0.53
9		0247	0248		10.85		0.59
10		0257	0257		11.19		0.66
11		0264	0267		11.73		0.72
12		0274	0275		12.14		0.78
13		0277	0284		12.37		0.84
14		0293	0290		12.66		0.91
15		0173	0178		12.98		0.97
16		0184	0184		13.35		1.03
17		0176	0181		13.10		1.10
18		0182	0184		13.55		1.16
19		0186	0189		13.77		1.22
20		0195	0195		14.38		1.28
21		0198	0200		14.33		1.34
22		0202	0201		14.74		1.41
23		0208	0208		15.11		1.47
24		0213	0213		15.60		1.53
25		0210	0208		15.55		1.60
26		0.0.F	0.0.F		--		1.72
27		0222	0218		16.24		1.78
28		0222	0223		16.48		1.85
29		0221	0226		16.53		

READ BY JEC RCS TYPED BY

DATE 1/29/60 DATE

REMARKS:

FIREBALL CALCULATIONS

SHOT HUMBOLDT FILM NO. 60872

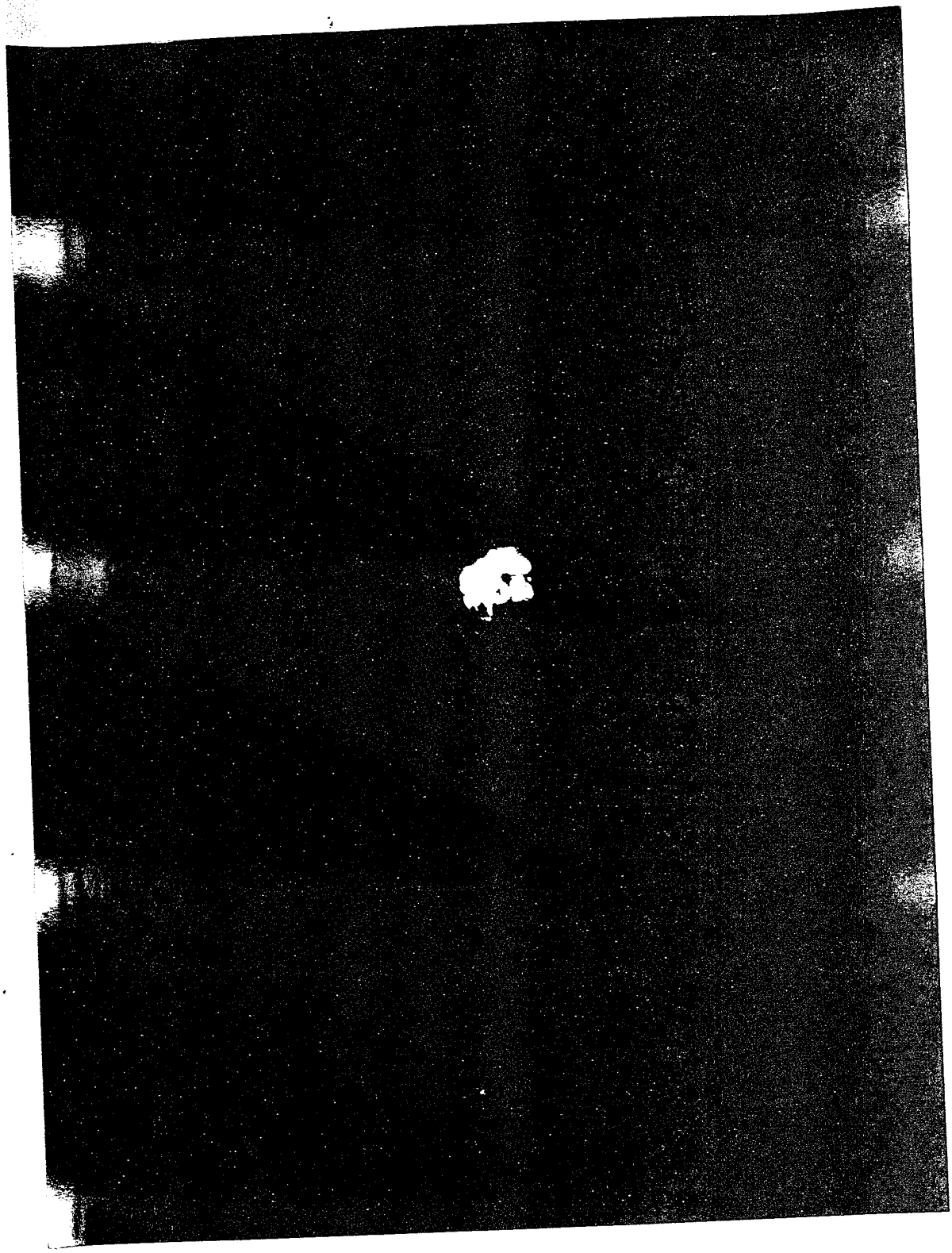
DATE

D	t	ln D	Int	$t^{2/5}$	ϕ
4.16	.03	1.425 59	3.506 58 -	.2459 99	16910
572	09	1 743 90	2 407 87 -	3816 91	14985
713	16	1 964 27	1 832 50 -	4804 63	14839
746	22	2 009 54	1 551 418 -	5457 06	13670
814	28	2 096 83	1 273 02 -	6009 69	13544
820	34	2 174 82	1 078 77 -	6495 26	13548
941	41	2 241 81	891 52 -	7000 45	13441
991	47	2 293 49	754 98 -	7393 41	13403
1039	53	2 340 83	634 90 -	7757 20	13393
1085	59	2 384 10	527 70 -	8097 07	13399
1119	66	2 414 94	415 59 -	8468 45	13213
1173	72	2 462 08	328 54 -	8768 51	13377
1214	78	2 496 45	248 44 -	9053 99	13408
1237	84	2 515 23	174 29 -	9326 57	13263
1266	91	2 538 42	94 24 -	9630 03	13146
1298	97	2 563 40	30 46 -	9878 86	13139
1335	1.03	2 591 53	29 56	10118 96	13193
1310	110	2 572 61	95 24	10388 31	12610
1355	116	2 606 41	148 34	10611 33	12769
1377	122	2 622 52	198 79	10827 66	12717
1438	128	2 665 89	246 83	11037 74	13028
1433	134	2 662 41	292 68	11242 00	12746
1474	141	2 690 63	343 63	11473 48	12847
1511	147	2 715 43	385 32	11666 42	12951
1560	153	2 747 35	425 34	11854 66	13159
1555	160	2 744 14	470 08	12068 72	12884
1624	172	2 787 55	542 38	12422 88	13072
1648	178	2 802 22	576 66	12594 38	13085
1653	185	2 805 25	615 21	12790 11	13024

APPENDIX A

HARDTACK PHASE II, HUMBOLDT

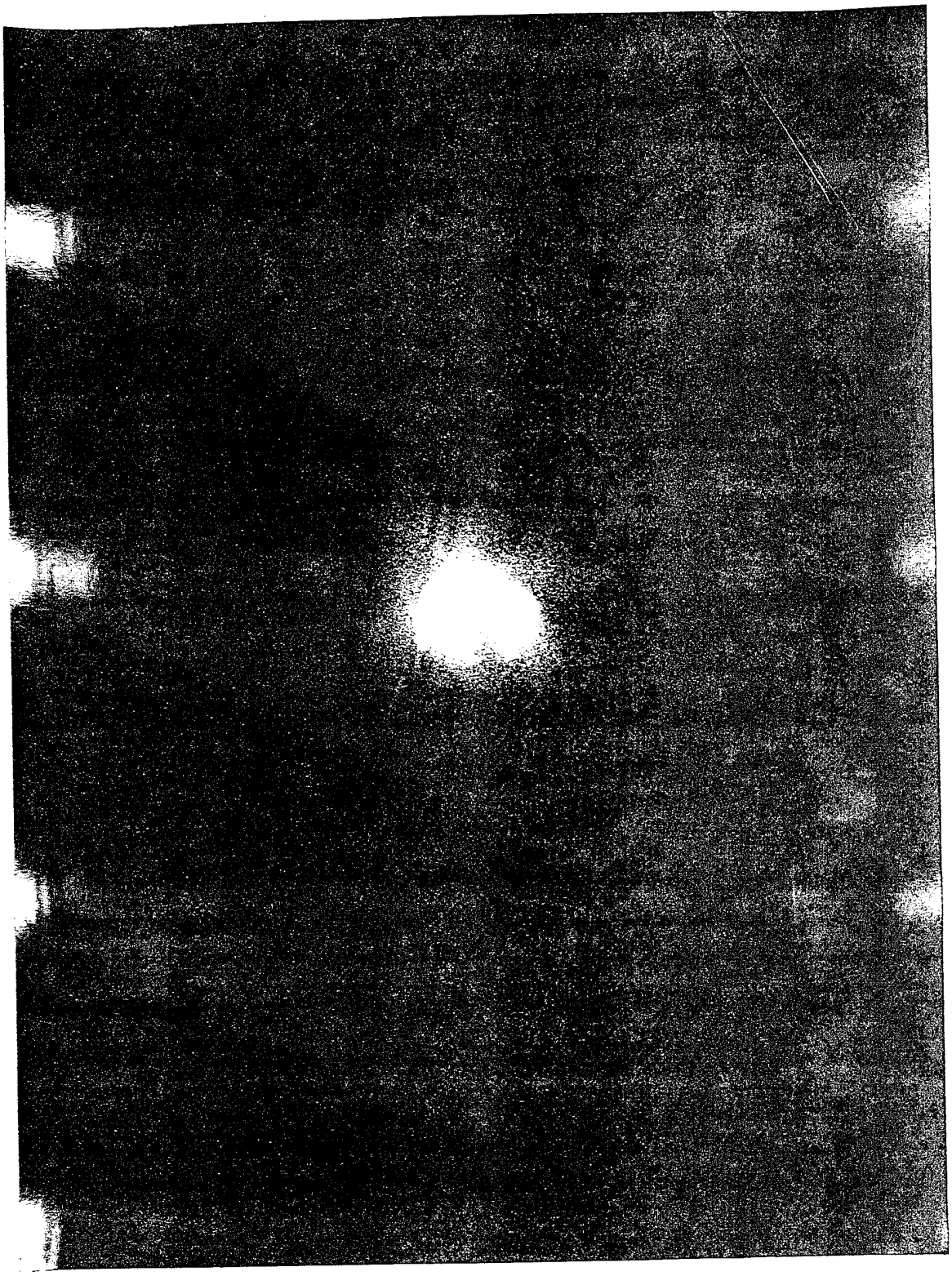
PHOTOGRAPHIC EXAMPLES



Camera: Rapatronic-30

Station: 3-357

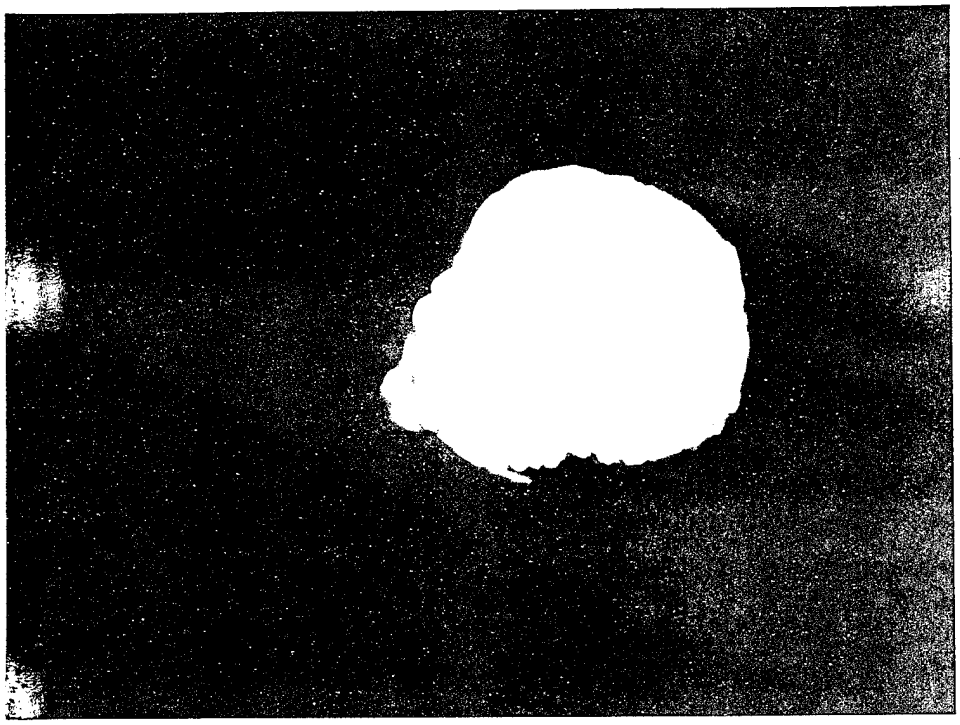
Time: 0.05 msec



Camera: XR-3

Station: 3-358

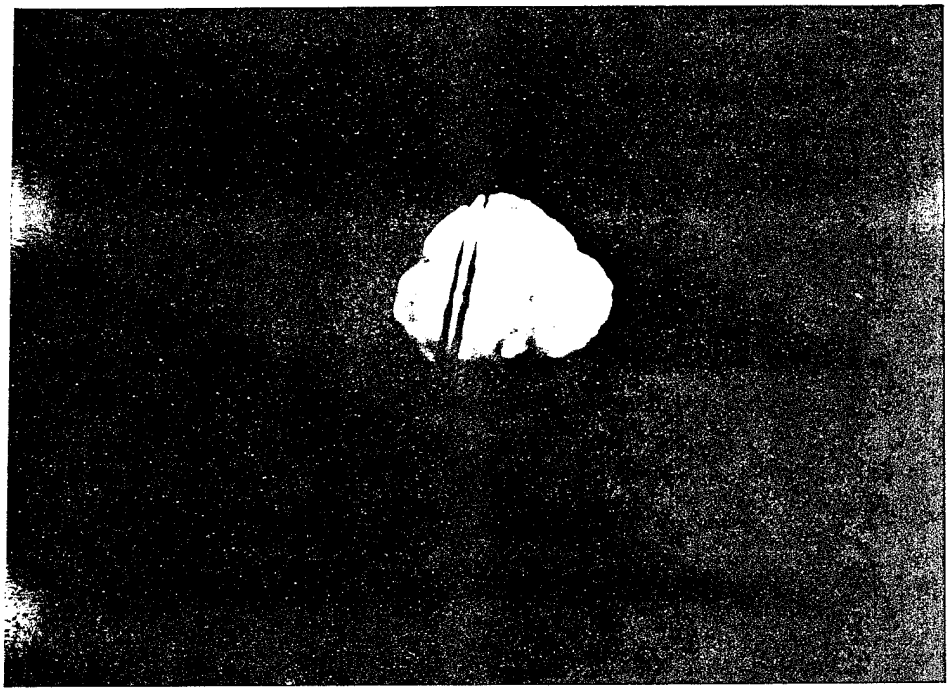
Time: 0.10 msec



Camera: E-1

Station: 3-357

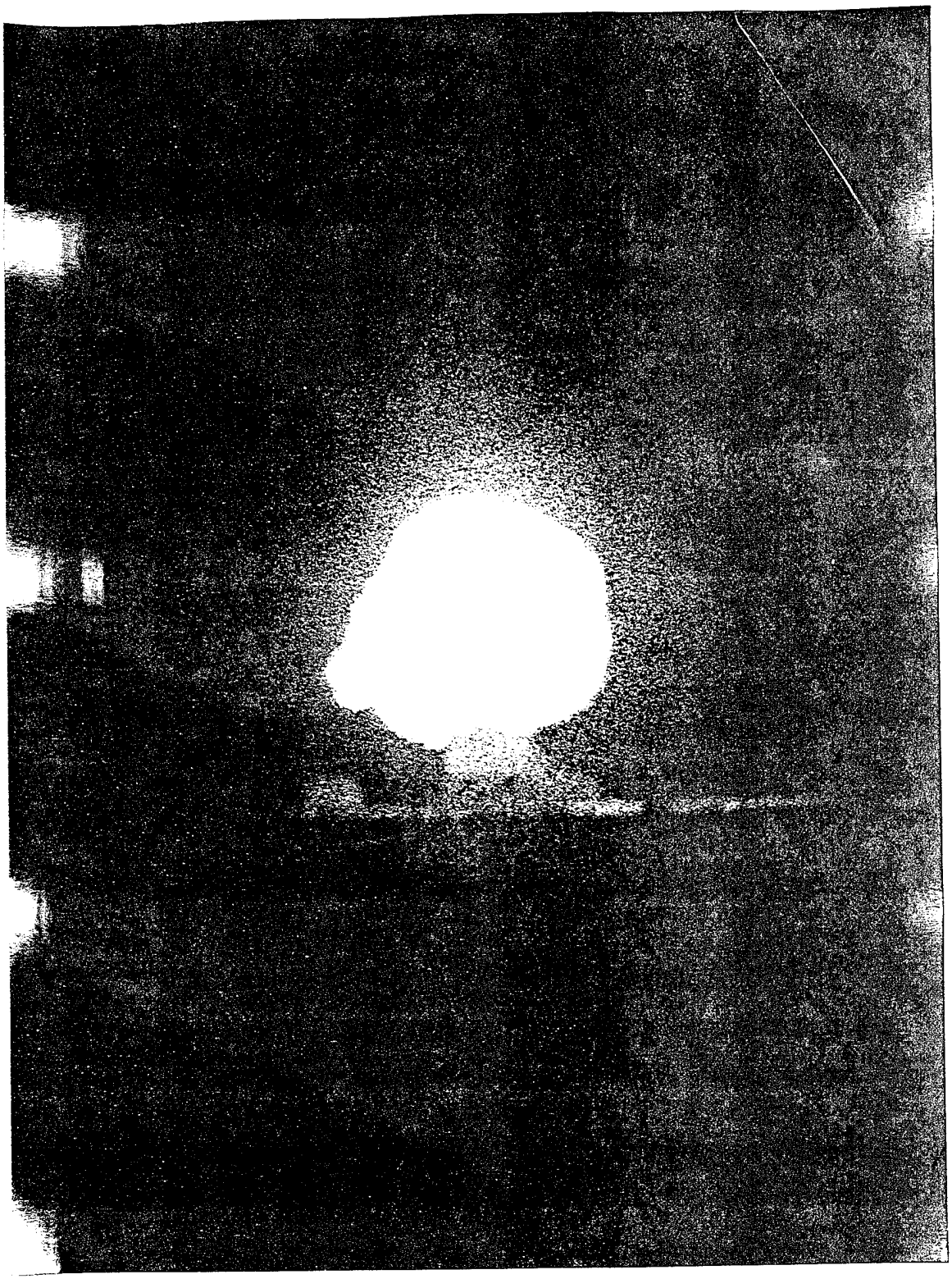
Time: 0.48



Camera: E-11

Station: 3-358 (White Truck No. 2)

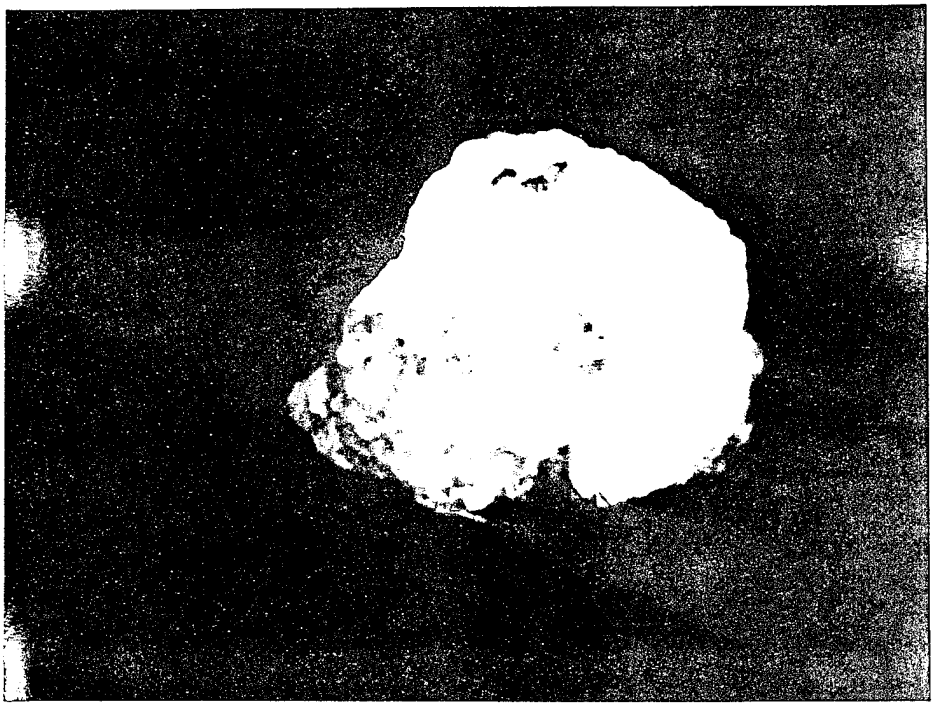
Time: 0.76 msec



Camera: Rapatronic R-34

Station: 3-357

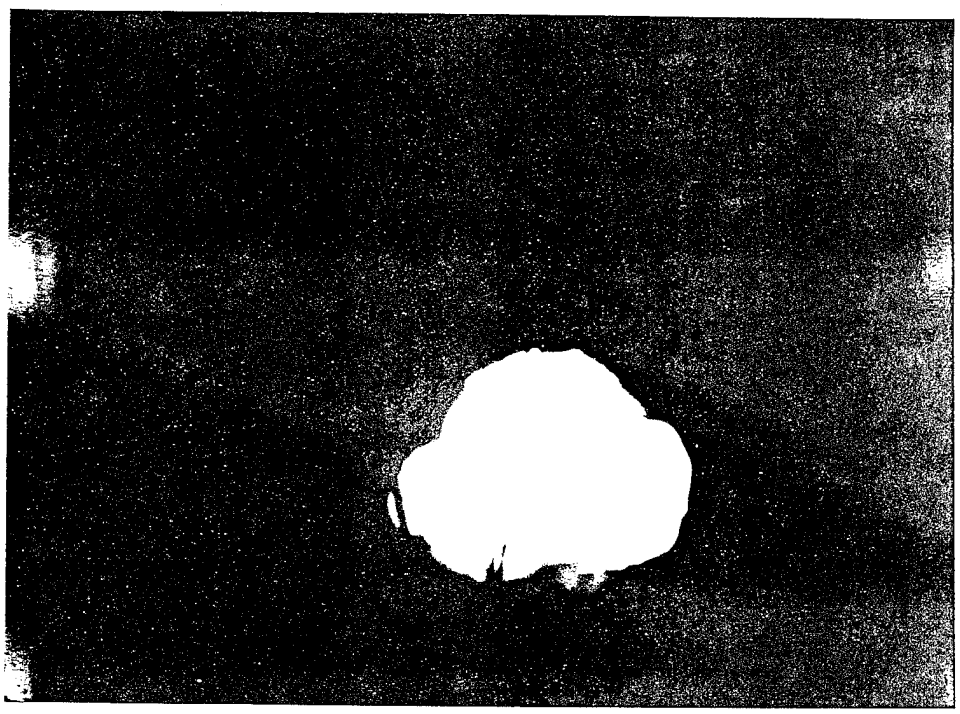
Time: 0.99 msec



Camera: E-1

Station: 3-357

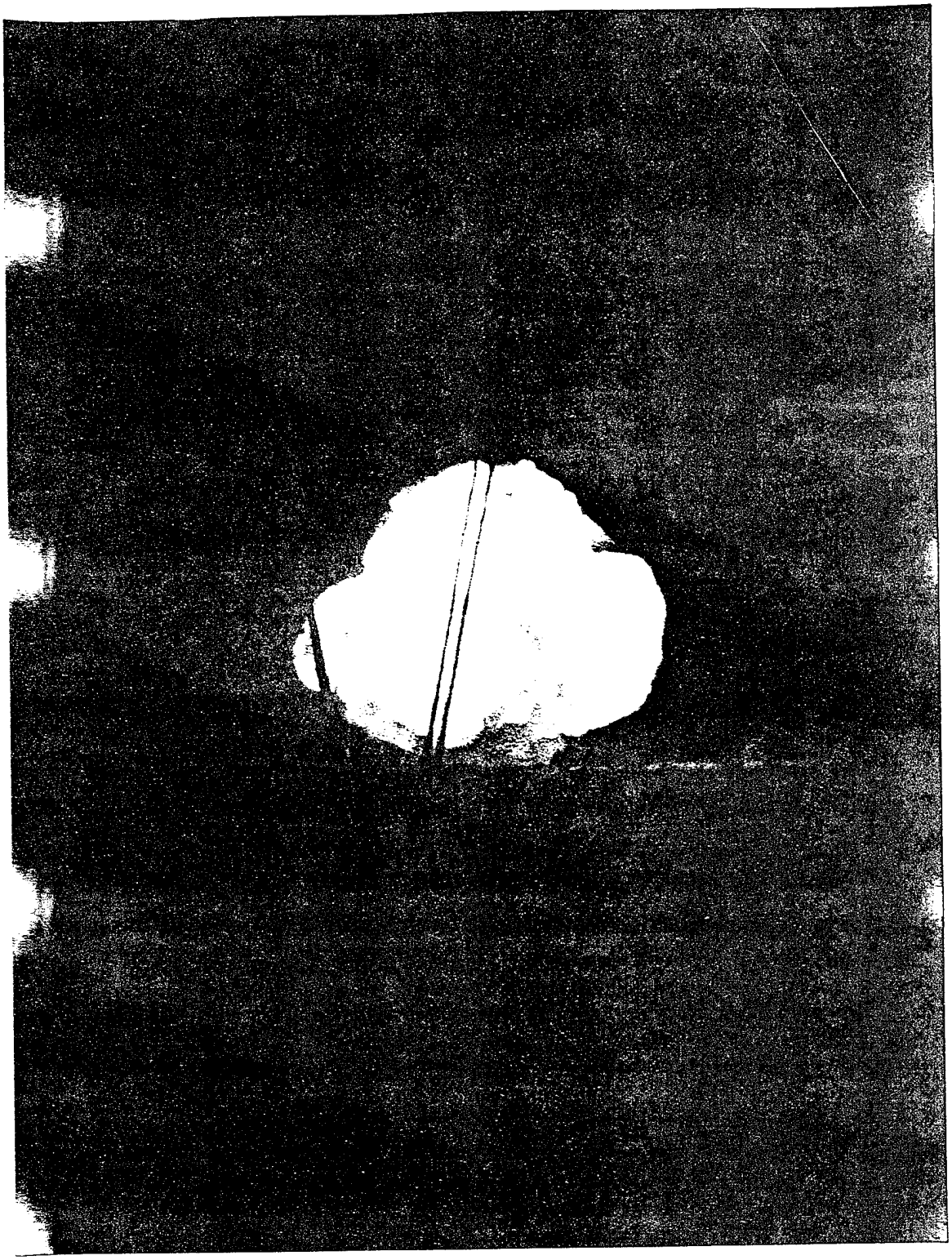
Time: 1.63 msec



Camera: E-5

Station: 3-358

Time: 2.94 msec



Camera: R-4

Station: 3-358

Time: 3.15 msec

Distribution

Copies to:

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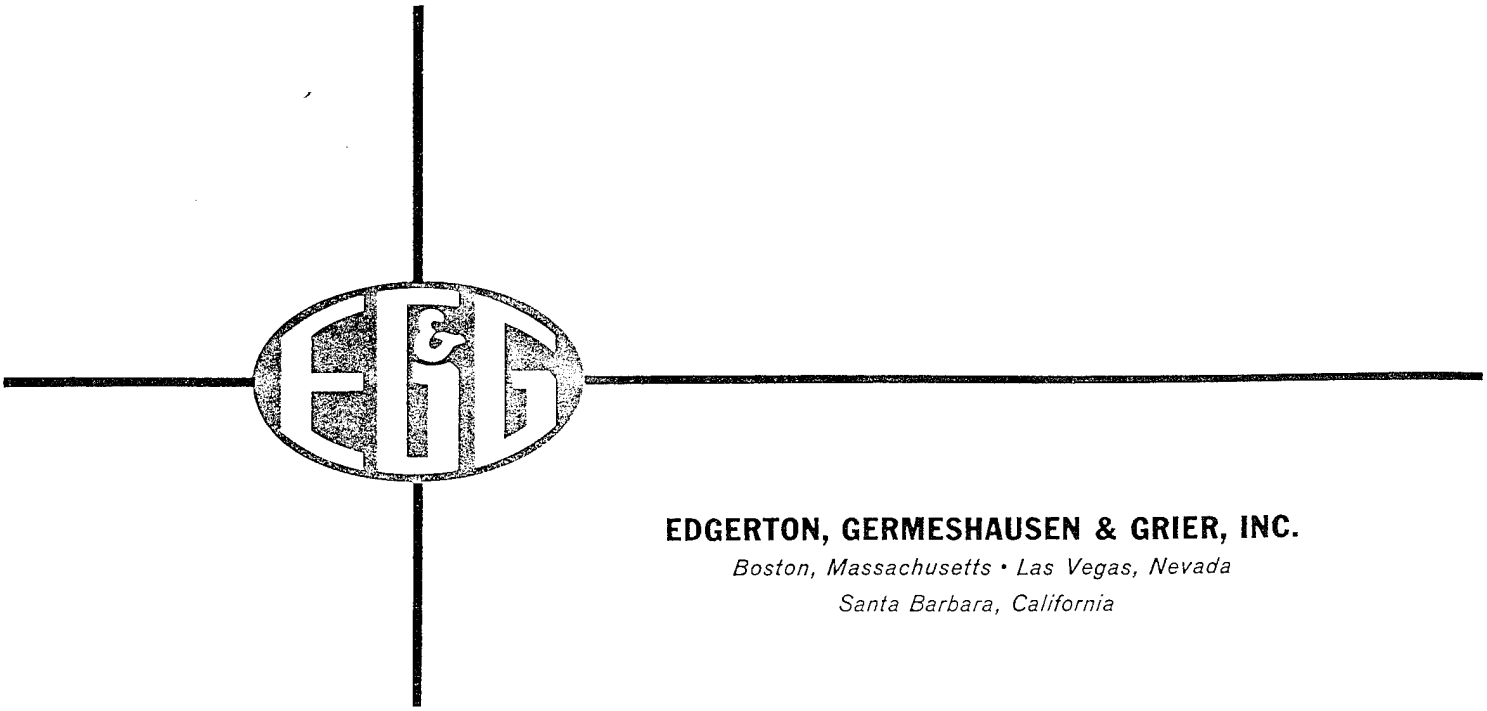
1	Dr. H. B. Keller, LRL Test Group Director
1	Dr. W. E. Ogle, LASL Test Group Director
1	Dr. L. S. Wouters, LRL
1	Dr. J. F. Mullaney, Group J-10
1	D. W. King, ALO
1	EG&G, Boston
1	EG&G, Las Vegas



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