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NOV 1 5 2007

Ref: 03-F-1599 DTRA FOIA Case Numbers 00-082 01-334

Mr. John Greenewald, Jr.

Dear Mr. Greenewald:

This is in response to your December 6, 1996 Freedom of Information Act (FOIA) request to the Defense Technical Information Center (DTIC), which was transferred to the Defense Threat Reduction Agency (DTRA). Because the record that you requested potentially concerns weapons of mass destruction or could be related to homeland security, DTRA forwarded it to this Office for review on June 5, 2003. The enclosed document is responsive to your request, for the document, "AD 341071, Fireball Yields (U)". Additionally an information sheet provided by the Department of Energy (DOE) is also enclosed.

Mr. Jeffrey A. Zarkin, Director, Document Declassification Division, Office of Classified and Controlled Information Review, Office of Security, Department of Energy, and Ms. Sandy Ford, Deputy, Freedom of Information Act / Privacy Act Officer, Defense Threat Reduction Agency, have determined that the release of portions of this document must be denied pursuant to 5 USC § 552(b) (3), which applies to information specifically exempted by a statute establishing particular criteria for withholding. In this instance, the statute is 42 USC 2162(a) which provides withholding of Restricted Data under the Atomic Energy Act of 1954, as amended. Accordingly, this information is denied pursuant to 5 USC § 552 (b)(3).

If you are dissatisfied with this action you may submit an appeal to this Office, by writing to James Hogan, Chief, Policy, Appeals and Litigation Branch, Office of Freedom of Information, 1155 Defense Pentagon, Washington, D.C. 20301-1155. Your appeal letter should be postmarked within 60 calendar days of the date of this letter and should cite case number 03-F-1599. Inasmuch as this completes the processing of your request, I am closing your file in this Office. There are no fees associated with this response.

Sincerely,

Will Kammer Chief

Enclosures: As stated

SAA 200138730000 01SA20C000018-BH

Information for Requester

Pursuant to Title 10, Code of Federal Regulations, section 1004.6 (10 CFR 1004.6), the Office of Nuclear and National Security Information (ONNSI) in the Department of Energy (DOE) has completed its review of the document responsive to your request. This document, located in the files of the Defense Threat Reduction Agency, contains classified information; therefore, it is provided to you with deletions.

Title 5, United States Code, section 552(b)(3) (5 U.S.C. 552(b)(3)) (exemption 3), exempts from disclosure information "specifically exempted from disclosure by statute (other than section 552(b) of this title), provided that such statute (A) requires that the matters be withheld from the public in such a manner as to leave no discretion on the issue, or (B) establishes particular criteria for withholding or refers to particular types of matters to be withheld . . . " The Atomic Energy Act (AEA) of 1954, as amended, 42 U.S.C. 2011 et seq., is an exemption 3 statute. Sections 141-146 of this Act (42 U.S.C. 2161-2166) prohibit the disclosure of information concerning atomic energy defense programs that is classified as Restricted Data (RD) pursuant to the AEA. The portions deleted from the subject document pursuant to exemption 3 contain information about weapon design that has been classified as RD. Disclosure of the exempt data could jeopardize the common defense and the security of the nation.

To the extent permitted by law, the DOE, pursuant to 10 CFR 1004.1, will make available records it is authorized to withhold under the Freedom of Information Act (FOIA) whenever it determines that such disclosure is in the public interest. With respect to the information withheld from disclosure pursuant to exemption 3, the DOE has no further discretion under the FOIA or DOE regulations to release information currently and properly classified pursuant to the AEA.

Pursuant to 10 CFR 1004.6(d), Mr. Finn K. Neilsen, Acting Director, ONNSI, is the official responsible for the denial of the DOE classified information.

Pursuant to 10 CFR 1004.8, the denial of a FOIA request may be appealed, in writing, within 30 days after receipt of a letter denying any portion of the request, to the Director, Office of Hearings and Appeals, Department of Energy, 1000 Independence Avenue, SW., Washington, D.C. 20585. The written appeal, including envelope, must clearly indicate that a Freedom of Information appeal is being made, and the appeal must contain all other elements required by 10 CFR 1004.8. If other agencies have denied information within this response, DOE will coordinate the appeal with those agencies. Judicial review will thereafter be available to you in the District of Columbia or in the district where: (1) you reside, (2) you have your principal place of business, or (3) the Department's records are situated.

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AD341071 SAC200157030000



Fireball Yields (U)

LOS ALAMOS NATIONAL LAB NM

17 AUG 1959

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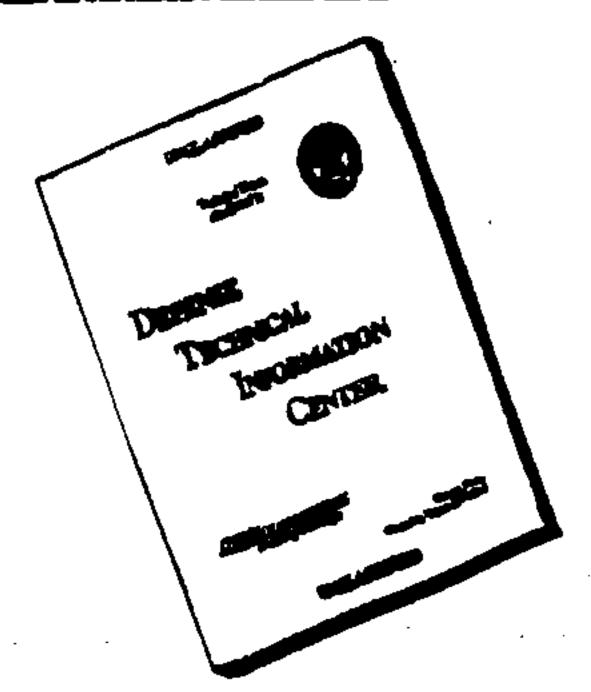
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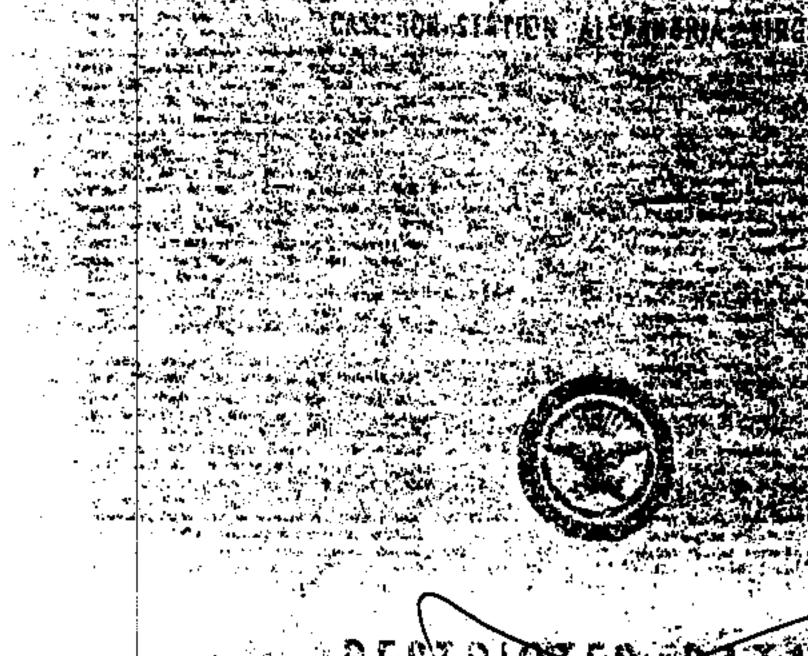
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Report to the Scientific Director

(FIREBALL YIELDS [],

Les Alames, New Mexico

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DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW

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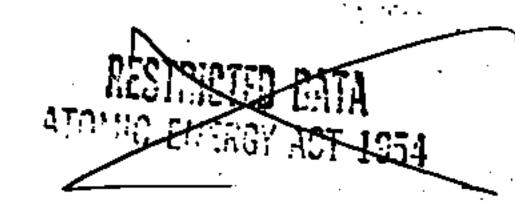
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ABSTRACT

The yields for the Los Alaxees Scientific Laboratory sints of Operation Redwing have been extended from Eroball diameter-time data using several suizied methods. The yield numbers obtained from these calculations are presented in the following table, and a yield is recommended for each abot.

PERSONAL VIELDS IN KILOTON

Shot	Differential mathed II	Mach-tember setting	EGEQ +1	Bestermind Probably piedd
Lacrosso	42.0 = 2.9	41.9	13.9 6 2.2	420.20
Charoline			4230 a 228	4000 + 400
Erts	16.2 a 1.0	35.0	15.00.0	15.0
Plathead	386 a 24	361	360 a 10	345 ± 15
Binchfoot	7.66 4 0.65	a.	83464	20404
Centre	L73 + 0.12	1,82	1.6+4.1	LTAGE
Debots	1058 ± 79	1020	1000 4 50	1100 a So
),maile	4500 to 220	4570	4430 a 230	4520 4 260
Paron	252 a 37	258	252 a 12	250 + 15 ··
	Differential mathed I	Integral method I		
Seminolo	12	14	24	13 + 2.5
Andrew Commence			=35 + 2	

*Chinami by Edgerton, Germanhamon, & Grier, hea., and reported in EGAG Report

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ACKNOWLEDGMENTS

The assistance at the Pacific Proving Ground of the following members of the Los Alamos Scientific Laboratory Theoretical Division is grandally acknowledged: D. H. Bradford, J. J. Devansy, P. E. Harper, C. E. Elsek, Jr., and A. M. Lochett III. Yield computation was done at Los Alamos with the assistance of Phocy E. Brown, Roslyn E. Elsenberg, and Phocy M. Waddell.

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ABSTRACT

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FIREBALL YIELDS

Yields have been calculated for the 10 Los Alamos Scientific Laboratory (LASL) shots of Operation Redwing from fireball radius-time data. These data were obtained by Edgerton, Germenhausen, & Grier, Inc. (EG&G) with high-speed motion-picture photography. Zero-frame time was determined by comparing the fireball diameters obtained from the motion-picture film with the diameter-time curve given by the Engetronic pictures.

The principal method used to calculate yield for Operation Reduing was the method of Bothe and Puchs, in the form called "differential method II," developed by Blumberg." In this method, which uses the IEM 704 compaint, the yield I in given by

$$E = \frac{4\pi}{3} R^2 \rho \left(\frac{dR}{dt}\right)^2 \frac{\gamma}{2(\gamma - 1)} \frac{1}{f(R)}$$
 (1)

where R is the shock radius at time t, ρ is the ambient density of air, γ is the ratio of specific beats within the fireball, and

$$I(R) = \frac{1 + 3 (R_1/R)^3 \ln (R_2/R)}{(1 + (R_1/R)^3)^3}$$
(2)

Equation 2 in the mass term in which the constant il, in the radius of that sphere of ambient air which weight the same as the excess mass, and il is the logarithmically averaged distance of the mass from the center of the explosion. This method of treating mass assumes that it is distributed with spherical symmetry about the center of the explosion. However, the actual distributed with spherical symmetry about the center of the explosion. However, the actual distribution of the mass, particularly in harps shots with big shields, in far removed from substical symmetry.

The calculation of yield developed by Blumberg' technics a method of cottoming values of E and R₀ to be used in the mass term (Eq. 2) by varying R and R₀ until the yield over a large range of the shock radius R becomes most marrly constant. As noted on page 21 of reference 2, the amount of mass given by this procedure does not always agree with the amount of mass known to be present in a simple nituation such as an explession of an airdropped spherically symmetric weapon.

For a surface shot the radius of the hemispherical firehall was measured. The radiustime data were used in the various expressions for yield, and the yield time chinined was multiplied by one-half to take into account the effect of the surface.

At Eniveroit, in the absence of computing-mechine Incliffies, a deak calculator was onployed to figure the yields and a simplified method (called "differential method I") based on Eq. 1 was used. In this method the fireball radius it was plotted us time, as given by BGBG, and the velocity dR/dt was determined graphically. The reciprocal of the quantity (y-1)/y is Eq. 1 had been determined empirically as a function of Mach number of the shock wave through use of the known radiochemical yield of certain strates bursts in previous operations. A plot of the curve used is presented as Fig. 1. Yields at various times in the fireball growth were

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determined by substituting in Eq. 1 the fireball radius R at the time t, the velocity dR/dz determined graphically, the quantity f(R) obtained after calculating R₀ and E, and the quantity $(\gamma-1)/\gamma$ from Fig. 1 corresponding to the Mach number [dR/dz]/c, where c is the velocity of sound in ambient aimombaric air.

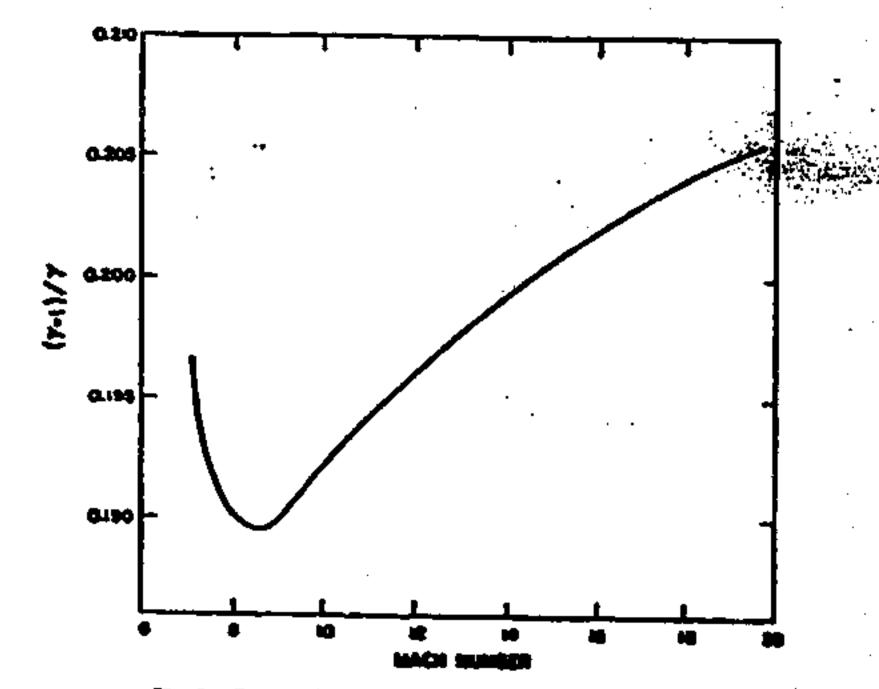


Fig. 1 -- Empirical (y-1)/y we black number of sheek waso,

A second method used in the field (called "integral method I") was developed early in 1954, and, although it was developed independently, it is consultably the method described by Puchs in Eq. 34 of reference 1. In this method the yield E in hilotest is given by the expression:

$$E = 4.15 \times 10^{-4} p\left(\frac{R^3}{t^2}\right) p\left(\frac{R}{R_0}, \frac{R_0}{R}\right)$$
(3)

where p = ambient air density (g/liter)

R = fireball radius (motern) at time t t = time (meec)

$$F\left(\frac{R}{R_0}, \frac{R_1}{R}\right) = \frac{25}{42^3} \left\{ \int_0^2 \frac{(Z^2 + 1) dZ}{[Z^2 + 3 \ln (ZR\sqrt{R})]^3} \right\}^2$$

Re and R have the same messing as before.

The integral involved in this method was calculated memorically before the operation using the 1914 701 computer at Los Alamos. Tables were prepared giving F as a function of Z for

regious values of the ratio R./R. The lower limit of integration was taken to be a small nonnero value. The method described in reference 1 differs slightly from integral method I, which was developed without knowledge of Fuchs's previous work.¹

The principal use of differential method I and integral method I was to give a proliminary yield with consideration of mans for field use. The only yield figures given in this report obtained by using these methods are for Semisole shot.

An additional method used in obtaining yields in Mach-number scaling, developed by Portel, Grier, and others. In this method, used principally to provide continuity with past operations and to provide a check, the radius R of the firstell is determined at a Mach-number

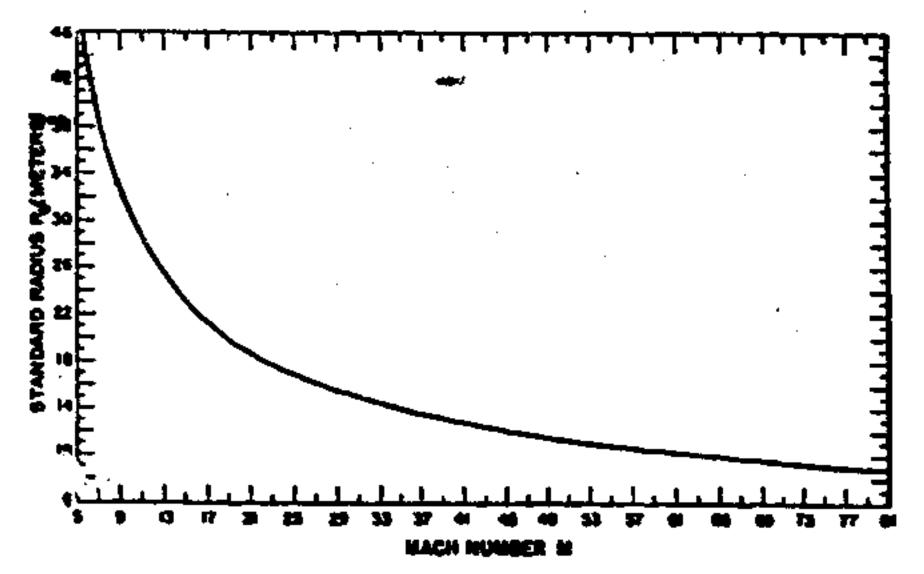


Fig. 2—Radius vs Mach number for standard 1-it shot. Atmospheric prossure is 2000 mb.

M = (dR/dt)/c. The yield is then obtained by scaling to a shot of known radiochemical yield W_0 through the relation

$$\frac{\mathbf{W}}{\mathbf{W}_{\bullet}} = \frac{\mathbf{P}}{\mathbf{P}_{\bullet}} \left(\frac{\mathbf{R}}{\mathbf{R}_{\bullet}}\right)^{3} \dots \dots \mathbf{M}$$

where P is the ambient atmospheric pressure and the subscript zero refers to the shot of known yield. To make scaling easier, R_0 (meters) vs M was determined for $W_0=1$ it and pressure $P_0=1000$ mb. Figure 2 is a plot of R_0 vs M obtained by F. B. Porsel, D. F. Sencord, Jr., and K. G. Snyder, using results of 1934 Problem M reduced to 1 bt and the observed radii and radiochemical yields of several shots, also reduced to 1 bt.

The method used by EG&G to determine yield in the familiar ϕ^3 method used since Operation Ranger. The yield (W) in kilotons is given by

where ρ = ambient air density (g/liter)

 $\phi = D/t^{0.4}$

#3.

D = fireball diameter (meters)

t = time (msec)

P(3)

Eding-time data were obtained from nine Eastman high-speed cameras, three each on Runit, Pitrani, and Parry. The Pitrani and Runit stations were on opposite sides of the fireball and nav approximately the same profile of the fireball. Because of construction in the foreground, there was some difficulty in establishing the positions of the bettern of the fireball at early times; this is particularly true for the Runit films, which were obtained from cameras at low elevation. The initial field readings of the films gave average radii about 1 per cent lower at a given time than did the final readings because of difference in assignment of the ground position; as a consequence the yields reported in the field were about 5 per cent lower than those reported here.

The effect of the mass of shields, pipes, etc., on firehalf growth was apparent. The horizontal radius of the firehalf was alightly greater than the vertical radius. Also, the cross section of the firehalf as seen from Parry Island was alightly smaller than the cross section seen from Pitrail and Runit. The hypothetical mass given by the procedure of differential method II indicated that \$8,200 lb was appropriate.

The yields obtained are

Differential method II 42.0 ± 2.9 kt Mach-number scaling 41.9 kt BGSG ϕ^3 method 41.9 ± 2.3 kt Recommended fireball yield 42.0 ± 2.0 kt

The meteorological data are

Pressure 1004.0 mb Temperature 27.2°C Air density 1.157 g/liter

Four photographic stations had been set up by EGSG to obtain data, but, since the actual position of the burst was a great distance from the predicted position, three of the four stations did not see the fireball, and the fourth station (1519 on Bulethyundan Islam) obtained off-center pictures in two cameras. These two cameras were a 35-mm Fastax running at about 900 frames per second and containing film No. 33,284 and a 16-mm Fastax running at about 2000 frames per second and containing film No. 33,284 and a 16-mm Fastax running at about 2000 frames per second and containing film No. 33,283. Owing to the difference between the actual and the intended burst positions, the images of the firehall were displaced from the center of the frame, and it was necessary to take into account the loss distortion existing for this off-axis positioning.

The distance between the airburst and station 1519 is not known exactly; as a result, a small uncertainty must be associated with the magnification factors of the two cameras. An estimate of this uncertainty was made in the field, and it was found to be all per cent in magnification factors and ±5 per cent in yield. The magnification factors calculated by EGAG are based on the burst position (i), as follows:

^{*}Marshall Islands dates and times are used throughout this report,

N 185,450 R

E 96,300 ft

Z 4320 ft

A slightly different burst point was obtained by a Los Alamos survey of the data. This burst position (II) has the following coordinates:

N 185,100 ft

E 96,200 ft

Z 4329 R

Dispulscration factors were also calculated for burst position II. Pirefull diameters obtained using the latter magnification factors were about 1 per cent smaller than these obtained builtGEG. and the yield was about 5 per cent less.

In view of the uncertainties introduced by less distortion and lack of insuledge of exact burst position and meteorological exactions, it was considered meaningless to use estimate of calculating yield other than the of method. The yields obtained are

EGAG of method¹⁰ (burnt position I) 4.18 ± 0.21 Me EGAG of method (burnt position II) 4.0 ± 0.3 Me Recommended (troball yield) 4.0 ± 0.4 Me

The air density at burst point was estimated to be 1.04 g/liter.

T moderate amount of most in the form of childle and cab construction was successful this shot.

Twelve films from high-speed Enstmen conserns were obtained for this shot, three each from Ruck, Mack, Prirate, and Passy. Although the kines from Ruck were badly fogged by re-diation, they gave images that could be read. The films from the Ruck and Passy stations, which saw approximately the same fireball profile, gave radii nonembal larger than those from black and Prirate induced. In differential method II, the data from all 12 films were used. In the o' method, EG&G used data from size films, omitting the data from the Passy station.

The mass-estimating procedure indicated that a hypothetical mean of 33,500 Ib should be used in the calculation.

The yields obtained are

Differential method II I4.2 \pm 1.0 kt Much-sampler scaling I5.8 kt EG&G ϕ^{1} method II I5.9 \pm 0.8 kt Recommended fireball yield I5.9 \pm 1.0 kt

Meteorological data are

Pressure 999.4 mb . Temperature 28.5°C Air density 1.151 g/liter

SOCRET

The tank was a 50-ft-diameter cylinder filled to a depth of 25 ft. The device was placed in an air-filled chamber within the tank. The total weight of union was 2,900,000 in.

The films were obtained to give data on the size of the firehalf as a function of time.

Three Eastines high-speed cameras were located at each of three stations: Parry, Engeld, and thick, and one camera was operated at Bogalhus.

The pictures (Figs. 4 to 6) showed an irregularly-expanding mass of material, with no

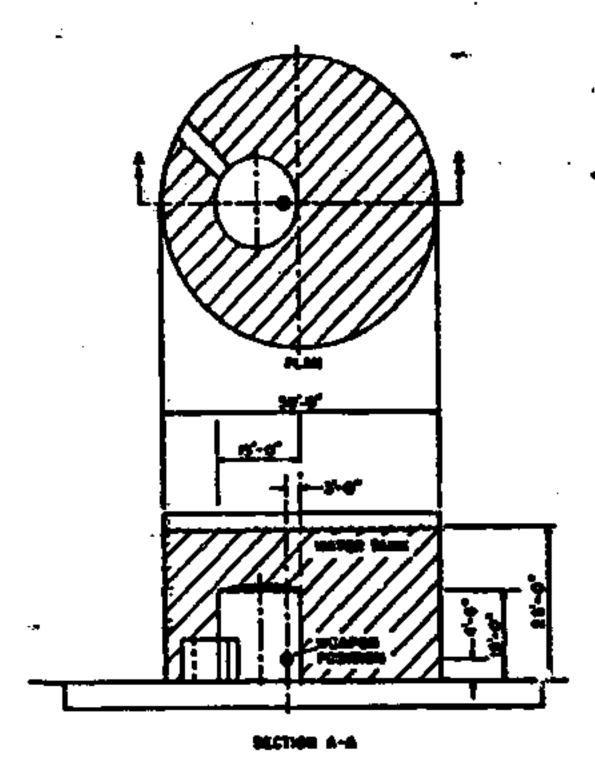


Fig. 3.—Water-tank chiefd for Sominate shot. The passegroup to the weepen chamber was filled with water at shot time. Total weight of water was 1,900,000 lb.

clear-cut shock wave emerging. In the field, EGAG emuniced¹² one film from each of the four stations. The diameter of a balf-circle baving the same area as the irregular cross section of the firsball was determined by EGAG; these diameters as a function of time are the bases of the yield numbers given in this report.

At a later time the pictures on all 10 films were reasonabled by EGAG with the purpose of measuring the diameter of the roughly semicircular portion beneath the irregularly shaped material, and not the dimension of the total disturbed material. The diameters given through this reasonable were comewhat smaller than those given in the field. On the basis of this reexamination, EGAG concludes that the shot Seminals yield was not less than 8 kt.

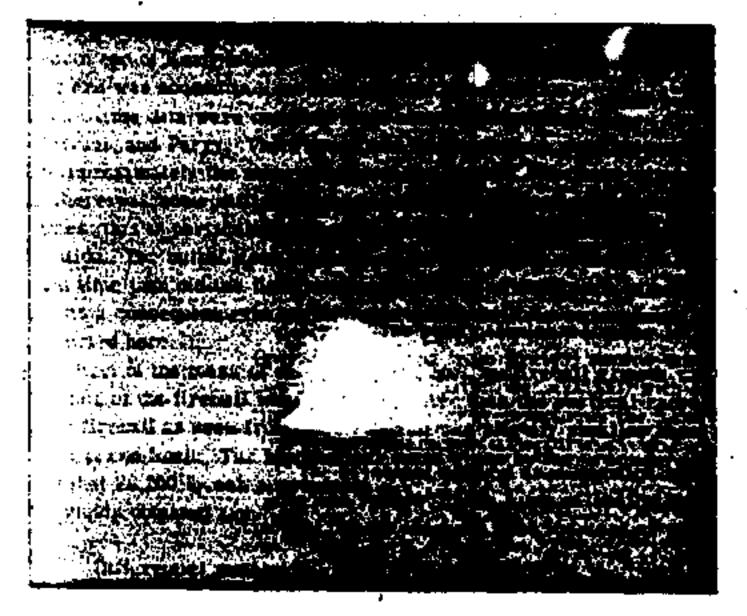


Fig. 4—Seminale (isoball at 2,31 mass as seen from Mack tower.



Fig. 5 —Seminole Streball at 14,7 meso as seen from the photostation on Engels.



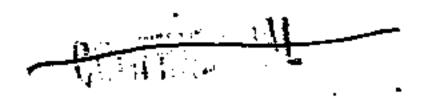




Fig. 6—Seminole (izoball at 16.9 mir : as men from Mack tower,

Using the diameter-time data obtained in the Beld, yields were calculated by differential method I and by the integral method. Various amounts of r any were included in the many term. The following tabulation gives the mass considered and the yield obtained.

Creess many	Tield,	-
lb.	Differential method ([stegral method I
2,570,000	12.2 ± 1,7	11.7
3,130,000	12.1 ± 1.4	14,1
3,380,000	12.0 + 1.3	14.4

The moderately good consistency of the numbers in sion that a firshall yield of 13 ht with 26 per cent probab. the field measurement of the dimension of the irregularly. The yields obtained are

delation has led to the conclucer can be given on the basis of ged material.

Differen	tial method I	12 kt
	method	14 kt
ECAC	* wethod ¹¹	≥F t
DC#C	.metbod ¹³	315 ± 2 kt
_	Maly Haderil behas	12 . 2 5 74

The meteorological data are

Pressure	1010.5 mb
Temperature	30.9°C
Air density	1.145 g/liter

No targe exposed of adjoining was used on this chat.

Seven Illian giving rather-time data were citained for this abot. There were three Pastman films from Aomone, o .) Fastex film from Chicarette, and two Enstance films and one Fastax film from Enys. The pictures showed the firstall to be symmetric, with no jets or bulges other than the small protuberance on top which is characteristic of large-yield barge abots.

The hypothetical mass given by the estimating proceedure was \$4,500 M; the yield cultulated using this mass was 376 M. On the basis of experience (Fig. 7) using differential method

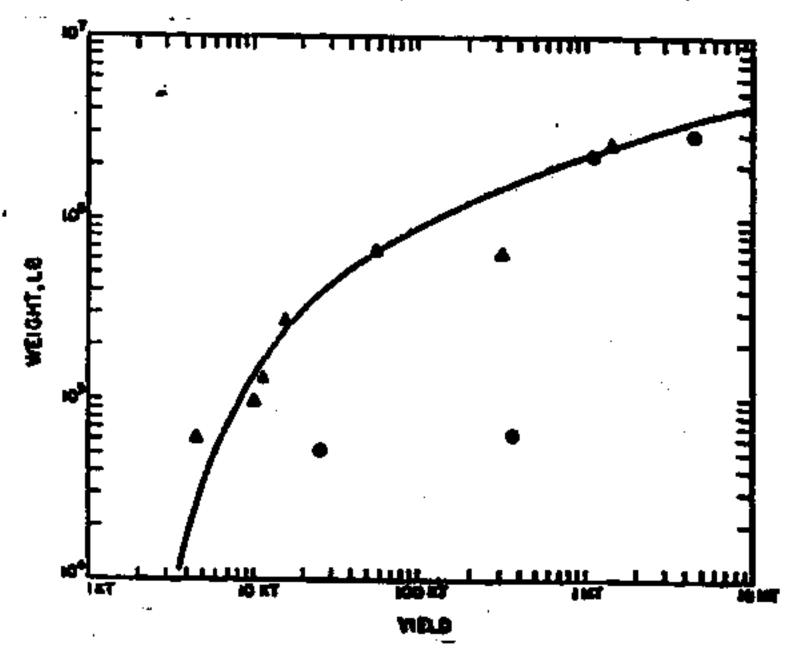


Fig. ?—Hypethotical mass or yield for harpy shale, & computed mass, Operation Hardack; O. computed mass, Operation Redwing.

If on barge about in Operation Mardiack, this hypothetical mass appeared to be unconsumbly amail; Operation Hardrack experience indicated that 1,700,000 to should be used. The yield calculation with this larger hypothetical mass gave a slightly lower number, which was believed to be more reliable.

The yields obtained are

Differential method II 366 \pm 34 kt Mach-number scaling 361 kt EGAG ϕ^{I} method II 366 \pm 18 kt Recommended fireball yield 365 \pm 15 kt

The meteorological data (surface) are

Pressure 1012.9 mb
Temperature 27.5°C
Air density 1.16 g/liter

WE THE THE PARTY OF THE PARTY O

Test equipment and can construction provided some nearby man to perturb the fireball.

Must films were cotained for this shot, three each from black, Perry, and Pitrani. In using the of method, EG&G disregarded two of the three films from Parry. In using differential method II, these two films were included. Comparison of the resulting average radius ve time curve obtained with that given by EG&G (reference 16, page 8) shows that inclusion of these two films did not substantially change the average radius.

The pictures of the fireball showed some evidence of the presence of mass. The hypothetical mass indicated by the calculation was 75,700 lb. This amount, on the basis of experience with other tower shots of about this yield, seems high, thus making the differential method II yield somewhat low.

The yields obtained are

Differential method II
Nach-sumber scaling

7.64 ± 0.85 ht

#13 F #4 FF

EGEG of method¹⁸ Recommended fireball yield

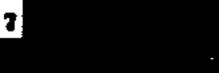
8.0 ± 0.5 H

The meteorological data are

Pressure Temperature 1005.6 mb 28.7°C

Air dessity

1.156 g/liter



and the state of t

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102,533 ± 20 ft

P

126,669 ± 20 ft

Altitude

685 ± 20 ft

Radius-time data were obtained from six Eastman high-apoed cameras, two each on Rust and Plirani and one each on Mack and Parry. In addition, two Repaironic cameras produced pictures.

ferential method I indicated that the hypothetical mass to be used in the calculation was about 10,800 in. This discrepancy indicates the need of the word "hypothetical."

For Osage, EG&G used a modified form of the of method in which scaling was done to small shots (~1 kt) of known radiochemical yield. The quantity of did not become constant for Osage.

The yields obtained are

Differential method II

Nach-sumber scaling

EGRG modified 5 method 11

Recommended fireball yield

1.78 ± 0.12 kt 1.62 kt

1.6 ± 0.1 kt

LTARIM

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The meteorological data are

Pressure 987 mb
Temperature 26.5°C
Air density 1.134 g/liter

SHALL WEST TO A SECOND STREET OF THE SHALL SHALL

Radius-time data were obtained from nine films. There were three Bastman high-speed cameras at Aomosa, two Rastmans and one Partax at Chicerete. The pictures showed the firshall to be symmetric, with no bulget or juta other than for the small disturbance on top.

The hypothetical mass given by the calculation was 2,250,000 lb, in good agreement with the curve used for Operation Sardack large shots. Recalculations were made with other mass distributions differing by neveral bandred thousand posses, but the yield changed by only 1 per cent.

The yields obtained are

Differential method II 1.05 \pm 0.07 Method II 1.05 \pm 0.07 Method II 1.05 \pm 0.05 Method II 1.09 \pm 0.05 Method II 1.1 \pm 0.1 \pm 0.05 Method II 1.1 \pm 0

Metsorological data are

Pressure 1000.1 mb Temperature 27.8°C Air density 1.158 g/liter

Acmora and two Enstmuse, one Mitchell, and one Fastux at Chicarete. The firehall appeared to be symmetrical, with no buiges or jots, other than the senall point on top.

The hypothetical mass given by the exhculation was 2,890,000 in. This amount is in good agreement with Operation Hardrack burge experience (Fig. 7).

The yields obtained are

Differential method II 4.58 \pm 0.33 Method II 4.58 \pm 0.33 Method II 4.57 Method II 4.41 \pm 0.22 Method Reconsecuted Broball yield 4.5 \pm 0.3 Method II 4.5 Method

Meteorological data are

Pressure 1010.2 mb
Temperature 27.3°C
Air density 1.159 g/liter

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SECRN

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There was no amenive chicking or other accurre and the ways.

Films groing radius-time data were obtained from one littchell and three Enstman cameras at black and a like rember at Pitraal. The fireboli showed so bulges or jets and appeared to be symmetrical.

The hypothetical mass indicated by the calculation was 52,000 h, and the yield associated with this mass in 264 kt. Based on experience with barys shots in Operation Marchaek (Fig. 7), this hypothetical mass seems small; a hypothetical mass of 1,400,000 h would be consistent. Using this larger mass, the yield was calculated to be about 4 per cost loss.

The yields obtained are

Differential method II 152 ± 17 kt.

Nuch-number scaling 258 kt.

EGAG of method 250 ± 15 kt.

Recommended Greball yield 250 ± 15 kt.

The meteorological data are

Pressure 1007.0 mb
Temperature 27.4°C
Air density 1.154 g/liter

APPENDER RECO

RECOMMENDED FIREBALL AND BADOCHEMICAL YIELDS

The recommended fireball and radiochemical yields for the shots of Operation Radiology are presented for comparison in the following table. The radiochemical yields are not necessarily final, and they may be modified in forthcoming reports.

Shot	Fireball yield,	Redsphamical yield,
Lacroses	42.0 ± 2.6	37.5 à 1,0
Charekee	4000 à 400	
Erie	15.0 4 1.0	14.0 A 0.5
فأصله وا	13 4 2.5	11,7 4 1,5
Flatheed	345 A 15	350 ± 46
Blackfoot	8.0 4 0.5	8,2 4 8,4
Coage	1.7 a 0.3	1.72 4 6.00
Dalmia	1100 4 50	1060 4 70
Navaje	4500 ± 300	
Muron	250 a 18	230 4 13

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***	On 1886 C.D.E. The Separational C.D.E. Stilling Assistance States, S.J., 1886 Species, V.S., Stilling Assistance, State Species, S.J., 1886 Species, of Grissman States, S.J., 1880 Species, Ol 1880 Species, Ol 1880 Species, Ol 1880 Species, St.E., 1887 Species, St.E., 1887 Species, Species, St.E., 1887 Species, Speci	**************************************	Charles of Speed Speedstone, Tolk, Smalegons St., R.C. 1880 1894 1888 Charles of Speed Speedstone, Tolk, Smalegons St., R.C. 1880 1894 1888 Charles of Speed Speedstone, Tolk, Smalegons St., R.C. 1880 1894 1888 Chief, Samon of Real Sugare, R.S., Stateograp St., R.C. 1880 1884 1884 Chief, Respect of Small Sugare, R.S., Stateograp St., R.C. 1880 1884-18 Chief, Respect of State Speeds Speed, Tolk, Stateograp St., R.C. 1880 1884-18 Chief, Respect of State Speeds Speed, R.S., Speedstone, R.S., R.C. Chief, Respect of State Speeds Speed, R.C., Speedstone, R.S., Respective St., R.C. Chief, Respect of State Stateograp, R.S., Stateograp, R.S., R.C. Chief, Respect of State Stateograp, R.S., Stateography St., R.C. 1880 1894 1895 Chief, Respect of State Stateograp, R.S., Stateography St., R.C. 1880 1894 1895
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