AD-775 422

CALCULATION OF TNT AIR-BLAST EQUIVALENCIES FOR SURFACE BURSTS

Thomas Caggiano

Picatinny Arsenal
Dover, New Jersey

December 1973

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

UNCLASSIFIED
Security Classification

AD-775422

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* U. S. Army, Picatinny Arsenal, Dover, NJ	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

CALCULATION OF TNT AIR-BLAST EQUIVALENCIES FOR SURFACE BURSTS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

Thomas Caggiano

6. REPORT DATE December 1973	7a. TOTAL NO. OF PAGES 52	7b. NO. OF REFS 11
8a. CONTRACT OR GRANT NO. AMCMS Code 4932.05.4169.8 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Technical Report 4567 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*	

10. DISTRIBUTION STATEMENT

Approved for Public Release: Distribution Unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Picatinny Arsenal, Dover, NJ U. S. Army Armament Command Rock Island, Illinois

13. ABSTRACT

TNT air-blast standards for hemispherical explosive charges (scaled positive unit impulse and peak pressure vs scaled distance) are presented in graphical and tabular forms. Equations for positive unit impulse and peak pressure TNT equivalencies are derived, permitting rapid manual calculation. The equivalencies relate the weight ratio of TNT to the sample material in terms of their relative explosive airblast. The calculation of TNT equivalencies will facilitate and expedite the efficient, reliable establishment of intraline distances in production facilities and loading plants. A FORTRAN Extended computer program with complete documentation and sample input and output is included in this study.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
TNT standards						
Scaled distance						
Scaled impulse						
TNT equivalency						
TNT Equivalency Computer Program						
Surface hemispherical blasts						
Barricade design aid						
Protective explosive structures						
Blast pressure						

UNCLASSIFIED
Security Classification

53

Technical Report 4567

CALCULATION OF TNT AIR-BLAST EQUIVALENCIES FOR SURFACE BURSTS

by

Thomas Caggiano

December 1973

D D C
MAR 14 1974

AMCMS Code 4932.05.4169.8

Approved for Public Release: Distribution Unlimited.

Manufacturing Technology Directorate
Picatinny Arsenal
Dover, New Jersey 07801

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation for valuable assistance and comments received from:

Mr. L. W. Saffian
Mr. S. Wachtell
Mr. M. Baer
Mr. C. H. Nichols
Mr. R. Rindner
Mr. M. Myers

The author also wishes to express his appreciation to Mrs. H. Napadinsky and Mr. J. Swatosh (IIT Research Institute) for providing mathematical expressions for the TNT impulse and pressure standards, for technical guidance, and other comments.

TABLE OF CONTENTS

		Page No.
Abstract		1
Conclusion		1
Recommendation		1
Background		2
Study		4
Glossary		5
References		8
Distribution		47
Figure		
1	Schematic of a surface burst	3
Appendix		
A	Derivation for TNT Pressure Equivalency	9
B	Derivation for TNT Impulse Equivalency	11
C	Derivation for TNT Scaled Impulse and Scaled Distance as a Function of Positive Impulse and Radial Distance	13
D	TNT Standards for Hemispherical-Shaped Charges	15
E	Sample Calculations	38
F	FORTRAN Extended Computer Program	40

ABSTRACT

TNT air-blast standards for hemispherical explosive charges (scaled positive unit impulse and peak pressure vs scaled distance) are presented in graphical and tabular forms. Equations for positive unit impulse and peak pressure TNT equivalencies are derived, permitting rapid manual calculation. The equivalencies relate the weight ratio of TNT to the sample material in terms of their relative explosive airblast. The calculation of TNT equivalencies will facilitate and expedite the efficient, reliable establishment of intraline distances in production facilities and loading plants. A FORTRAN Extended computer program with complete documentation and sample input and output is included in this study.

CONCLUSION

TNT airblast standards were established in terms of peak pressure and scaled positive unit impulse vs scaled distance for surface hemispherical explosive charges. A rapid, efficient computational procedure was formulated to determine TNT equivalencies directly, taking into account booster effects.

RECOMMENDATION

Adoption of the TNT airblast standards and computational procedure will permit a uniform comparison of explosive output in terms of TNT equivalencies. Utilizing TNT equivalencies will facilitate and expedite the efficient reliable design of barricades and establishment of the required intraline distances in production facilities and loading plants in accordance with References 1 and 2.

BACKGROUND

TNT airblast standards and the computational procedure for determining TNT equivalencies were devised to assist in barricade design and in determining intraline distances.

In the design of protective structures to resist the effects of accidental explosions, the two prime factors of the explosive output of a material to be considered are blast pressures and primary fragments. Of these two parameters, the blast pressure is usually the governing factor in determining the structure's capability to withstand damage.

The blast effect of an explosion is in the form of a shock wave composed of a high-pressure shock front which expands outward from the center of the detonation, with the intensity of the pressure decaying with distance and as a function of time. As the wave front impinges on a protective structure, a portion or all of the structure will be engulfed by the shock pressure. The magnitude and distribution of the blast loads on the structure, arising from pressure, are a function of three factors:

1. Explosive properties (i.e., the type of explosive material and energy output (high or low order detonation)) and weight of explosives;

2. Location of the explosion relative to the protective structure;

3. Magnitude and reinforcement of the pressure by its interaction with the ground, barrier, or the protective structure itself.

The blast pressure environment produced will vary not only among different materials, but may also differ for a particular material. Different factors in manufacturing, storage and handling may alter the blast effects of an explosive material.

Unlike high explosive materials, other solid, liquid, and gaseous materials will exhibit a variation of their blast pressure output. An explosion of these materials is in many cases incomplete, and only a portion of the total mass of the explosive is involved in the detonation process. The remainder of the mass is usually consumed in deflagration, resulting in a large amount of the material chemical energy being dissipated as thermal energy, which in turn may cause fires.

The major quantity of blast effect data presented in Reference 2 pertains to the blast pressure output of TNT explosions. This data can be extended to include other potentially mass detonating materials whose shapes differ from those considered in the manual by relating the explosive energy of the "effective charge weight" of these materials to that of an equivalent weight of TNT. To obtain the equivalencies of the blast effects of other materials in the anticipated environments, they must be analyzed and then related to the blast effects produced by the TNT explosion at the range of interest. To illustrate a typical analysis:

Explosive tests of certain propellant liquids and hydrocarbon mixtures indicated that their explosive equivalent, which relates both the peak blast pressures and impulse, is constant over the entire intermediate and low pressure ranges. At higher pressures, the TNT equivalent will vary for each pressure level and will be different from the TNT equivalent which relates to the impulse. For blast-resistant design in general, the TNT equivalent should be based on a pressure and/or impulse relationship, depending on the anticipated pressure-design range.

A charge located on or very near the ground is considered to be a surface burst (see Fig 1).

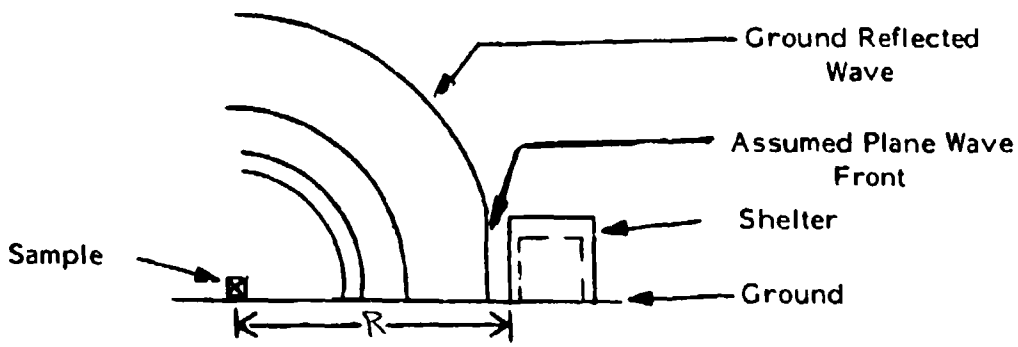


Fig 1 Schematic of a surface burst

The initial wave of the explosion is reflected and reinforced by the ground surface, producing a reflected wave. Unlike the airburst above the surface, however, the reflected wave merges with the incident wave at the point of detonation to form a single wave. This wave is similar in nature to the reflected wave of the airburst, but is essentially hemispherical in shape. It should be noted that at a given distance from the detonation of a given weight of explosive, all the explosive output parameters of a surface burst environment are larger than those for a free-air burst environment.

STUDY

The explosive airblast parameters, peak pressure, and positive impulse for hemispherical-shaped TNT charges were established by References 1 through 3. The mathematical expressions correlating scaled impulse (Y) and pressure (P) to scaled distance (Z) for TNT have been determined to be of the form:

$$\log Z = \sum C_i \left\{ \log P \right\}^i$$

$$Z = a\, Y^{-b}$$

where a, b, and c are constants.

The TNT pressure equivalency (EP) and scaled distance (ZP) are related to the radial distance from the sample (R), weight of the sample (WS), pressure (P), and booster effects (B) as:

$$EP = \left\{ \left[\frac{R}{Z} \right]^3 - B \right\} \Big/ WS \qquad ZP = Z \times EP^{1/3}$$

$$Z = 10^{\left\{ \sum C_i \times \left[\log P \right]^i \right\}}$$

Similarly, the TNT impulse equivalency (EI) and scaled distance (ZI) are related to the positive unit impulse (IT), TNT scaled impulse (Y) and scaled distance (Z) as:

$$EI = \left\{ \left[\frac{IT}{Y} \right]^3 - B \right\} \Big/ WS = \left\{ \left[\frac{R}{Z} \right]^3 - B \right\} \Big/ WS$$

$$Y = \text{function}\left\{ IT, R \right\} \qquad Z = \text{function}\left\{ IT, R \right\}$$

Sample calculations for TNT equivalencies and scaled distances are given in Appendix E. A FORTRAN Extended computer program is given in Appendix F.

GLOSSARY

<u>Intraline Distance</u> (as outlined in Ref 2):

This distance is the minimum permitted between any two buildings within one operating line. Intraline distances are also used for separating certain specified areas, buildings, and locations even though actual line operations are not involved. All unpacked ammunition and explosives except Classes 1, 2, and 2A in such a line are considered Class 7. Intraline distance is expected to protect buildings from propagation of explosion due to blast effects, but not against the possibility of propagation due to missiles. Buildings separated by intraline distances will probably still suffer substantial structural damage.

A service type magazine shall be located at intraline distance (based on the quantity of explosives within the magazine) from the nearest operating building of the line of which it forms a part. Service type magazines shall be separated from each other by intraline distances.

Separate facilities (excluding service magazines) servicing a single explosives operating building may be located at less than intraline distances but not less than 100 feet from the operating building. Such facilities, which include low pressure heating boilers and paint storage buildings, must, however, be at least intraline distance from other explosive buildings.

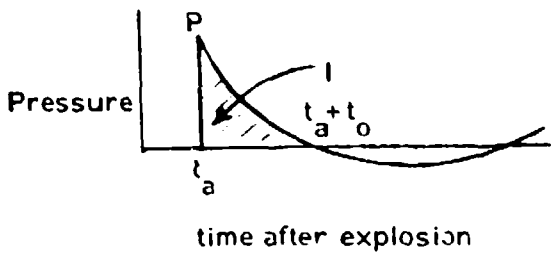
Peak Pressure (P): Maximum Pressure (psig) attained

$$\left.\frac{\partial P}{\partial t}\right|_{Z,WT} = 0$$

Positive Impulse (I): The unit impulse (psi-millisecond) produced by a pressure is proportional to the change in momentum over the time duration in which the positive pressure acts.

I = shaded area under curve

$$I = \int_{t_a}^{t_a+t_o} P(t)\,dt$$



Scaled Distance (Z): Radial distance (ft) divided by the scaling factor which is the cube root of the weight (lb) of the material.

$$Z = R/W^{1/3}$$

Scaled Impulse (Y): Positive unit impulse (psi-millisecond) divided by the scaling factor which is the cube root of the weight (lb) of the material.

$$Y = I/W^{1/3}$$

TNT Impulse Equivalency (EI): The ratio of the weights (weight of TNT/weight of test sample) which will yield the same positive impulse at the same radial distance from the test sample.

TNT Pressure Equivalency (EP): The ratio of weights (weight of TNT/weight of test sample) which will yield the same peak pressure at the same radial distance from the test sample.

REFERENCES

1. Department of the Army, *Structures to Resist the Effects of Accidental Explosions*, TM 5-1300, NAVFAC P-397, AFM 88-22, 15 June 1969

2. Department of the Army, *Safety*, Army Materiel Command Regulation 385-100, April 1970 and Change 1, 14 October 1971

3. C. N. Kingery and B. F. Pannill, *Peak Overpressure vs Scaled Distance for TNT Surface Bursts (Hemispherical Charges)*, Ballistic Research Laboratories Memorandum, Report 1510, April 1964

4. H. S. Napadensky and J. J. Swatosh Jr., *TNT Equivalency of Black Powder*, Report J6265-3, IIT Research Institute, Chicago, Illinois, September 1972

5. H. S. Napadesnky and J. J. Swatosh Jr., *TNT Equivalency of Nitroguanidine, Guanidine Nitrate, and GN Reactor*, Report J6276-1, ITT Research Institute, Chicago, October 1973

6. Richard Rindner et al., *Manual for Design of Protective Structures Used in Explosive Processing and Storage Facilities*, Picatinny Arsenal Technical Report 3808, November 1968

7. Letter from Picatinny Arsenal to U. S. Army Munitions Command, Subject: *TNT Equivalency of Black Powder*, 15 August 1972

8. Letter from U. S. Army Munitions Command to U. S. Army Materiel Command, First Indorsement, Subject: *TNT Equivalency of Black Powder*, 15 August 1972

9. Letter from U. S. Army Materiel Command to Chairman, Department of Defense Explosives Safety Board, Second Indorsement, Subject: *TNT Equivalency of Black Powder*, 14 September 1972

10. Department of Defense Explosives Safety Board to U. S. Army Materiel Command, Third Indorsement, Subject: *TNT Equivalency of Black Powder*, 27 September 1972

11. C. V. Moore, *The Design of Barricades for Hazardous Pressure Systems*, Nuclear Engineering and Design, North-Holland Publishing Co., Amsterdam, Holland, Volume 5, 1967, pp. 81-97

APPENDIX A

DERIVATION FOR TNT PRESSURE EQUIVALENCY

APPENDIX A

TNT PRESSURE EQUIVALENCY DERIVATION
ENGINEER - THOMAS CAGGIANO

DEFINITION:

TNT EQUIVALENCY FOR PRESSURE IS DEFINED AS THE RATIO OF CHARGE WEIGHT(W/WS) THAT WILL GIVE THE SAME PEAK PRESSURE AT THE SAME RADIAL DISTANCE.

NOMENCLATURE:

B	BOOSTER CORRECTION FACTOR
EP	TNT PRESSURE EQUIVALENCY FOR SAMPLE
EB	BOOSTER EQUIVALENCY (IF - C4=1.25)
R	RADIAL DISTANCE(FT)
WB	WEIGHT OF BOOSTER(LBS)
WS	WEIGHT OF SAMPLE(LBS)
WT	TOTAL EFFECTIVE WEIGHT OF SAMPLE + BOOSTER(LBS)
W	WEIGHT OF TNT (LBS)
ZT	SCALED DISTANCE FOR SAMPLE + BOOSTER FT/(LB)$^{1/3}$
Z	SCALED DISTANCE FOR TNT
Z	FUNCTION OF PRESSURE (IE - 8TH DEGREE POLYNOMIAL)

$$B = EB * WB$$

$$WT = WS + (B/EP)$$

$$Z = R/W^{1/3}$$

$$EP = W/WT = (ZT/Z)^3$$

$$Z^3 EP = ZT^3 = R^3/WT$$

$$Z^3 EP = R^3/(WS + B/EP) = EP*R^3/(EP*WS + B)$$

$$Z^3 = R^3/(EP*WS + B)$$

$$EP*WS + B = (R/Z)^3$$

$$EP*WS = (R/Z)^3 - B$$

$$EP = ((R/Z)^3 - B)/WS$$

APPENDIX B

DERIVATION FOR TNT IMPULSE EQUIVALENCY

APPENDIX B

TNT IMPULSE EQUIVALENCY DERIVATION
ENGINEER - THOMAS CAGGIANO

DEFINITION:

INT EQUIVALENCY FOR IMPULSE IS DEFINED AS THE RATIO OF CHARGE WEIGHT(W/WS) THAT WILL GIVE THE SAME POSITIVE IMPULSE AT THE SAME RADIAL DIATANCE.

NOMENCLATURE:

B	BOOSTER CORRECTION FACTOR
EB	BOOSTER EQUIVALENCY (IE - C4=1.25)
EI	TNT IMPULSE EQUIVALENCY FOR SAMPLE
IT	IMPULSE (PSI-MSEC) FOR SAMPLE AND BOOSTER
I	IMPULSE FOR TNT
R	RADIAL DISTANCE(FT)
WB	WEIGHT OF BOOSTER(LBS)
WS	WEIGHT OF SAMPLE(LBS)
WT	TOTAL EFFECTIVE WEIGHT OF SAMPLE + BOOSTER(LBS)
W	WEIGHT OF TNT (LBS)
YT	SCALED IMPULSE (PSI-MSEC/(LB)$^{1/3}$) FOR BOOSTER + SAMPLE
Y	SCALED IMPULSE FOR TNT FOR WT=W,IT=I
Y	FUNCTION OF IT AND R (SEE DERIVATION - APPENDIX C)

$$Y = I/W^{1/3}$$

$$WT = WS + (B/EI)$$

$$B = EB * WB$$

$$EI = W/WT = (YT/Y)^3$$

$$Y^3 EI = YT^3 = IT^3/WT$$

$$Y^3 EI = IT^3/(WS + (B/EI)) = EI*IT^3/(WS*EI + B)$$

$$EI*WS + B = (IT/Y)^3$$

$$EI = ((IT/Y)^3 - B)/WS$$

APPENDIX C

DERIVATION FOR TNT SCALED IMPULSE AND SCALED DISTANCE AS A FUNCTION OF POSITIVE IMPULSE AND RADIAL DISTANCE

APPENDIX C

DERIVATION FOR Y = FUNCTION (IT*R)
Z = FUNCTION (IT*R)

$YT = II/(RT)^{1/3}$ $\qquad$ $ZT = RT/(RT)^{1/3}$

$IT = YI*(RT)^{1/3}$ $\qquad$ $RT = ZI*(RT)^{1/3}$

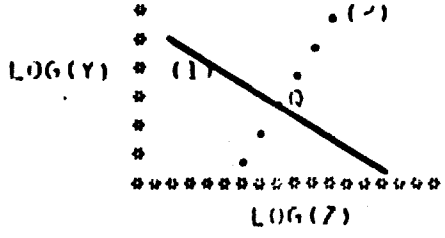
FOR EQUAL IMPULSES: $\qquad$ FOR EQUAL DISTANCES:

$IT = I$ $\qquad$ $RI = R$

$YT*(RT)^{1/3} = Y*(R)^{1/3}$ $\qquad$ $ZT*(RT)^{1/3} = Z*(R)^{1/3}$

$(R/RT)^{1/3} = ZT// = YI/Y = RI$

LOG(YT) - LOG(Y) = LOG(ZT) - LOG(Z)
THIS REPRESENTS THE EQUATION OF A 45 DEGREE LINE FROM A POINT, P (YT,ZI) TO A POINT, Q (Y,Z) ON LOG-LOG PAPER, THUS SATISFYING THE CONDITIONS OF EQUAL POSITIVE IMPULSES AT EQUAL DISTANCES.



NOTE: Z = (ZT/YT)*Y

Z = (RT/IT)*Y

Z = C*Y

CURVE 1: $A*Y^{-D} = Z$ $\qquad$ CURVE 2: $C*Y = Z$

A and D are constants

AT POINT Q: $A*Y^{-D} = C*Y$

$A/C = Y^{+D}\ Y = Y^{(1+D)}$ $\qquad$ $Z = A^{1/(1+D)}\ C^{(1-(1/(1+D)))}$

$(A/C)^{1/(1+D)} = Y$

FROM IITRI DATA: $\quad$ A=77.541
D= 1.02409

THEREFORE : $\qquad$ $Y=(77.761(IT/RT))^{0.49405}$ $\qquad$ $Z = (70.086A(RT/IT))^{.50595}$

APPENDIX D

TNT STANDARDS FOR HEMISPHERICAL-SHAPED CHARGES

APPENDIX D
TNT STANDARDS FOR SURFACE HEMISPHERICAL BURSTS

GRAPHICAL CORRELATIONS FOR TNT STANDARDS

SCALED IMPULSE VERSUS SCALED DISTANCE

$$YTNT = A*Z^{-B}$$

WHERE: A = 77.641
B = 1.02409

SCALED DISTANCE VERSUS PEAK OVER-PRESSURE

$$ZTNT = 10.^{((A1+P*(A2+P*(A3+P*(A4+P*(A5+P*(A6+P*(A7+P*A8)))))))}$$

WHERE:

A1 = 1.6556442

A2 = -.78501286

A3 = .042385534

A4 = .1301777

A5 = -.052100399

A6 = -.0076767222

A7 = .0068537028

A8 = -.00094665924

P = LOG(P) UNITS P= PSIG

TABLE I

PRESSURE OR IMPULSE AS A FUNCTION OF SCALED DISTANCE

SCALED DISTANCE (FT/LB$^{1/3}$)	PRESSURE (PSIG)	SCALED IMPULSE (PSI-MS/LB$^{1/3}$)	SCALED DISTANCE (FT/LB$^{1/3}$)	PRESSURE (PSIG)	SCALED IMPULSE (PSI-MS/LB$^{1/3}$)
2.000	320.71	35.61	10.800	8.31	6.87
2.200	262.98	32.45	11.000	8.03	6.75
2.400	218.47	29.81	11.200	7.77	6.63
2.600	183.61	27.57	11.400	7.52	6.51
2.800	155.95	25.65	11.600	7.28	6.40
3.000	133.71	23.98	11.800	7.06	6.30
3.200	115.64	22.51	12.000	6.85	6.20
3.400	100.81	21.22	12.200	6.65	6.10
3.600	88.51	20.07	12.400	6.46	6.00
3.800	78.24	19.04	12.600	6.28	5.91
4.000	69.58	18.11	12.800	6.11	5.82
4.200	62.24	17.26	13.000	5.94	5.73
4.400	55.96	16.50	13.200	5.79	5.65
4.600	50.57	15.80	13.400	5.64	5.56
4.800	45.90	15.15	13.600	5.50	5.48
5.000	41.84	14.56	13.800	5.36	5.41
5.200	38.29	14.02	14.000	5.23	5.33
5.400	35.17	13.51	14.200	5.11	5.26
5.600	32.42	13.04	14.400	4.99	5.19
5.800	29.98	12.60	14.600	4.88	5.12
6.000	27.82	12.19	14.800	4.77	5.05
6.200	25.88	11.80	15.000	4.67	4.98
6.400	24.14	11.44	15.200	4.57	4.92
6.600	22.58	11.11	15.400	4.47	4.86
6.800	21.16	10.79	15.600	4.38	4.80
7.000	19.89	10.49	15.800	4.29	4.74
7.200	18.73	10.20	16.000	4.20	4.68
7.400	17.67	9.93	16.200	4.12	4.62
7.600	16.71	9.68	16.400	4.04	4.57
7.800	15.82	9.43	16.600	3.96	4.51
8.000	15.01	9.20	16.800	3.89	4.46
8.200	14.27	8.99	17.000	3.82	4.41
8.400	13.58	8.78	17.200	3.75	4.36
8.600	12.95	8.58	17.400	3.68	4.31
8.800	12.36	8.39	17.600	3.62	4.26
9.000	11.82	8.20	17.800	3.55	4.22
9.200	11.31	8.03	18.000	3.49	4.17
9.400	10.84	7.86	18.200	3.44	4.13
9.600	10.41	7.70	18.400	3.38	4.08
9.800	10.00	7.55	18.600	3.32	4.04
10.000	9.61	7.40	18.800	3.27	4.00
10.200	9.26	7.26	19.000	3.22	3.96
10.400	8.92	7.13	19.200	3.17	3.92
10.600	8.60	6.99	19.400	3.12	3.88

TABLE I

PRESSURE OR IMPULSE AS A FUNCTION OF SCALED DISTANCE

SCALED DISTANCE $(FT/LB^{1/3})$	PRESSURE (PSIG)	SCALED IMPULSE $(PSI\text{-}MS/LB^{1/3})$	SCALED DISTANCE $(FT/LB^{1/3})$	PRESSURE (PSIG)	SCALED IMPULSE $(PSI\text{-}MS/LB^{1/3})$
19,600	3,07	3,84	28,400	1,83	2,67
19,800	3,03	3,80	28,600	1,82	2,65
20,000	2,98	3,76	28,800	1,80	2,64
20,200	2,94	3,73	29,000	1,78	2,62
20,400	2,90	3,69	29,200	1,77	2,60
20,600	2,86	3,66	29,400	1,75	2,58
20,800	2,82	3,62	29,600	1,74	2,57
21,000	2,78	3,59	29,800	1,72	2,55
21,200	2,74	3,56	30,000	1,71	2,53
21,400	2,71	3,52	30,200	1,69	2,52
21,600	2,67	3,49	30,400	1,68	2,50
21,800	2,63	3,46	30,600	1,66	2,49
22,000	2,60	3,43	30,800	1,65	2,47
22,200	2,57	3,40	31,000	1,63	2,45
22,400	2,53	3,37	31,200	1,62	2,44
22,600	2,50	3,34	31,400	1,61	2,42
22,800	2,47	3,31	31,600	1,59	2,41
23,000	2,44	3,28	31,800	1,58	2,39
23,200	2,41	3,26	32,000	1,57	2,38
23,400	2,38	3,23	32,200	1,56	2,36
23,600	2,36	3,20	32,400	1,54	2,35
23,800	2,33	3,18	32,600	1,53	2,34
24,000	2,30	3,15	32,800	1,52	2,32
24,200	2,28	3,12	33,000	1,51	2,31
24,400	2,25	3,10	33,200	1,50	2,29
24,600	2,22	3,08	33,400	1,48	2,28
24,800	2,20	3,05	33,600	1,47	2,27
25,000	2,18	3,03	33,800	1,46	2,26
25,200	2,15	3,00	34,000	1,45	2,24
25,400	2,13	2,98	34,200	1,44	2,23
25,600	2,11	2,96	34,400	1,43	2,22
25,800	2,08	2,94	34,600	1,42	2,20
26,000	2,06	2,91	34,800	1,41	2,19
26,200	2,04	2,89	35,000	1,40	2,18
26,400	2,02	2,87	35,200	1,39	2,17
26,600	2,00	2,85	35,400	1,38	2,16
26,800	1,98	2,83	35,600	1,37	2,14
27,000	1,96	2,81	35,800	1,36	2,13
27,200	1,94	2,79	36,000	1,35	2,12
27,400	1,92	2,77	36,200	1,34	2,11
27,600	1,90	2,75	36,400	1,33	2,10
27,800	1,89	2,73	36,600	1,32	2,09
28,000	1,87	2,71	36,800	1,31	2,08
28,200	1,85	2,69	37,000	1,30	2,06

TABLE I

PRESSURE OR IMPULSE AS A FUNCTION OF SCALED DISTANCE

SCALED DISTANCE $(FT/LB^{1/3})$	PRESSURE (PSIG)	SCALED IMPULSE $(PSI\text{-}MS/LB^{1/3})$
37.200	1.29	2.05
37.400	1.28	2.04
37.600	1.27	2.03
37.800	1.27	2.02
38.000	1.26	2.01
38.200	1.25	2.00
38.400	1.24	1.99
38.600	1.23	1.98
38.800	1.22	1.97
39.000	1.22	1.96
39.200	1.21	1.95
39.400	1.20	1.94
39.600	1.19	1.93
39.800	1.19	1.92
40.000	1.18	1.91
40.200	1.17	1.90
40.400	1.16	1.89
40.600	1.16	1.89
40.800	1.15	1.88
41.000	1.14	1.87
41.200	1.14	1.86
41.400	1.13	1.85
41.600	1.12	1.84
41.800	1.11	1.83
42.000	1.11	1.82
42.200	1.10	1.82
42.400	1.09	1.81
42.600	1.09	1.80
42.800	1.08	1.79
43.000	1.08	1.78
43.200	1.07	1.77
43.400	1.06	1.77
43.600	1.06	1.76
43.800	1.05	1.75
44.000	1.04	1.74
44.200	1.04	1.74
44.400	1.03	1.73
44.600	1.03	1.72
44.800	1.02	1.71
45.000	1.01	1.71
45.200	1.01	1.70
45.400	1.00	1.69
45.600	1.00	1.68
45.800	.99	1.68
46.000	.99	1.67
46.200	.98	1.66
46.400	.98	1.66
46.600	.97	1.65
46.800	.97	1.64
47.000	.96	1.63
47.200	.96	1.63
47.400	.95	1.62
47.600	.94	1.61
47.800	.94	1.61
48.000	.93	1.60
48.200	.93	1.59
48.400	.93	1.59
48.600	.92	1.58
48.800	.92	1.58
49.000	.91	1.57
49.200	.91	1.56
49.400	.90	1.56
49.600	.90	1.55
49.800	.89	1.54
50.000	.89	1.54

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
300.00	2.060	.225	291.40	2.089	.232
299.80	2.061	.225	291.20	2.090	.232
299.60	2.061	.226	291.00	2.091	.233
299.40	2.062	.226	290.80	2.091	.233
299.20	2.063	.226	290.60	2.092	.233
299.00	2.063	.226	290.40	2.093	.233
298.80	2.064	.226	290.20	2.093	.233
298.60	2.065	.226	290.00	2.094	.233
298.40	2.065	.227	289.80	2.095	.234
298.20	2.066	.227	289.60	2.096	.234
298.00	2.067	.227	289.40	2.096	.234
297.80	2.067	.227	289.20	2.097	.234
297.60	2.068	.227	289.00	2.098	.234
297.40	2.069	.227	288.80	2.098	.234
297.20	2.069	.228	288.60	2.099	.235
297.00	2.070	.228	288.40	2.100	.235
296.80	2.071	.228	288.20	2.100	.235
296.60	2.071	.228	288.00	2.101	.235
296.40	2.072	.228	287.80	2.102	.235
296.20	2.073	.228	287.60	2.103	.235
296.00	2.073	.228	287.40	2.103	.235
295.80	2.074	.229	287.20	2.104	.236
295.60	2.075	.229	287.00	2.105	.236
295.40	2.075	.229	286.80	2.105	.236
295.20	2.076	.229	286.60	2.106	.236
295.00	2.077	.229	286.40	2.107	.236
294.80	2.078	.229	286.20	2.108	.237
294.60	2.078	.230	286.00	2.108	.237
294.40	2.079	.230	285.80	2.109	.237
294.20	2.080	.230	285.60	2.110	.237
294.00	2.080	.230	285.40	2.110	.237
293.80	2.081	.230	285.20	2.111	.237
293.60	2.082	.230	285.00	2.112	.238
293.40	2.082	.231	284.80	2.113	.238
293.20	2.083	.231	284.60	2.113	.238
293.00	2.084	.231	284.40	2.114	.238
292.80	2.084	.231	284.20	2.115	.238
292.60	2.085	.231	284.00	2.115	.239
292.40	2.086	.231	283.80	2.116	.239
292.20	2.086	.231	283.60	2.117	.239
292.00	2.087	.232	283.40	2.118	.239
291.80	2.088	.232	283.20	2.118	.239
291.60	2.089	.232	283.00	2.119	.239

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
282.80	2.120	.239	274.20	2.152	.247
282.60	2.121	.240	274.00	2.152	.247
282.40	2.121	.240	273.80	2.153	.248
282.20	2.122	.240	273.60	2.154	.248
282.00	2.123	.240	273.40	2.155	.248
281.80	2.123	.240	273.20	2.156	.248
281.60	2.124	.240	273.00	2.156	.248
281.40	2.125	.241	272.80	2.157	.249
281.20	2.126	.241	272.60	2.158	.249
281.00	2.126	.241	272.40	2.159	.249
280.80	2.127	.241	272.20	2.159	.249
280.60	2.128	.241	272.00	2.160	.249
280.40	2.129	.241	271.80	2.161	.249
280.20	2.129	.242	271.60	2.162	.250
280.00	2.130	.242	271.40	2.162	.250
279.80	2.131	.242	271.20	2.163	.250
279.60	2.132	.242	271.00	2.164	.250
279.40	2.132	.242	270.80	2.165	.250
279.20	2.133	.243	270.60	2.165	.251
279.00	2.134	.243	270.40	2.166	.251
278.80	2.134	.243	270.20	2.167	.251
278.60	2.135	.243	270.00	2.168	.251
278.40	2.136	.243	269.80	2.169	.251
278.20	2.137	.243	269.60	2.169	.252
278.00	2.137	.244	269.40	2.170	.252
277.80	2.138	.244	269.20	2.171	.252
277.60	2.139	.244	269.00	2.172	.252
277.40	2.140	.244	268.80	2.172	.252
277.20	2.140	.244	268.60	2.173	.253
277.00	2.141	.245	268.40	2.174	.253
276.80	2.142	.245	268.20	2.175	.253
276.60	2.143	.245	268.00	2.176	.253
276.40	2.143	.245	267.80	2.176	.253
276.20	2.144	.245	267.60	2.177	.254
276.00	2.145	.245	267.40	2.178	.254
275.80	2.146	.246	267.20	2.179	.254
275.60	2.146	.246	267.00	2.179	.254
275.40	2.147	.246	266.80	2.180	.254
275.20	2.148	.246	266.60	2.181	.254
275.00	2.149	.246	266.40	2.182	.255
274.80	2.149	.247	266.20	2.183	.255
274.60	2.150	.247	266.00	2.183	.255
274.40	2.151	.247	265.80	2.184	.255

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
265.60	2.185	.255	257.00	2.220	.264
265.40	2.186	.255	256.80	2.221	.264
265.20	2.187	.256	256.60	2.221	.265
265.00	2.187	.256	256.40	2.222	.265
264.80	2.188	.256	256.20	2.223	.265
264.60	2.189	.256	256.00	2.224	.265
264.40	2.190	.256	255.80	2.225	.266
264.20	2.191	.257	255.60	2.226	.266
264.00	2.191	.257	255.40	2.226	.266
263.80	2.192	.257	255.20	2.227	.266
263.60	2.193	.257	255.00	2.228	.266
263.40	2.194	.257	254.80	2.229	.267
263.20	2.195	.258	254.60	2.230	.267
263.00	2.195	.258	254.40	2.231	.267
262.80	2.196	.258	254.20	2.232	.267
262.60	2.197	.258	254.00	2.232	.267
262.40	2.198	.258	253.80	2.233	.268
262.20	2.199	.259	253.60	2.234	.268
262.00	2.199	.259	253.40	2.235	.268
261.80	2.200	.259	253.20	2.236	.268
261.60	2.201	.259	253.00	2.237	.269
261.40	2.202	.259	252.80	2.237	.269
261.20	2.203	.260	252.60	2.238	.269
261.00	2.203	.260	252.40	2.239	.269
260.80	2.204	.260	252.20	2.240	.269
260.60	2.205	.260	252.00	2.241	.270
260.40	2.206	.260	251.80	2.242	.270
260.20	2.207	.261	251.60	2.243	.270
260.00	2.207	.261	251.40	2.243	.270
259.80	2.208	.261	251.20	2.244	.270
259.60	2.209	.261	251.00	2.245	.271
259.40	2.210	.262	250.80	2.246	.271
259.20	2.211	.262	250.60	2.247	.271
259.00	2.212	.262	250.40	2.248	.271
258.80	2.212	.262	250.20	2.249	.272
258.60	2.213	.262	250.00	2.249	.272
258.40	2.214	.263	249.80	2.250	.272
258.20	2.215	.263	249.60	2.251	.272
258.00	2.216	.263	249.40	2.252	.272
257.80	2.217	.263	249.20	2.253	.273
257.60	2.217	.263	249.00	2.254	.273
257.40	2.218	.264	248.80	2.255	.273
257.20	2.219	.264	248.60	2.255	.273

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
248.40	2.256	.273
248.20	2.257	.274
248.00	2.258	.274
247.80	2.259	.274
247.60	2.260	.274
247.40	2.261	.275
247.20	2.262	.275
247.00	2.262	.275
246.80	2.263	.275
246.60	2.264	.275
246.40	2.265	.276
246.20	2.266	.276
246.00	2.267	.276
245.80	2.268	.276
245.60	2.269	.277
245.40	2.269	.277
245.20	2.270	.277
245.00	2.271	.277
244.80	2.272	.278
244.60	2.273	.278
244.40	2.274	.278
244.20	2.275	.278
244.00	2.276	.278
243.80	2.277	.279
243.60	2.277	.279
243.40	2.278	.279
243.20	2.279	.279
243.00	2.280	.280
242.80	2.281	.280
242.60	2.282	.280
242.40	2.283	.280
242.20	2.284	.281
242.00	2.285	.281
241.80	2.285	.281
241.60	2.286	.281
241.40	2.287	.282
241.20	2.288	.282
241.00	2.289	.282
240.80	2.290	.282
240.60	2.291	.282
240.40	2.292	.283
240.20	2.293	.283
240.00	2.294	.283

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
239.80	2.295	.284
239.60	2.295	.284
239.40	2.296	.284
239.20	2.297	.284
239.00	2.298	.285
238.80	2.299	.285
238.60	2.300	.285
238.40	2.301	.285
238.20	2.302	.286
238.00	2.303	.286
237.80	2.304	.286
237.60	2.305	.286
237.40	2.306	.287
237.20	2.306	.287
237.00	2.307	.287
236.80	2.308	.287
236.60	2.309	.288
236.40	2.310	.288
236.20	2.311	.288
236.00	2.312	.288
235.80	2.313	.289
235.60	2.314	.289
235.40	2.315	.289
235.20	2.316	.289
235.00	2.317	.290
234.80	2.318	.290
234.60	2.319	.290
234.40	2.320	.290
234.20	2.320	.291
234.00	2.321	.291
233.80	2.322	.291
233.60	2.323	.291
233.40	2.324	.292
233.20	2.325	.292
233.00	2.326	.292
232.80	2.327	.292
232.60	2.328	.293
232.40	2.329	.293
232.20	2.330	.293
232.00	2.331	.293
231.80	2.332	.294
231.60	2.333	.294
231.40	2.334	.294

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
231.20	2.335	.294	222.60	2.377	.306
231.00	2.336	.295	222.40	2.378	.306
230.80	2.337	.295	222.20	2.379	.307
230.60	2.338	.295	222.00	2.380	.307
230.40	2.339	.295	221.80	2.381	.307
230.20	2.340	.296	221.60	2.382	.308
230.00	2.341	.296	221.40	2.383	.308
229.80	2.341	.296	221.20	2.384	.308
229.60	2.342	.296	221.00	2.385	.308
229.40	2.343	.297	220.80	2.386	.309
229.20	2.344	.297	220.60	2.387	.309
229.00	2.345	.297	220.40	2.388	.309
228.80	2.346	.297	220.20	2.389	.310
228.60	2.347	.298	220.00	2.390	.310
228.40	2.348	.298	219.80	2.391	.310
228.20	2.349	.298	219.60	2.392	.310
228.00	2.350	.298	219.40	2.393	.311
227.80	2.351	.299	219.20	2.394	.311
227.60	2.352	.299	219.00	2.395	.311
227.40	2.353	.299	218.80	2.396	.312
227.20	2.354	.300	218.60	2.397	.312
227.00	2.355	.300	218.40	2.399	.312
226.80	2.356	.300	218.20	2.400	.313
226.60	2.357	.300	218.00	2.401	.313
226.40	2.358	.301	217.80	2.402	.313
226.20	2.359	.301	217.60	2.403	.313
226.00	2.360	.301	217.40	2.404	.314
225.80	2.361	.301	217.20	2.405	.314
225.60	2.362	.302	217.00	2.406	.314
225.40	2.363	.302	216.80	2.407	.315
225.20	2.364	.302	216.60	2.408	.315
225.00	2.365	.303	216.40	2.409	.315
224.80	2.366	.303	216.20	2.410	.315
224.60	2.367	.303	216.00	2.411	.316
224.40	2.368	.303	215.80	2.412	.316
224.20	2.369	.304	215.60	2.413	.316
224.00	2.370	.304	215.40	2.414	.317
223.80	2.371	.304	215.20	2.415	.317
223.60	2.372	.305	215.00	2.416	.317
223.40	2.373	.305	214.80	2.417	.318
223.20	2.374	.305	214.60	2.418	.318
223.00	2.375	.305	214.40	2.420	.318
222.80	2.376	.306	214.20	2.421	.319

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
214.00	2.422	.319	205.40	2.469	.333
213.80	2.423	.319	205.20	2.470	.333
213.60	2.424	.319	205.00	2.471	.333
213.40	2.425	.319	204.80	2.472	.334
213.20	2.426	.320	204.60	2.473	.334
213.00	2.427	.320	204.40	2.474	.334
212.80	2.428	.320	204.20	2.476	.335
212.60	2.429	.321	204.00	2.477	.335
212.40	2.430	.321	203.80	2.478	.335
212.20	2.431	.321	203.60	2.479	.336
212.00	2.432	.322	203.40	2.480	.336
211.80	2.433	.322	203.20	2.481	.336
211.60	2.435	.322	203.00	2.482	.337
211.40	2.436	.323	202.80	2.484	.337
211.20	2.437	.323	202.60	2.485	.337
211.00	2.438	.323	202.40	2.486	.338
210.80	2.439	.323	202.20	2.487	.338
210.60	2.440	.324	202.00	2.488	.338
210.40	2.441	.324	201.80	2.489	.339
210.20	2.442	.324	201.60	2.491	.339
210.00	2.443	.325	201.40	2.492	.339
209.80	2.444	.325	201.20	2.493	.340
209.60	2.445	.325	201.00	2.494	.340
209.40	2.447	.326	200.80	2.495	.340
209.20	2.448	.326	200.60	2.496	.341
209.00	2.449	.326	200.40	2.498	.341
208.80	2.450	.327	200.20	2.499	.341
208.60	2.451	.327	200.00	2.500	.342
208.40	2.452	.327	199.80	2.501	.342
208.20	2.453	.328	199.60	2.502	.342
208.00	2.454	.328	199.40	2.503	.343
207.80	2.455	.328	199.20	2.505	.343
207.60	2.457	.329	199.00	2.506	.343
207.40	2.458	.329	198.80	2.507	.344
207.20	2.459	.329	198.60	2.508	.344
207.00	2.460	.330	198.40	2.509	.345
206.80	2.461	.330	198.20	2.510	.345
206.60	2.462	.330	198.00	2.512	.345
206.40	2.463	.331	197.80	2.513	.346
206.20	2.464	.331	197.60	2.514	.346
206.00	2.465	.331	197.40	2.515	.346
205.80	2.467	.332	197.20	2.516	.347
205.60	2.468	.332	197.00	2.518	.347

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
196.80	2.519	.347
196.60	2.520	.347
196.40	2.521	.348
196.20	2.522	.348
196.00	2.524	.349
195.80	2.525	.349
195.60	2.526	.349
195.40	2.527	.350
195.20	2.528	.350
195.00	2.530	.350
194.80	2.531	.351
194.60	2.532	.351
194.40	2.533	.351
194.20	2.534	.352
194.00	2.536	.352
193.80	2.537	.353
193.60	2.538	.353
193.40	2.539	.353
193.20	2.541	.354
193.00	2.542	.354
192.80	2.543	.354
192.60	2.544	.355
192.40	2.546	.355
192.20	2.547	.356
192.00	2.548	.356
191.80	2.549	.356
191.60	2.550	.357
191.40	2.552	.357
191.20	2.553	.357
191.00	2.554	.358
190.80	2.555	.358
190.60	2.557	.359
190.40	2.558	.359
190.20	2.559	.359
190.00	2.560	.360
189.80	2.562	.360
189.60	2.563	.361
189.40	2.564	.361
189.20	2.566	.361
189.00	2.567	.362
188.80	2.568	.362
188.60	2.569	.363
188.40	2.571	.363
188.20	2.572	.364
188.00	2.573	.364
187.80	2.574	.365
187.60	2.576	.365
187.40	2.577	.365
187.20	2.578	.366
187.00	2.580	.366
186.80	2.581	.367
186.60	2.582	.367
186.40	2.583	.367
186.20	2.585	.368
186.00	2.586	.368
185.80	2.587	.369
185.60	2.589	.369
185.40	2.590	.369
185.20	2.591	.370
185.00	2.592	.370
184.80	2.594	.371
184.60	2.595	.371
184.40	2.596	.371
184.20	2.598	.372
184.00	2.599	.372
183.80	2.600	.373
183.60	2.602	.373
183.40	2.603	.373
183.20	2.604	.374
183.00	2.606	.374
182.80	2.607	.375
182.60	2.608	.375
182.40	2.610	.376
182.20	2.611	.376
182.00	2.612	.376
181.80	2.614	.377
181.60	2.615	.377
181.40	2.616	.378
181.20	2.618	.378
181.00	2.619	.379
180.80	2.620	.379
180.60	2.622	.379
180.40	2.623	.380
180.20	2.624	.380
180.00	2.626	.381
179.80	2.627	.381

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
179.60	2.628	.381	171.00	2.689	.401
179.40	2.630	.382	170.80	2.690	.402
179.20	2.631	.382	170.60	2.692	.402
179.00	2.632	.382	170.40	2.693	.403
178.80	2.634	.383	170.20	2.695	.403
178.60	2.635	.383	170.00	2.696	.404
178.40	2.637	.384	169.80	2.697	.404
178.20	2.638	.384	169.60	2.699	.405
178.00	2.639	.385	169.40	2.700	.405
177.80	2.641	.385	169.20	2.702	.406
177.60	2.642	.386	169.00	2.703	.406
177.40	2.643	.386	168.80	2.705	.407
177.20	2.645	.386	168.60	2.706	.407
177.00	2.646	.387	168.40	2.708	.408
176.80	2.648	.387	168.20	2.709	.408
176.60	2.649	.388	168.00	2.711	.409
176.40	2.650	.388	167.80	2.712	.409
176.20	2.652	.389	167.60	2.714	.410
176.00	2.653	.389	167.40	2.715	.410
175.80	2.655	.390	167.20	2.717	.411
175.60	2.656	.390	167.00	2.718	.411
175.40	2.657	.391	166.80	2.720	.412
175.20	2.659	.391	166.60	2.721	.412
175.00	2.660	.391	166.40	2.723	.413
174.80	2.662	.392	166.20	2.724	.413
174.60	2.663	.392	166.00	2.726	.414
174.40	2.664	.393	165.80	2.727	.414
174.20	2.666	.393	165.60	2.729	.415
174.00	2.667	.394	165.40	2.730	.415
173.80	2.669	.394	165.20	2.732	.416
173.60	2.670	.395	165.00	2.733	.416
173.40	2.671	.395	164.80	2.735	.417
173.20	2.673	.396	164.60	2.736	.417
173.00	2.674	.396	164.40	2.738	.418
172.80	2.676	.397	164.20	2.739	.418
172.60	2.677	.397	164.00	2.741	.419
172.40	2.679	.397	163.80	2.743	.419
172.20	2.680	.398	163.60	2.744	.420
172.00	2.681	.398	163.40	2.746	.420
171.80	2.683	.399	163.20	2.747	.421
171.60	2.684	.399	163.00	2.749	.421
171.40	2.686	.400	162.80	2.750	.422
171.20	2.687	.400	162.60	2.752	.423

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
162.40	2.753	.423	153.80	2.823	.447
162.20	2.755	.423	153.60	2.825	.448
162.00	2.756	.424	153.40	2.826	.449
161.80	2.758	.424	153.20	2.828	.449
161.60	2.760	.425	153.00	2.830	.450
161.40	2.761	.425	152.80	2.831	.450
161.20	2.763	.426	152.60	2.833	.451
161.00	2.764	.426	152.40	2.835	.452
160.80	2.766	.427	152.20	2.836	.452
160.60	2.767	.427	152.00	2.838	.453
160.40	2.769	.428	151.80	2.840	.453
160.20	2.771	.429	151.60	2.842	.454
160.00	2.772	.429	151.40	2.843	.455
159.80	2.774	.430	151.20	2.845	.455
159.60	2.775	.430	151.00	2.847	.456
159.40	2.777	.431	150.80	2.848	.457
159.20	2.779	.431	150.60	2.850	.457
159.00	2.780	.432	150.40	2.852	.458
158.80	2.782	.432	150.20	2.854	.458
158.60	2.783	.433	150.00	2.855	.459
158.40	2.785	.433	149.80	2.857	.460
158.20	2.787	.434	149.60	2.859	.460
158.00	2.788	.435	149.40	2.861	.461
157.80	2.790	.435	149.20	2.862	.462
157.60	2.792	.436	149.00	2.864	.462
157.40	2.793	.436	148.80	2.866	.463
157.20	2.795	.437	148.60	2.868	.463
157.00	2.796	.437	148.40	2.869	.464
156.80	2.798	.438	148.20	2.871	.465
156.60	2.800	.439	148.00	2.873	.465
156.40	2.801	.439	147.80	2.875	.466
156.20	2.803	.440	147.60	2.876	.467
156.00	2.805	.440	147.40	2.878	.467
155.80	2.806	.441	147.20	2.880	.468
155.60	2.808	.441	147.00	2.882	.469
155.40	2.810	.442	146.80	2.884	.469
155.20	2.811	.443	146.60	2.885	.470
155.00	2.813	.443	146.40	2.887	.471
154.80	2.815	.444	146.20	2.889	.471
154.60	2.816	.444	146.00	2.891	.472
154.40	2.818	.445	145.80	2.893	.473
154.20	2.820	.446	145.60	2.894	.473
154.00	2.821	.446	145.40	2.896	.474

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
145.20	2.898	.474
145.00	2.900	.475
144.80	2.902	.475
144.60	2.903	.476
144.40	2.905	.477
144.20	2.907	.477
144.00	2.909	.478
143.80	2.911	.479
143.60	2.913	.479
143.40	2.914	.480
143.20	2.916	.481
143.00	2.918	.481
142.80	2.920	.482
142.60	2.922	.483
142.40	2.924	.483
142.20	2.926	.484
142.00	2.928	.485
141.80	2.929	.486
141.60	2.931	.486
141.40	2.933	.487
141.20	2.935	.488
141.00	2.937	.488
140.80	2.939	.489
140.60	2.941	.490
140.40	2.943	.491
140.20	2.945	.491
140.00	2.946	.492
139.80	2.948	.493
139.60	2.950	.493
139.40	2.952	.494
139.20	2.954	.495
139.00	2.956	.496
138.80	2.958	.496
138.60	2.960	.497
138.40	2.962	.498
138.20	2.964	.499
138.00	2.966	.499
137.80	2.968	.500
137.60	2.970	.501
137.40	2.972	.501
137.20	2.974	.502
137.00	2.976	.503
136.80	2.977	.504

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
136.60	2.979	.505
136.40	2.981	.506
136.20	2.983	.507
136.00	2.985	.508
135.80	2.987	.508
135.60	2.989	.509
135.40	2.991	.510
135.20	2.993	.511
135.00	2.995	.511
134.80	2.997	.512
134.60	2.999	.513
134.40	3.001	.514
134.20	3.003	.515
134.00	3.006	.515
133.80	3.008	.516
133.60	3.010	.517
133.40	3.012	.518
133.20	3.014	.519
133.00	3.016	.519
132.80	3.018	.520
132.60	3.020	.521
132.40	3.022	.522
132.20	3.024	.523
132.00	3.026	.523
131.80	3.028	.524
131.60	3.030	.525
131.40	3.032	.526
131.20	3.034	.527
131.00	3.036	.527
130.80	3.039	.528
130.60	3.041	.529
130.40	3.043	.530
130.20	3.045	.531
130.00	3.047	.532
129.80	3.049	.532
129.60	3.051	.533
129.40	3.053	.534
129.20	3.055	.535
129.00	3.058	.536
128.80	3.060	.537
128.60	3.062	.538
128.40	3.064	.538
128.20	3.066	.539

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
128.00	3.068	.539	119.40	3.166	.580
127.80	3.070	.540	119.20	3.168	.581
127.60	3.073	.541	119.00	3.171	.582
127.40	3.075	.542	118.80	3.173	.583
127.20	3.077	.543	118.60	3.175	.584
127.00	3.079	.544	118.40	3.178	.585
126.80	3.081	.544	118.20	3.180	.586
126.60	3.084	.545	118.00	3.183	.587
126.40	3.086	.546	117.80	3.185	.588
126.20	3.088	.547	117.60	3.187	.589
126.00	3.090	.548	117.40	3.190	.590
125.80	3.092	.549	117.20	3.192	.591
125.60	3.095	.550	117.00	3.195	.592
125.40	3.097	.551	116.80	3.197	.593
125.20	3.099	.552	116.60	3.200	.594
125.00	3.101	.553	116.40	3.202	.595
124.80	3.103	.553	116.20	3.204	.596
124.60	3.106	.554	116.00	3.207	.598
124.40	3.108	.555	115.80	3.209	.599
124.20	3.110	.556	115.60	3.212	.600
124.00	3.112	.557	115.40	3.214	.601
123.80	3.115	.558	115.20	3.217	.602
123.60	3.117	.559	115.00	3.219	.603
123.40	3.119	.560	114.80	3.222	.604
123.20	3.122	.561	114.60	3.224	.605
123.00	3.124	.562	114.40	3.227	.606
122.80	3.126	.563	114.20	3.229	.607
122.60	3.128	.564	114.00	3.232	.608
122.40	3.131	.565	113.80	3.235	.609
122.20	3.133	.566	113.60	3.237	.611
122.00	3.135	.566	113.40	3.240	.612
121.80	3.138	.567	113.20	3.242	.613
121.60	3.140	.568	113.00	3.245	.614
121.40	3.142	.569	112.80	3.247	.615
121.20	3.145	.570	112.60	3.250	.616
121.00	3.147	.571	112.40	3.252	.617
120.80	3.149	.572	112.20	3.255	.618
120.60	3.152	.573	112.00	3.258	.619
120.40	3.154	.574	111.80	3.260	.621
120.20	3.156	.575	111.60	3.263	.622
120.00	3.159	.576	111.40	3.265	.623
119.80	3.161	.577	111.20	3.268	.624
119.60	3.163	.578	111.00	3.271	.625

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
110.80	3.273	.625	102.20	3.393	.681
110.60	3.276	.626	102.00	3.396	.682
110.40	3.279	.628	101.80	3.399	.683
110.20	3.281	.629	101.60	3.402	.685
110.00	3.284	.630	101.40	3.405	.686
109.80	3.287	.631	101.20	3.408	.687
109.60	3.289	.632	101.00	3.411	.689
109.40	3.292	.633	100.80	3.414	.690
109.20	3.295	.635	100.60	3.417	.692
109.00	3.297	.636	100.40	3.420	.693
108.80	3.300	.637	100.20	3.423	.694
108.60	3.303	.638	100.00	3.426	.696
108.40	3.305	.639	99.80	3.429	.697
108.20	3.308	.641	99.60	3.432	.699
108.00	3.311	.642	99.40	3.435	.700
107.80	3.314	.643	99.20	3.438	.702
107.60	3.316	.644	99.00	3.441	.703
107.40	3.319	.645	98.80	3.444	.705
107.20	3.322	.647	98.60	3.447	.706
107.00	3.325	.648	98.40	3.451	.707
106.80	3.327	.649	98.20	3.454	.709
106.60	3.330	.650	98.00	3.457	.710
106.40	3.333	.652	97.80	3.460	.712
106.20	3.336	.653	97.60	3.463	.713
106.00	3.339	.654	97.40	3.466	.715
105.80	3.341	.655	97.20	3.469	.716
105.60	3.344	.657	97.00	3.472	.718
105.40	3.347	.658	96.80	3.476	.720
105.20	3.350	.659	96.60	3.479	.721
105.00	3.353	.661	96.40	3.482	.723
104.80	3.355	.662	96.20	3.485	.724
104.60	3.358	.663	96.00	3.488	.726
104.40	3.361	.664	95.80	3.492	.727
104.20	3.364	.666	95.60	3.495	.729
104.00	3.367	.667	95.40	3.498	.730
103.80	3.370	.668	95.20	3.501	.732
103.60	3.373	.670	95.00	3.505	.734
103.40	3.376	.671	94.80	3.508	.735
103.20	3.378	.672	94.60	3.511	.737
103.00	3.381	.674	94.40	3.514	.738
102.80	3.384	.675	94.20	3.518	.740
102.60	3.387	.676	94.00	3.521	.742
102.40	3.390	.678	93.80	3.524	.743

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
93.60	3.528	.743	85.00	3.680	.822
93.40	3.531	.745	84.80	3.684	.824
93.20	3.534	.746	84.60	3.688	.826
93.00	3.538	.748	84.40	3.692	.828
92.80	3.541	.750	84.20	3.696	.830
92.60	3.544	.751	84.00	3.700	.832
92.40	3.548	.753	83.80	3.703	.834
92.20	3.551	.755	83.60	3.707	.836
92.00	3.555	.756	83.40	3.711	.838
91.80	3.558	.758	83.20	3.715	.841
91.60	3.561	.760	83.00	3.719	.843
91.40	3.565	.761	82.80	3.723	.845
91.20	3.568	.763	82.60	3.727	.847
91.00	3.572	.765	82.40	3.731	.849
90.80	3.575	.767	82.20	3.735	.851
90.60	3.579	.768	82.00	3.739	.853
90.40	3.582	.770	81.80	3.743	.855
90.20	3.586	.772	81.60	3.747	.857
90.00	3.589	.774	81.40	3.751	.860
89.80	3.593	.775	81.20	3.755	.862
89.60	3.596	.777	81.00	3.759	.864
89.40	3.600	.779	80.80	3.763	.866
89.20	3.603	.781	80.60	3.767	.868
89.00	3.607	.783	80.40	3.771	.871
88.80	3.610	.784	80.20	3.775	.873
88.60	3.614	.786	80.00	3.779	.875
88.40	3.618	.788	79.80	3.784	.877
88.20	3.621	.790	79.60	3.788	.880
88.00	3.625	.792	79.40	3.792	.882
87.80	3.628	.793	79.20	3.796	.884
87.60	3.632	.795	79.00	3.800	.886
87.40	3.636	.797	78.80	3.804	.889
87.20	3.639	.799	78.60	3.809	.891
87.00	3.643	.801	78.40	3.813	.893
86.80	3.647	.803	78.20	3.817	.896
86.60	3.650	.805	78.00	3.821	.898
86.40	3.654	.807	77.80	3.826	.900
86.20	3.658	.809	77.60	3.830	.903
86.00	3.662	.810	77.40	3.834	.905
85.80	3.665	.812	77.20	3.839	.908
85.60	3.669	.814	77.00	3.843	.910
85.40	3.673	.816	76.80	3.847	.913
85.20	3.677	.818	76.60	3.852	.915

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
76.40	3.856	.915	67.80	4.062	1.037
76.20	3.861	.917	67.60	4.067	1.040
76.00	3.865	.920	67.40	4.073	1.044
75.80	3.870	.922	67.20	4.078	1.047
75.60	3.874	.925	67.00	4.083	1.050
75.40	3.878	.927	66.80	4.088	1.053
75.20	3.883	.930	66.60	4.094	1.056
75.00	3.887	.932	66.40	4.099	1.060
74.80	3.892	.935	66.20	4.104	1.063
74.60	3.897	.938	66.00	4.110	1.066
74.40	3.901	.940	65.80	4.115	1.070
74.20	3.906	.943	65.60	4.121	1.073
74.00	3.910	.945	65.40	4.126	1.076
73.80	3.915	.948	65.20	4.132	1.080
73.60	3.920	.951	65.00	4.137	1.083
73.40	3.924	.953	64.80	4.143	1.087
73.20	3.929	.956	64.60	4.148	1.090
73.00	3.934	.959	64.40	4.154	1.094
72.80	3.938	.961	64.20	4.159	1.097
72.60	3.943	.964	64.00	4.165	1.101
72.40	3.948	.967	63.80	4.171	1.104
72.20	3.952	.970	63.60	4.176	1.108
72.00	3.957	.972	63.40	4.182	1.111
71.80	3.962	.975	63.20	4.188	1.115
71.60	3.967	.978	63.00	4.194	1.119
71.40	3.972	.981	62.80	4.199	1.122
71.20	3.977	.984	62.60	4.205	1.126
71.00	3.981	.986	62.40	4.211	1.130
70.80	3.986	.989	62.20	4.217	1.133
70.60	3.991	.992	62.00	4.223	1.137
70.40	3.996	.995	61.80	4.229	1.141
70.20	4.001	.998	61.60	4.235	1.145
70.00	4.006	1.001	61.40	4.241	1.148
69.80	4.011	1.004	61.20	4.247	1.152
69.60	4.016	1.007	61.00	4.253	1.156
69.40	4.021	1.010	60.80	4.259	1.160
69.20	4.026	1.013	60.60	4.265	1.164
69.00	4.031	1.016	60.40	4.271	1.168
68.80	4.036	1.019	60.20	4.277	1.172
68.60	4.041	1.022	60.00	4.283	1.176
68.40	4.047	1.025	59.80	4.290	1.180
68.20	4.052	1.028	59.60	4.296	1.184
68.00	4.057	1.031	59.40	4.302	1.188

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
59.20	4.308	1.188
59.00	4.315	1.192
58.80	4.321	1.197
58.60	4.327	1.201
58.40	4.334	1.205
58.20	4.340	1.209
58.00	4.347	1.213
57.80	4.353	1.218
57.60	4.360	1.222
57.40	4.366	1.225
57.20	4.373	1.231
57.00	4.380	1.235
56.80	4.386	1.240
56.60	4.393	1.244
56.40	4.400	1.249
56.20	4.406	1.253
56.00	4.413	1.258
55.80	4.420	1.262
55.60	4.427	1.267
55.40	4.434	1.272
55.20	4.441	1.277
55.00	4.448	1.281
54.80	4.455	1.286
54.60	4.462	1.291
54.40	4.469	1.296
54.20	4.476	1.301
54.00	4.483	1.306
53.80	4.490	1.311
53.60	4.498	1.316
53.40	4.505	1.321
53.20	4.512	1.326
53.00	4.520	1.331
52.80	4.527	1.336
52.60	4.535	1.341
52.40	4.542	1.346
52.20	4.550	1.352
52.00	4.557	1.357
51.80	4.565	1.362
51.60	4.572	1.368
51.40	4.580	1.373
51.20	4.588	1.379
51.00	4.596	1.384
50.80	4.603	1.390
50.60	4.611	1.401
50.40	4.619	1.407
50.20	4.627	1.413
50.00	4.635	1.419
49.80	4.643	1.424
49.60	4.651	1.430
49.40	4.659	1.436
49.20	4.668	1.442
49.00	4.676	1.448
48.80	4.684	1.454
48.60	4.692	1.461
48.40	4.701	1.467
48.20	4.709	1.473
48.00	4.718	1.479
47.80	4.726	1.486
47.60	4.735	1.492
47.40	4.744	1.499
47.20	4.752	1.505
47.00	4.761	1.512
46.80	4.770	1.518
46.60	4.779	1.525
46.40	4.788	1.532
46.20	4.796	1.539
46.00	4.805	1.546
45.80	4.815	1.553
45.60	4.824	1.560
45.40	4.833	1.567
45.20	4.842	1.574
45.00	4.851	1.581
44.80	4.861	1.588
44.60	4.870	1.596
44.40	4.880	1.603
44.20	4.889	1.610
44.00	4.899	1.618
43.80	4.909	1.626
43.60	4.918	1.633
43.40	4.928	1.641
43.20	4.938	1.649
43.00	4.948	1.657
42.80	4.958	1.665
42.60	4.968	1.673
42.40	4.978	1.681
42.20	4.989	1.689

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
42.00	4.999	1.689	33.40	5.524	2.149
41.80	5.009	1.697	33.20	5.538	2.162
41.60	5.020	1.706	33.00	5.553	2.176
41.40	5.030	1.714	32.80	5.568	2.190
41.20	5.041	1.723	32.60	5.583	2.203
41.00	5.051	1.731	32.40	5.598	2.217
40.80	5.062	1.740	32.20	5.613	2.232
40.60	5.073	1.749	32.00	5.629	2.246
40.40	5.084	1.758	31.80	5.644	2.261
40.20	5.095	1.767	31.60	5.660	2.275
40.00	5.106	1.776	31.40	5.676	2.290
39.80	5.117	1.785	31.20	5.692	2.305
39.60	5.128	1.794	31.00	5.708	2.321
39.40	5.140	1.803	30.80	5.724	2.336
39.20	5.151	1.813	30.60	5.741	2.352
39.00	5.162	1.822	30.40	5.757	2.368
38.80	5.174	1.832	30.20	5.774	2.384
38.60	5.186	1.842	30.00	5.791	2.401
38.40	5.197	1.851	29.80	5.808	2.417
38.20	5.209	1.861	29.60	5.826	2.434
38.00	5.221	1.871	29.40	5.843	2.451
37.80	5.233	1.882	29.20	5.861	2.468
37.60	5.245	1.892	29.00	5.879	2.486
37.40	5.257	1.902	28.80	5.897	2.504
37.20	5.270	1.913	28.60	5.915	2.522
37.00	5.282	1.923	28.40	5.933	2.540
36.80	5.295	1.934	28.20	5.952	2.559
36.60	5.307	1.945	28.00	5.971	2.578
36.40	5.320	1.956	27.80	5.990	2.597
36.20	5.333	1.967	27.60	6.009	2.616
36.00	5.346	1.978	27.40	6.029	2.636
35.80	5.359	1.989	27.20	6.048	2.656
35.60	5.372	2.001	27.00	6.068	2.676
35.40	5.385	2.012	26.80	6.088	2.697
35.20	5.398	2.024	26.60	6.109	2.718
35.00	5.412	2.036	26.40	6.129	2.739
34.80	5.425	2.048	26.20	6.150	2.761
34.60	5.439	2.060	26.00	6.171	2.783
34.40	5.453	2.072	25.80	6.193	2.805
34.20	5.467	2.085	25.60	6.214	2.828
34.00	5.481	2.097	25.40	6.236	2.851
33.80	5.495	2.110	25.20	6.258	2.874
33.60	5.509	2.123	25.00	6.281	2.898

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
24.80	6.303	2.898	16.20	7.673	4.540
24.60	6.326	2.922	16.00	7.719	4.599
24.40	6.350	2.946	15.80	7.765	4.659
24.20	6.373	2.971	15.60	7.813	4.721
24.00	6.397	2.997	15.40	7.862	4.785
23.80	6.421	3.022	15.20	7.911	4.850
23.60	6.446	3.049	15.00	7.962	4.917
23.40	6.471	3.075	14.80	8.014	4.986
23.20	6.496	3.103	14.60	8.067	5.057
23.00	6.522	3.130	14.40	8.121	5.130
22.80	6.547	3.158	14.20	8.176	5.205
22.60	6.574	3.187	14.00	8.233	5.283
22.40	6.600	3.216	13.80	8.291	5.362
22.20	6.627	3.246	13.60	8.351	5.444
22.00	6.655	3.276	13.40	8.412	5.529
21.80	6.682	3.307	13.20	8.474	5.616
21.60	6.711	3.338	13.00	8.539	5.706
21.40	6.739	3.370	12.80	8.604	5.799
21.20	6.768	3.403	12.60	8.672	5.894
21.00	6.798	3.436	12.40	8.742	5.993
20.80	6.828	3.470	12.20	8.813	6.096
20.60	6.858	3.504	12.00	8.887	6.202
20.40	6.889	3.539	11.80	8.962	6.311
20.20	6.920	3.575	11.60	9.040	6.425
20.00	6.952	3.612	11.40	9.120	6.542
19.80	6.984	3.649	11.20	9.202	6.664
19.60	7.017	3.688	11.00	9.288	6.790
19.40	7.050	3.727	10.80	9.375	6.922
19.20	7.084	3.766	10.60	9.466	7.058
19.00	7.119	3.807	10.40	9.560	7.200
18.80	7.154	3.848	10.20	9.656	7.348
18.60	7.190	3.891	10.00	9.756	7.501
18.40	7.226	3.934	9.80	9.860	7.661
18.20	7.263	3.978	9.60	9.967	7.826
18.00	7.301	4.024	9.40	10.079	8.003
17.80	7.339	4.070	9.20	10.194	8.183
17.60	7.378	4.117	9.00	10.314	8.376
17.40	7.418	4.166	8.80	10.439	8.575
17.20	7.459	4.216	8.60	10.569	8.784
17.00	7.500	4.266	8.40	10.704	9.004
16.80	7.542	4.318	8.20	10.845	9.234
16.60	7.585	4.372	8.00	10.993	9.477
16.40	7.629	4.426	7.80	11.146	9.733

TABLE II

SCALED DISTANCE AS A FUNCTION OF PRESSURE OR IMPULSE

PRESSURE/ SCALED IMPULSE (PSIG) OR (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)
7.60	11.308	9.733
7.40	11.476	10.002
7.20	11.654	10.287
7.00	11.840	10.588
6.80	12.036	10.907
6.60	12.242	11.246
6.40	12.460	11.606
6.20	12.691	11.990
6.00	12.936	12.399
5.80	13.196	12.837
5.60	13.472	13.307
5.40	13.767	13.812
5.20	14.083	14.357
5.00	14.422	14.945
4.80	14.787	15.583
4.60	15.181	16.277
4.40	15.607	17.036
4.20	16.071	17.867
4.00	16.578	18.782
3.80	17.134	19.795
3.60	17.947	20.923
3.40	18.428	22.184
3.20	19.187	23.605
3.00	20.041	25.218
2.80	21.009	27.064
2.60	22.116	29.197
2.40	23.395	31.691
2.20	24.893	34.644
2.00	26.671	38.195
1.80	28.819	42.545
1.60	31.469	47.997
1.40	34.822	55.026
1.20	39.209	64.429
1.00	45.199	77.641

APPENDIX E

SAMPLE CALCULATIONS

APPENDIX E
SAMPLE CALCULATIONS

TEST DATA:

WS	75 LBS	WB	0.5 LBS
RT	20.75 FT	P	8.2 PSIG
EB	1.25 (C4)	IT	18.5 PSI-MSEC

::::: PRESSURE EQUIVALENCY :::::

FROM APPENDIX D, TABLE II

FOR P = 8.2 PSIG, Z = 10.845

FROM APPENDIX A

B = EB * WB = 1.25 * 0.5 = 0.625

$$EP=((R/Z)^3-B)/WS=((20.75/10.845)^3-0.625)/75 = 0.085 = \boxed{8.5}$$

$$ZP=(R/(WS+P/EP)^{1/3})=(20.75/(75+0.625/.085)^{1/3}) = \boxed{4.77}$$

::::: IMPULSE EQUIVALENCY :::::

FROM APPENDIX C

$$Y=(77.641(IT/R))^{.49405}=(77.641(18.5/20.75))^{.49405} = \boxed{8.1}$$

$$Z=(70.0868(R/IT))^{.50595}=(70.0868(20.75/18.5))^{.50595} = \boxed{9.1}$$

FROM APPENDIX B

$$EI=((IT/Y)^3-B)/WS=((18.5/8.1)^3-.625)/75 = .15 = \boxed{15}$$

OR:

$$EI=((R/Z)^3-B)/WS=((20.75/9.1)^3-.625)/75 = .15 = \boxed{15}$$

$$ZI=R/(WS+B/EI)^{1/3}=20.75/(75+.625/.15)^{1/3} = \boxed{4.83}$$

ALTERNATIVELY:

$$ZI=(Y*R/IT)*(EI)^{1/3}=(8.1*20.75/18.5)*(.15)^{1/3} = \boxed{4.83}$$

OR:

$$ZI=EI^{1/3}*Z = (.15)^{1/3}*9.1 = \boxed{4.83}$$

APPENDIX F

FORTRAN EXTENDED COMPUTER PROGRAM

```
      PROGRAM TNTEQ(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C
C     TNTEQ PROGRAM ABSTRACT:
C
C     THE TNT EQUIVALENCY OF A MATERIAL/SUBSTANCE IS CALCULATED IN
C     TERMS OF  -IMPULSE-  AND  -PRESSURE-  .
C     IN ADDITON, THE BOOSTER EFFECTS ARE TAKEN INTO ACCOUNT, AND
C     THE SCALED DISTANCES ARE DETERMINED.
C
C
C     ***************************************************************
C     ***************************************************************
C     *****                                                     *****
C     *****        VERSION 2            FEB 1973               *****
C     *****                                                     *****
C     *****        MANUFACTURING TECHNOLOGY DIRECTORATE         *****
C     *****        CHEMICAL PROCESS TECHNOLOGY DIVISION         *****
C     *****                                                     *****
C     *****        PROGRAMMER/ENGINEER - THOMAS CAGGIANO        *****
C     *****                                                     *****
C     ***************************************************************
C     ***************************************************************
C
C
C
C
C     ****************************************
C     ****************************************
C     **                                    **
C     **************NOMENCLATURE**************
C     **                                    **
C     ** A          COEFFICIENTS OF EQUATION **
C     **            ZTNTI = FUNC(PRESSURE)   **
C     ** BCORREC    BOOSTER CORRECTION       **
C     ** BOOSTER    BOOSTER WEIGHT           **
C     ** BSTREQ     BOOSTER EQUIVALENCY      **
C     ** CARD1      IDENTIFICATION CARD 1    **
C     ** CARD2      IDENTIFICATION CARD 2    **
C     ** DISTANC    DISTANCE IN FEET         **
C     ** IMPULEQ    IMPULSE EQUIVALENCY %    **
C     ** IMPULSE    POSITIVE IMPULSE         **
C     ** P          LOG ( OVER-PRESSURE )    **
C     ** PRESSEQ    PRESSURE EQUIVALENCY %   **
C     ** PRESSUR    OVER-PRESSURE (PSI)      **
C     ** SAMPLE     SAMPLE WEIGHT            **
C     ** SAMPL13    CUBE ROOT OF SAMPLE WT   **
C     ** SCALIMP    SCALED IMPULSE           **
C     ** ZI         IMPULSE SCALED DISTANCE  **
C     ** ZP         PRESSURE SCALED DISTANCE **
C     ** ZTNTI      TNT IMPULSE STANDARD     **
C     ** ZTNTP      TNT PRESSURE STANDARD    **
C     **                                    **
C     ****************************************
C     ****************************************
```

```
C
C
C
C     *********
C     *********    REFERENCES:
C     *********
C
C     *********    BRL MEMORANDUM REPORT # 1518
C     *********    C.N.KINGERY AND B.F.PANNILL
C     *********    APRIL 1964
C     *********    LIBRARY # U 105.683
C     *********    PEAK OVER-PRESSURE VERSUS SCALED DISTANCE FOR
C     *********    TNT (HEMISPHERICAL CHARGE) SURFACE BURST
C
C     *********    IIT RESEARCH INSTITUTE / CHICAGO.ILL.
C     *********    MRS.H.NAPADENSKY / MR.J.SWATOSH
C     *********    CONTRACT # DAAA-21-72-0695
C
C
C
C
C)()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()
C
C     SAMPLE DATA INPUT
C
C     COLUMNS
C     12345678901234567890123456789012345678901234567890123456789O
C
C     IDENTIFICATION CARD 1 MAXIMUM 50 CHARACTERS
C IE  BLACK POWDER TEST BY IITRI AT KINGSBURY
C
C     IDENTIFICATION CARD 2 MAXIMUM 50 CHARACTERS
C IE  TEST ID BP 30   ENGR:CAGGIANO
C
C     SAMPLE      BOOSTER     BSTREQ
C IE  25.         .25         1.25
C
C     DISTANC     PRESSUR     IMPULSE
C IE  6.          30.32       24.8
C IE  8.98        15.30       16.87
C IE  12.79       8.62        11.98
C
C     TO END THE DATA ENTRIES PUT A 0. IN DISTANC COLUMNS
C IE  0.
C
C
C     YOU CAN THEN START ANOTHER RUN      START WITH NEW CARD1
C IE  NITROGUANIDINE TEST BY IITRI AT JEFFERSON PROVING GROUNDS
C
C)()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()()
C
C
C
C
C
```

```
      DIMENSION CARD1(5),CARD2(5)
      REAL IMPULSE,IMPULEQ
      DATA A1,A2,A3,A4,A5,A6,A7,AB/1.6556442,-.78501286,.042385634,
     DATA.1301777,-.052100399,-.0076767222,.0068537028,-.00094665924/
C
C
C     READ INPUT SECTION
C
C
    1 READ(5,11)CARD1,CARD2
      IF(EOF(5)) 2,3
    2 STOP
    3 READ(5,12)SAMPLE,BOOSTER,BSTREQ
      WRITE(6,13) CARD1,CARD2,SAMPLE,BOOSTER
      BCORREC =BOOSTER*BSTREQ
      SAMPL13=SAMPLE**.3333333
    4 READ(5,12) DISTANC,PRESSUR,IMPULSE
      IF(EOF(5))2,5
    5 IF(DISTANC.EQ.0.) GO TO 1
      P=ALOG10(PRESSUR)
C
C
C     ******************    IMPULSE CALCULATIONS     *************************
C
      ZTNTI=(77.641*IMPULSE/DISTANC)**0.49405
      IMPULEQ=((IMPULSE/ZTNTI)**3.-BCORREC )/SAMPLE*100.
      ZI=DISTANC/((SAMPLE*BCORREC/IMPULEQ/.01)**.33333333)
      SCALIMP=IMPULSE/SAMPL13
C
C
C     ******************    PRESSURE CALCULATIONS    *************************
C
      ZTNTP=10.**(A1+P*(A2+P*(A3+P*(A4+P*(A5+P*(A6+P*(A7+P*AB)))))))
      IF(ZTNTP.GT.74.)ZTNTP=47.25732167*(PRESSUR**(-.710938564))
      PRESSEQ=((DISTANC/ZTNTP)**3.-BCORREC )/SAMPLE*100.
      ZP=DISTANC/((SAMPLE*BCORREC/PRESSEQ/.01)**.33333333)
C
C
      WRITE(6,14)DISTANC,PRESSUR,IMPULSE,SCALIMP,ZTNTI,ZI,IMPULEQ,ZTNTP,
     61422P,PRESSEQ
C
      GO TO 4.
C
C     FORMAT STATEMENTS
C
   11 FORMAT(5A10/5A10)
   12 FORMAT(7F10.4)
   13 FORMAT(1H1///T10,5A10/T10,5A10/T10,*SAMPLE*,T20,F10.4,T38,*BOOSTER
   131*,T48,F10.4///                    T10,*DISTANCE*,T20,*PRESSURE*,T30,
   132*IMPULSE*,T40,*SCALED IMP*,T50,*  ZTNTI*,T60,  *   ZI*,T70,*  %EQ
   133(I)*,T80,*   ZTNTP*,T90,*    ZP*,T100,*   %EQ (PI*/T5,110(1H*)//)
   14 FORMAT(T10,4(F7.3,3X),6(F6.1,4X))
C
      END
```

SYMBOLIC REFERENCE MAP

ENTRY POINTS
4052 INTEQ

VARIABLES	SN	TYPE	RELOCATION				
4302	A1	REAL		4303	A2	REAL	
4304	A3	REAL		4305	A4	REAL	
4306	A5	REAL		4307	A6	REAL	
4310	A7	REAL		4311	A8	REAL	
4375	BCORREC	REAL		4373	BOOSTER	REAL	
4374	BSTREQ	REAL		4410	CARD1	REAL	ARRAY
4415	CARD2	REAL	ARRAY	4377	DISTANC	REAL	
4371	IMPULEQ	REAL		4370	IMPULSE	REAL	
4401	P	REAL		4406	PRESSEQ	REAL	
4400	PRESSUR	REAL		4372	SAMPLE	REAL	
4376	SAMPL13	REAL		4404	SCALIMP	REAL	
4403	Z1	REAL		4407	ZP	REAL	
4402	ZTNTI	REAL		4405	ZTNTP	REAL	

FILE NAMES	MODE						
0 INPUT		2022 OUTPUT	0 TAPES	FMT	2022 TAPE6	FMT	

EXTERNALS	TYPE	ARGS			
ALOG10	REAL	1	EOF	REAL	1

STATEMENT LABELS

4053	1	4065	2		4067	3		
4120	4	0	5	INACTIVE	4312	11	FMT	
4315	12 FMT	4317	13 FMT		4347	14	FMT	

STATISTICS

PROGRAM LENGTH	360B	240
BUFFER LENGTH	4044B	2084

BLACK POWDER TEST RUN BO 5/6
THOMAS CAGGIANO CPTD TEST RUN 1
SAMPLE 25.0000 BOOSTER .2500

DISTANCE	PRESSURE	IMPULSE	SCALED IMP	ZTNTI	ZI	%EQ (I)	ZTNTP	ZP	%EQ (P)
6.000	30.320	27.250	9.319	18.1	2.0	12.3	5.8	1.8	3.3
8.980	15.300	16.870	5.769	11.7	3.0	10.7	7.9	2.8	4.7
12.790	8.620	11.980	4.097	8.3	4.2	10.7	10.6	4.1	5.9
17.750	5.180	8.740	2.989	6.1	5.9	10.8	14.1	5.7	6.7
22.630	3.610	6.930	2.370	4.8	7.5	10.9	17.7	7.3	7.1
46.710	1.310	3.450	1.180	2.4	15.4	11.1	36.7	15.1	7.0

THOMAS CAGGIANO CPTD TEST RUN 2
BLACK POWDER TEST RUN 30/31
SAMPLE 75.0000 BOOSTER 1.5000

DISTANCE	PRESSURE	IMPULSE	SCALED IMP	ZTNTI	ZI	%EQ (I)	ZTNTP	ZP	%EQ (P)
12.000	36.000	51.510	12.214	17.6	2.8	30.7	5.3	2.7	12.6
14.980	24.220	38.710	9.179	13.7	3.5	27.4	6.4	3.4	14.8
18.790	16.150	29.690	7.040	10.8	4.3	25.5	7.7	4.3	17.0
23.750	10.630	23.060	5.468	8.5	5.5	24.5	9.5	5.4	18.6
28.630	7.610	19.150	4.541	7.0	6.6	24.3	11.3	6.5	19.2
52.710	2.560	11.430	2.710	4.0	12.1	27.8	22.4	11.9	15.0