

TOXISKA GASER VID ANFO-SPRÄNGÄMNET.

EN TEORETISK BERÄKNING

Roger Holmberg

DS 1973:27

11.12.1973

STIFTELSEN
SVENSK DETONIKFORSKNING
SWEDISH DETONIC RESEARCH FOUNDATION

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Sammanfattning

Vid kontinuerlig brytning i dagbrott och gruvor strävar man efter att minimera koncentrationen av sådana skadliga gaser främst CO och NO resp. NO₂ samt H₂ som bildas efter en sprängning. Gashalterna beror på en mängd faktorer såsom bergets hårdhet, förekommande sprickor, ventilering, sprängplatsens omgivning, tidsfaktorn etc., men den primära variabeln är först och främst det använda sprängämnets komposition.

Denna rapport avser att teoretiskt belysa hur gaskoncentrationerna fluktuerar för ett av de mest använda civila sprängämnena, nämligen ANFO med olika tillsatser av aluminium.

Försöken visar att högre CO- och H₂-halter erhålles vid reducering av syrebalansen medan däremot en höjning medför högre koncentrationer av kvävemonoxid. Vid en ökning av aluminiumhalten erhålles högre temperaturer och härigenom koncentrationsökningar av de skadliga gaserna. Dessutom bör man försöka att nå så hög packningsgrad som möjligt eftersom detta medför förbättrade gasvärden.

Innehåll

1. Inledning
2. Förklaringar till vissa rubriker på databladen
3. Beräkningsserie I (ANFO vid olika syrebalans)
4. Beräkningsserie II (ANFO+10% AI vid olika syrebalans)
5. Beräkningsserie III (ANFO-AI vid olika syrebalans)
6. Beräkningsserie IV (Vattenskadad ANFO-AI)
7. Kommentarer
8. Referenser

1. Inledning

Vid termokemiska beräkningar av ett sprängämnes detonationsegenskaper gäller att den kemiskt frigjorda energin är helt och hållet beroende på vilka detonationsprodukter som erhålles. Dessa produkters koncentrationer kan beräknas genom att använda en tillståndsekvation och genom jämviktsberäkningar.

I denna rapport har BKW-tillståndsekvationen [1] använts.

$$\frac{P \cdot V}{R \cdot T} = 1 + w \cdot e^{\beta w}$$

där

$$w = \frac{K \cdot \sum_{i=1}^n \frac{x_i}{x} \cdot k_i}{V(T + \theta)^{\alpha}}$$

där α , β , θ och K är empiriskt bestämda konstanter.

x_i är antalet gasmoler av den i :te produkten.

x är totala antalet gasmoler.

k_i betecknar kovolymer för den i :te gasen:

Vid jämviktsberäkningen utförs en minimering av Gibbs fria energi och härigenom kan detonationsprodukternas koncentrationer fastställas.

Vid BKW-beräkningarna antas det att en ideal detonation med fullständig kemisk omsättning av sprängämnet sker vid detonationsfronten. Reaktionskinetiken tas det alltså ingen hänsyn till utan de kemiska reaktionerna antas förlöpa oändligt snabbt.

I rapporten har NO_2 ej upptagits som tänkbar slutprodukt. Detta beror på att oxidationen av NO till NO_2 befrämjas av låg temperatur och är starkt tidsberoende varför kvävedioxiden icke bildas i någon större utsträckning förrän spränggaserna expanderat.

2. Förklaringar till vissa rubriker på databladenHEAT OF DETONATION (Detonationsenergi, Q)

$$Q = - \frac{(\sum_{i=1}^n x_i \cdot \Delta H_i) - \Delta H_{\text{spr.}}}{\text{Molvikt} \cdot 0.239 \cdot 10^3} \quad \text{MJ/kg}$$

där ΔH_i betecknar bildningsentalpin vid 0°K för i:te produkten
och ΔH_{spr} dito för sprängämneskompositionen.

WEIGHT STRENGTH REL. LFB (Viktstyrka, s)

$$s = \frac{5 \cdot Q}{6 \cdot Q_{\text{LFB}}} + \frac{1}{6} \frac{V_{\text{gas}}}{V_{\text{LFB}}}$$

där $V_{\text{LFB}} = 0.850 \text{ m}^3/\text{kg}$ och

$$Q_{\text{LFB}} = 5 \text{ MJ/kg}$$

Syrebalans

Syrebalansen utgör differensen mellan den viktsmängd syre som finns bundet i kompositionen och den viktsmängd syre som åtgår för att fullständigt förbränna de resterande ingående elementen i sprängämnet. Den anges i procent av molekyllvikten.

3. Beräkningsserie I

Utgående från en syrebalanserad komposition av ammoniumnitrat (AN) och brännolja (FO) varierades oljehalten för att se hur gaskoncentrationerna påverkades.

Fem stycken beräkningar gjordes där syrebalansen skiftades enligt nedan.

Projekt-nr.	46-73	47-73	48-73	49-73	50-73
Vikts-% AN	93.34	94.15	94.56	94.97	95.79
Vikts-% FO	6.66	5.85	5.44	5.03	4.21
Syrebalans g/100 g	-4.5	-1.5	+0.	+1.5	+4.5

Vid beräkningarna har brännoljan ersatts med dodecan $\text{C}_{12}\text{H}_{26}$ beroende på att brännoljan i praktiken varierar något i sammansättningen och dodecan ger här ett bra medelvärde.

Densiteten har för samtliga kompositioner varit 900 kg/m^3 .

Resultat

Indata och resultat för datorberäkningarna finns redovisade på tre datablad för vardera projektnummer.

Resultaten finns även sammanställda i diagrambladen 1-3.

Om man betraktar diagramblad 1 får man en uppfattning hur pass viktigt det är att en noggrann kontroll görs när blandningen bereds. Det räcker med att brännoljan varieras med $\pm 0.5\%$ för att en oroväckande ökning av koncentrationerna skall erhållas. Ett överskott av oljan medför en ökning av vätgas- och kolmonoxid-halterna och ett underskott medför en ökning av kväve-monoxiden. En ytterligare fördel med att hålla blandningen vid syre-balansen ± 0 är att maximal frigjord kemisk energi utvinnes ur kompositionen.

4. Beräkningsserie II

I detta försök utfördes fem stycken beräkningar på en komposition innehållande 10 viktsprocent aluminium. Syrebalansen varierades från -4.5% till $+4.5\%$ genom nedanstående variationer av FO-halten:

Projekt-nr.	51-73	52-73	53-73	54-73	55-73
Vikts-% Al	10.00	10.00	10.00	10.00	10.00
Vikts-% AN	86.30	87.12	87.53	87.93	88.75
Vikts-% FO	3.70	2.88	2.47	2.07	1.25
Syrebalans g/100 g	-4.5	-1.5	$\pm 0.$	+1.5	+4.5

Densiteten var i samtliga fall 900 kg/m^3 .

Försöksserien skiljer sig från serie I genom att 10% aluminium ingår

Resultat

Resultaten redovisas på datablad och en sammanställning i diagrambladen 4-6. Vid inblandning av aluminium fås den effekten att detonationstrycket reduceras och temperaturen stiger relativt kraftigt i detonationsfronten.

Betrakta jämviktsekvationen:



Enligt Le Chateliers princip strävar jämvikten att förskjutas till höger om en tryckminskning sker och till vänster om temperaturen höjs. I detta fall har vi en mycket stor temperaturökning, ca 1000°K större än om inget Al ingår, vilket medför att jämvikten förskjuts till vänster.

För jämviktsekvationen:



sker på samma sätt en förskjutning till vänster vid en temperaturstegring.

Detta innebär att det ingående aluminiumet inte enbart har fördelar (hög detonationsenergi) utan även bidrager till försämrade gasprodukter. Diagram 4 visar att koncentrationerna mer än fördubblas i denna serie gentemot serie I (Diagram 1).

5. Beräkningsserie III

Även denna serie omfattar fem stycken beräkningar vid en densitet på 900 kg/m^3 . Förhållandet mellan viktsprocenten ammoniumnitrat och brännolja har emellertid hållits konstant i dessa fall medan aluminiumhalten varierats.

Projekt-nr.	56-73	57-73	53-73	58-73	59-73
Vikts-% Al	14.55	11.52	10.00	8.48	5.45
Vikts-% AN	83.10	86.05	87.53	89.00	91.95
Vikts-% FO	2.35	2.43	2.47	2.52	2.60
Syrebilans g/100 g	-4.5	-1.5	$\pm 0.$	+1.5	+4.5

Resultat

De numeriska resultaten finns bland databladerna och en sammanställning finns på diagramblad 7-9.

En jämförelse mellan serie II och denna serie visar att för aluminiserad ANFO gäller det att kompositionen är mera känslig om viktsprocenten FO varierar än om aluminiumet varierar om man betraktar de skadliga gaserna i slutprodukterna. För vätgasen gäller det däremot att betydligt större mängder frigörs i denna serie, vilket beror på den höga temperaturen. Vid 14% Al ligger temperaturen omkring 3900°K .

Enär det har visat sig att vätgas kan ackumuleras i omgivande bergmaterial och i sprickor under relativt långa tidsperioder efter en sprängning så bör man vara försiktig med höga aluminiumblandningar om en sådan laddningsmetod användes där risk finns för elektrostatiska urladdningar.

6. Beräkningsserie IV

En beräkning gjordes för att fastställa hur vatten påverkar en aluminiserad ANFO-blandning. Till jämförelse valdes en syrebalanserad ANFO-komposition innehållande 10% Al (projekt-nr. 53-73) med packningsgrad 900 kg/m^3 . Det antogs att laddningen i ett borrhål vattenskadades med 10% vatten varför beräkningen gjordes på en komposition bestående av 10% H_2O , 10% Al och 90% ANFO samt med en densitet på 1000 kg/m^3 (projekt-nr. 62-73).

Resultat

De numeriska värdena finns i databladet och i tabellblad I.

Inga högre koncentrationer av skadliga gaser erhöles för den vattenskadade blandningen. Detta berodde på att temperaturen sjönk med 600°K vid CJ-punkten och härigenom fick man lägre gashalter än vad man skulle kunna vänta sig. Energin sjönk från 4.96 MJ per borrhålsliter till 4.84 MJ när vatten tillsattes.

Kommentar

De redovisade värdena i diagrammen är beräknade i Chapman-Jouguet-punkten där expansionen icke ännu har påbörjats. Om värdena hade hämtats från den punkt på isentropen där en eventuell frysning av jämvikterna sker, ungefär vid temperaturen 1900°K , skulle halterna reducerats något men förhållandet mellan gaskoncentrationerna för kompositionerna i fråga hade varit ungefär detsamma. Vid den termokemiska beräkningen läggs heller icke några reaktionskinetiska aspekter vid jämvikternas bestämning vilket kan ge stora avvikelser på detonationsprestanda för kompositioner där större mängder kondenserat kol bildas, dvs vid en syrebalans lägre än ca -10%. De teoretiska beräkningarna uppvisar samma tendenser i gasfluktuationerna vid olika syrebalans, olika emballage och packningsgrad som praktiska mätningar /4/.

De värden på gaskoncentrationerna som är tillräckliga för att en arbetsplats skall utrymmas (efter längre exponering än 30 min.) är enligt Arbetarskyddsstyrelsens Meddelanden 1973:18:

CO	50 ppm
CO ₂	$1.5 \cdot 10^4$ "
NO+NO ₂	30 "

Ovanstående innebär att ur miljösynpunkt bör sprängämnen vara något syreunderbalanserade (omkr. -1/4%) för att ge ett minimum icke önskvärda gaser.

Användes plastkorv eller annat emballage för sprängämnet måste hänsyn tagas till detta vid beredningen av blandningen så att en större mängd av syregivaren (ammoniumnitrat) tillsättes för att kompensera det syreunderskott som eljest skulle erhållits.

När aluminium ingår i blandningen och detonationstemperaturen härigenom stiger fås vid syreunderskott relativt höga ammoniakhalter. Ammoniaken NH_3 vilken är lättlöslig bildar sannolikt kaustik ammoniak, vilket är en basisk lösning mellan ammoniak och vatten där största delen av ammoniakgasen är fysiskt löst och enbart en del av gasen har reagerat med vatten och bildat ammonium- och hydroxidjoner.

Följande mängder NH_3 (l/kg) erhöles vid de olika beräkningsserierna:

Syrebalans g O/100 g	Serie I ANFO	Serie II ANFO+10% Al	Serie III ANFO+Al
- 4.5	0.69	2.68	2.82
- 1.5	0.54	0.36	0.39
± 0.0	0.00	0.02	0.00
+ 1.5	0.00	0.00	0.00
+ 4.5	0.00	0.00	0.00

8. Referenser

- /1/ Mader, Charles A Code for Computing the Detonation Properties of Explosives. Los Alamos Scientific Laboratory Report. LA 3704, Los Alamos, New Mexico, USA, 1967.
- /2/ White, W.B.,
Johnson, S.M. and
Dautzig, G.B. Chemical Equilibrium in Complex Mixtures
Journal of Chemical Physics, vol 28(1953),
s. 751.
- /3/ Rossi, R.D. Control of Noxious Gases in Blasting Work,
and New Methods of Testing Industrial
Explosives. Scientific and Technical
Mining Society. Moskva 1970, U.S. Departm.
of Commerce, Springfield, Va 22151.
- /4/ Davidsson, B. Bergsprängningskommittén, Stockholm,
p 213, 1971.

Tabell 1.

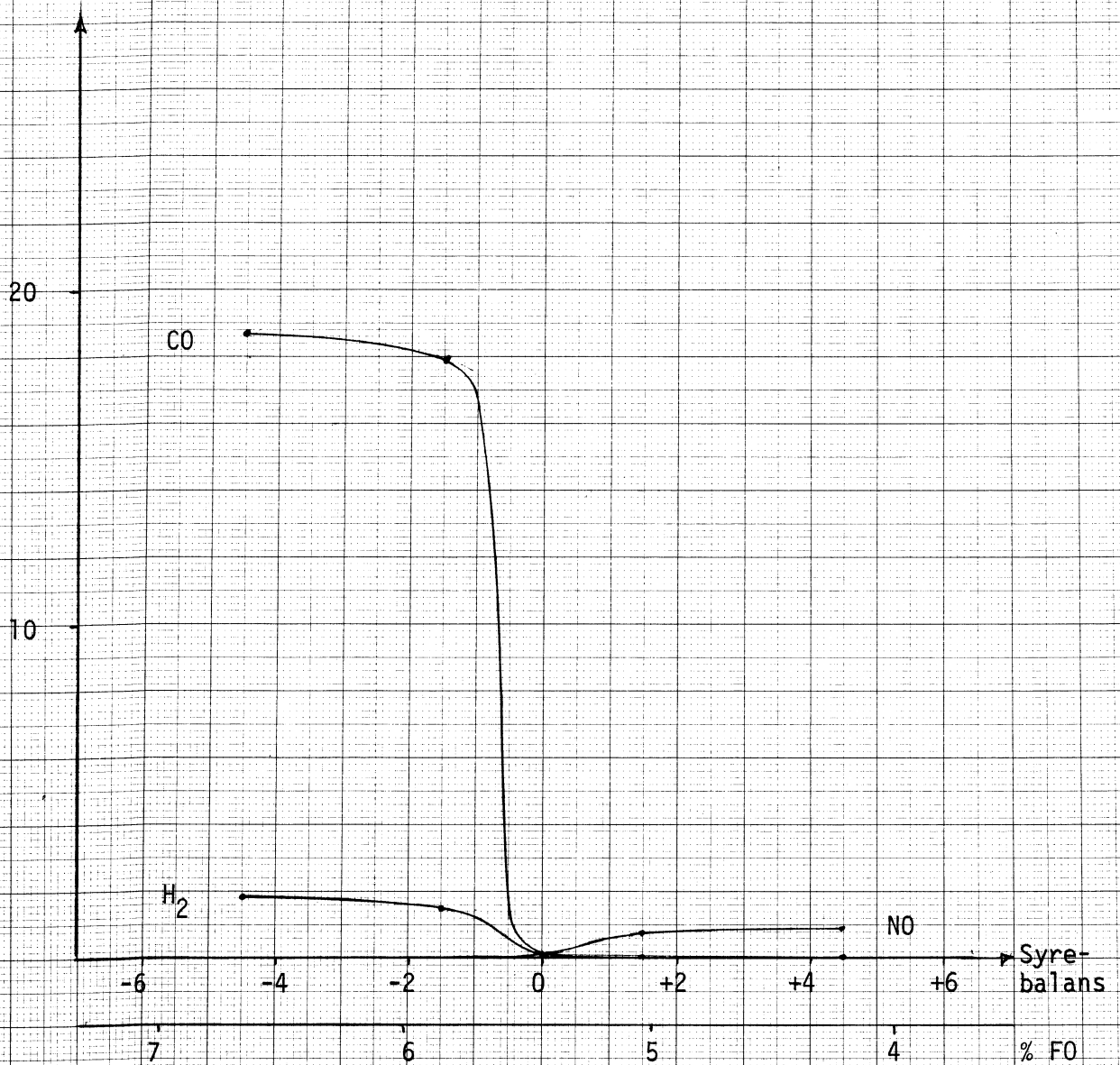
Spräng- ämne	Projekt- nummer	$\rho_{0,3}$ kg/m ³	Syre - balans %	Chapman-Jouguet-data			Prestanda		Skadliga gaser l/kg		
				P Kb	D m/s	T °K	Q MJ/kg	Vgas l/kg	CO	NO	H ₂
ANFO med varierande % brännolja	46-73	900	-4.5	91.1	5436	2075	3.81	982	18.84	0.00	1.88
	47-73	900	-1.5	74.4	5451	2090	3.84	982	17.98	0.00	1.59
	48-73	900	+0.0	74.3	5442	2135	3.92	973	0.10	0.05	0.01
	49-73	900	+1.5	72.8	5393	2061	3.74	974	0.00	0.77	0.00
	50-73	900	+4.5	69.6	5292	1913	3.39	975	0.00	0.88	0.00
ANFO med varierande syrebalans + 10 % Al	51-73	900	-4.5	70.3	5234	3147	5.35	843	38.27	0.04	19.48
	52-73	900	-1.5	69.2	5189	3260	5.48	827	15.22	0.23	5.52
	53-73	900	+0.0	68.6	5165	3293	5.51	819	2.74	1.80	0.85
	54-73	900	+1.5	67.4	5123	3214	5.35	818	0.60	5.20	0.21
	55-73	900	+4.5	64.9	5039	3036	5.00	818	0.11	7.78	0.06
Syre- balanserad ANFO + varierande Al-mängd	56-73	900	-4.5	67.5	5113	3797	6.11	773	27.01	0.32	31.74
	57-73	900	-1.5	68.1	5145	3470	5.73	803	14.21	0.47	6.85
	58-73	900	+1.5	68.4	5169	3018	5.11	841	0.36	4.21	0.09
	59-73	900	+4.5	67.6	5165	2491	4.28	890	0.02	3.53	0.00
10 % H ₂ O i 53-73	62-73	1000	+0.0	82.0	5458	2689	4.84	856	0.51	0.31	0.11

De skadliga gasernas koncentration som funktion av syrebalans och ingående viktsprocent brännolja för ANFO vid ideal detonation.

Diagram 1

10.

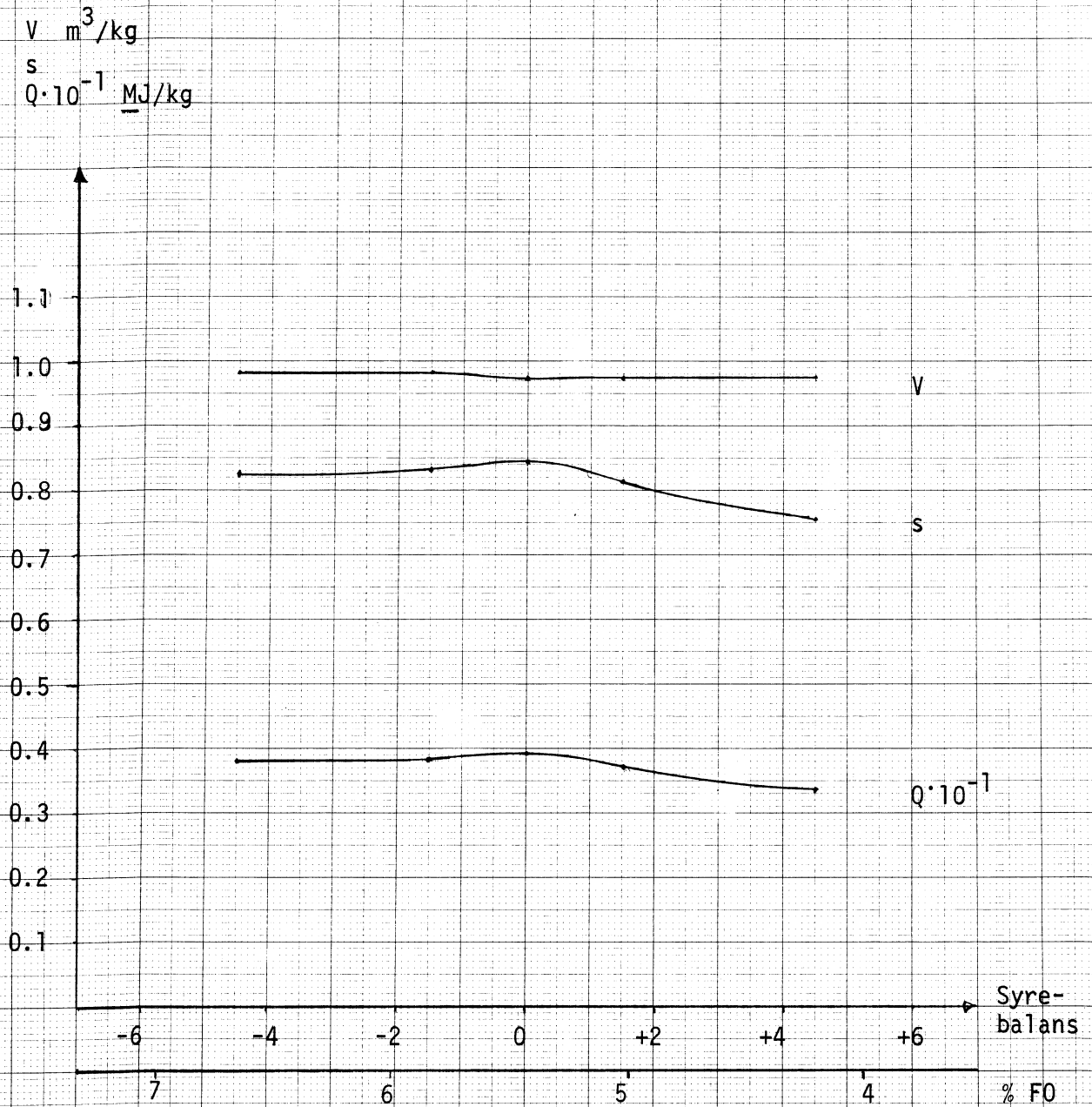
Antal l/kg



Viktstyrka, detonationsenergi och
gasvolym som funktion av syrebalans
för ANFO vid ideal detonation.

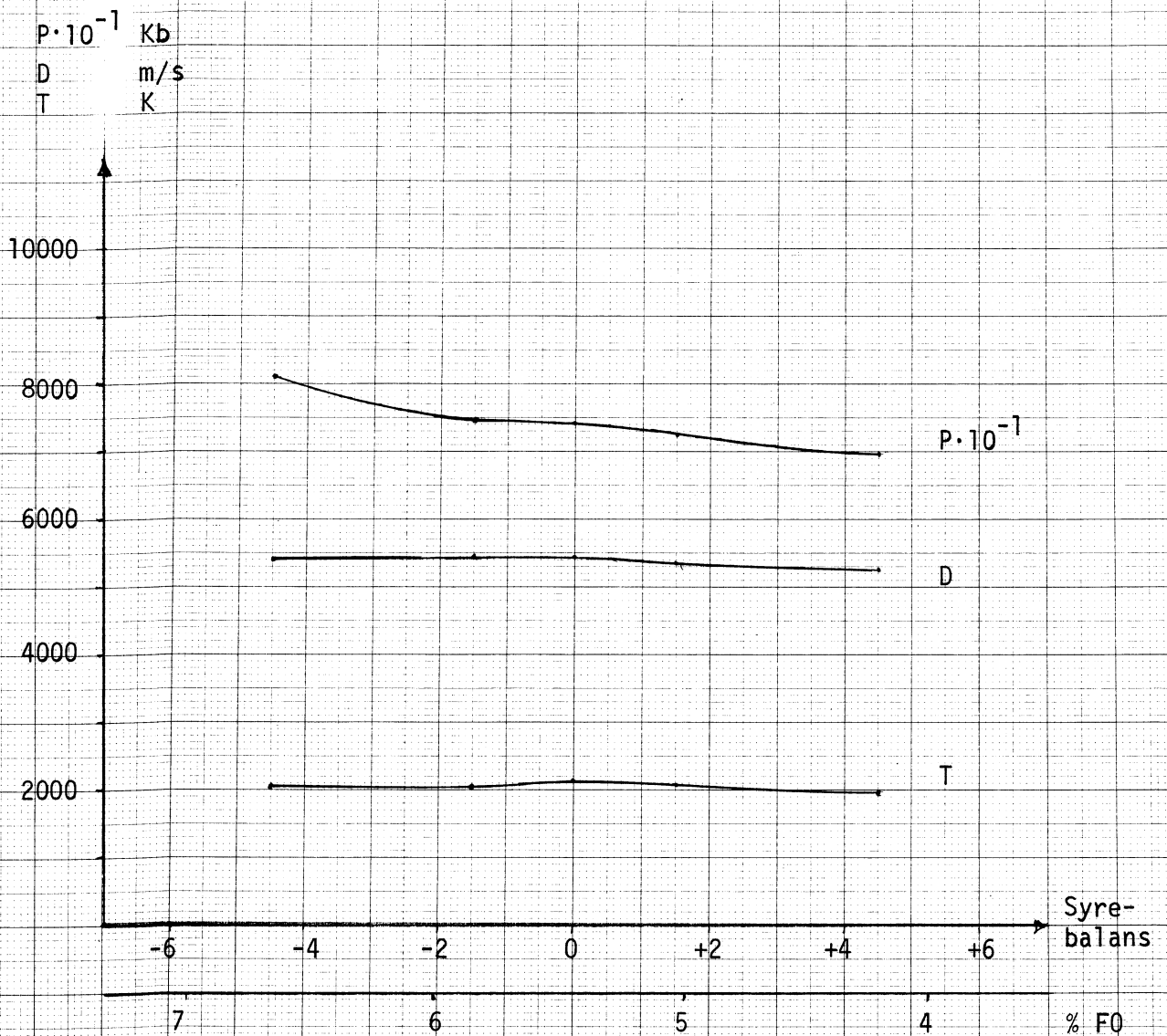
Diagram 2

11.



Detonationstryck, -temperatur och
-hastighet som funktion av syre-
balans för ANFO vid ideal detonation.

Diagram 3 12.



De skadliga gasernas koncentration
som funktion av syrebalans och in-
gående viktprocent brännolja för
ANFO + 10% Al vid ideal detonation.

Diagram 4 13.

Antal 1/kg

40

30

20

10

CO

H₂

NO

Syre-
balans

-6

-4

-2

0

+2

+4

+6

4

3

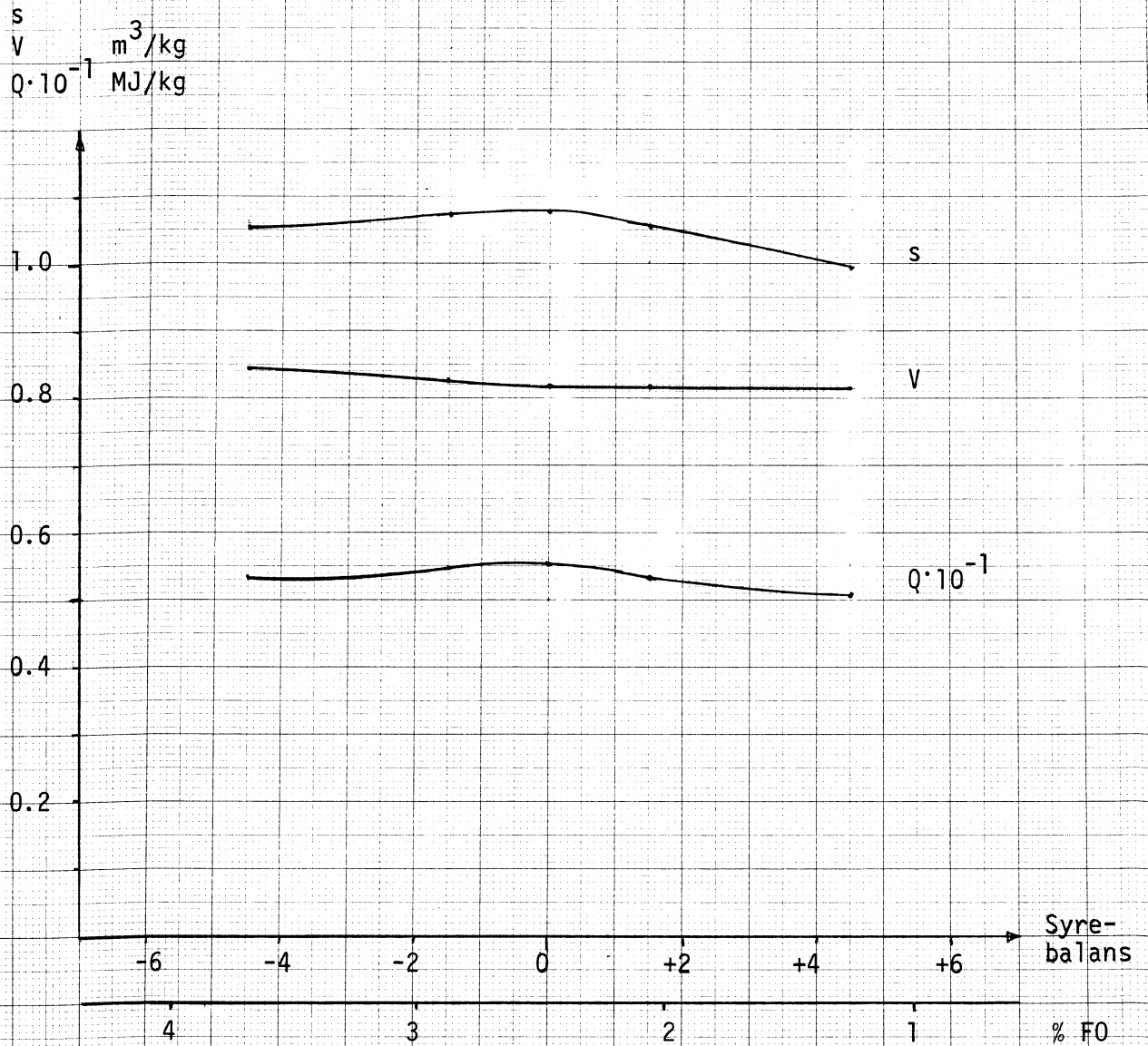
2

1

% FO

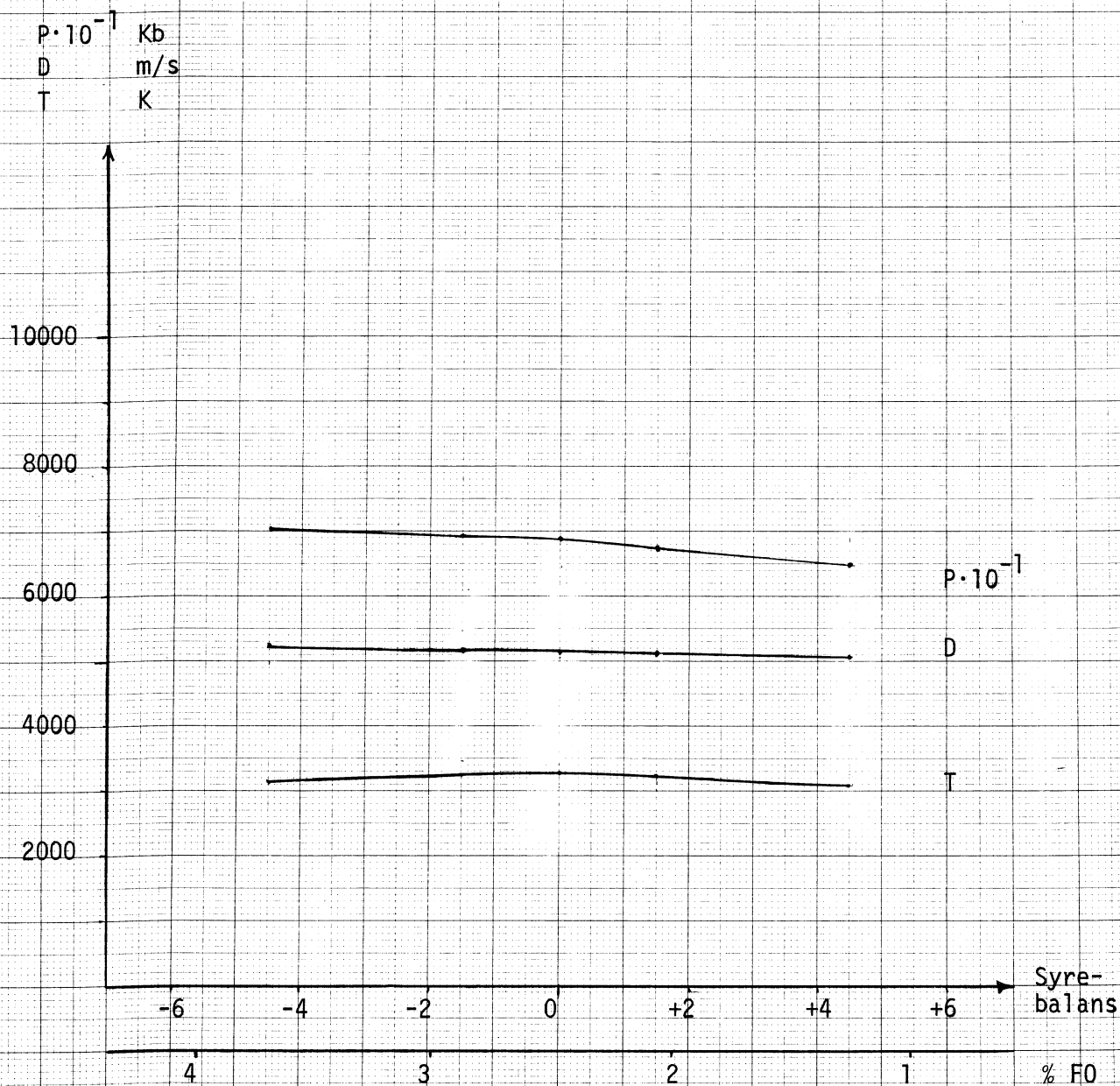
Viktstyrka, detonationsenergi och
gasvolym som funktion av syrebalans
för ANFO + 10% Al vid ideal detonation.

Diagram 5 14.



Detonationstryck, -temperatur och
-hastighet som funktion av syrebalans
för ANFO + 10% Al vid ideal detonation.

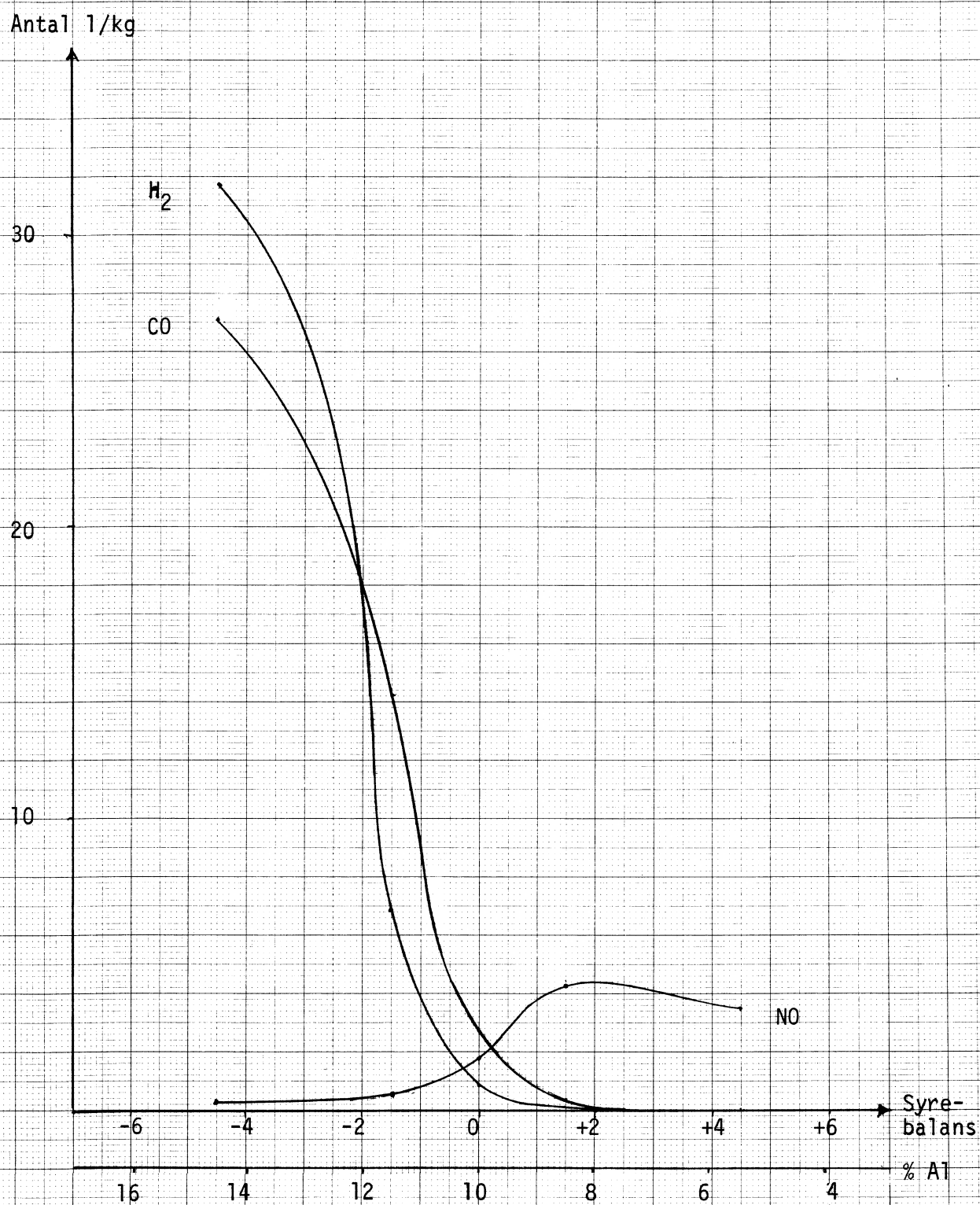
Diagram 6 15.



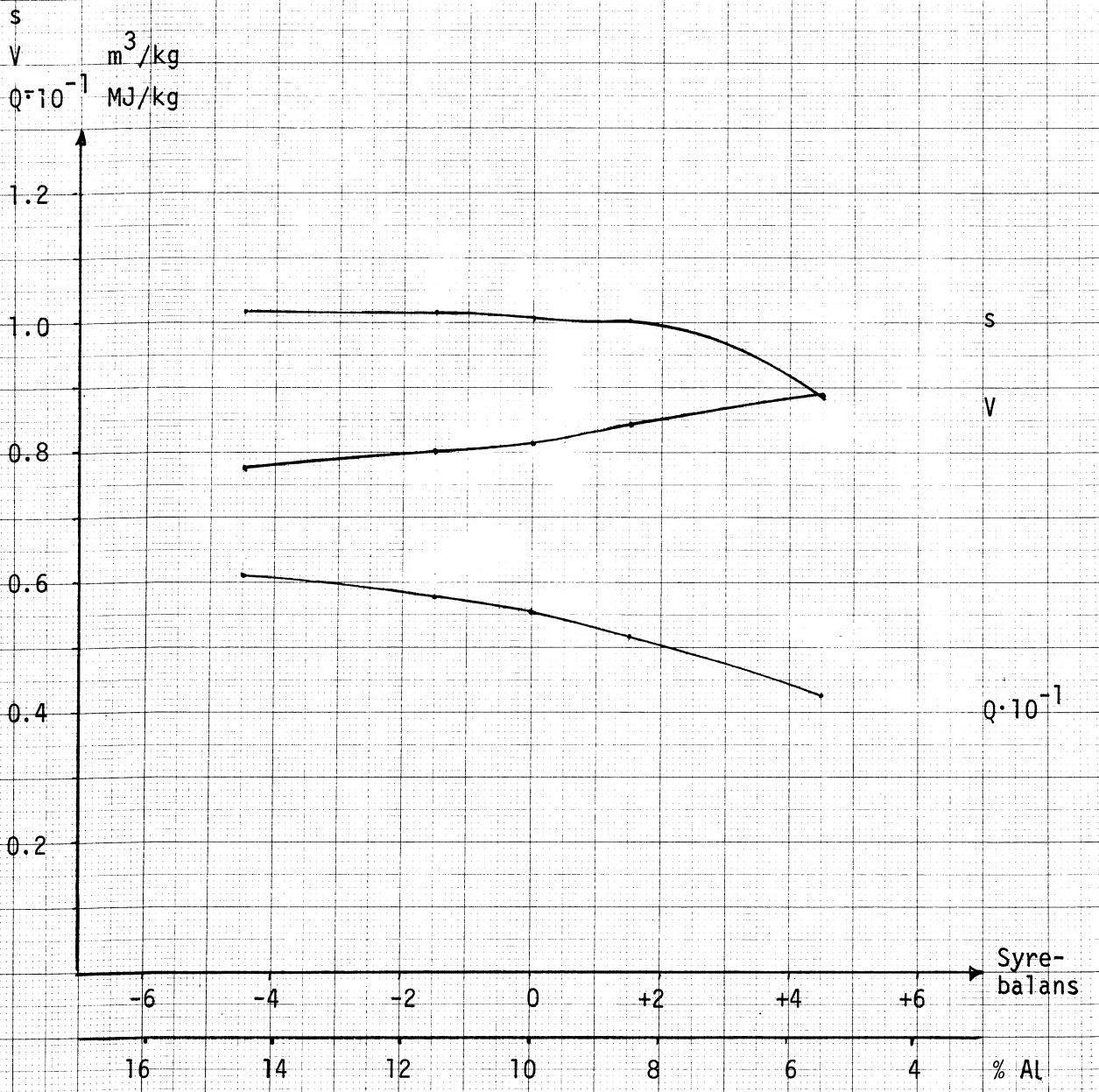
De skadliga gasernas koncentration
som funktion av syrebalans och in-
gående viktsprocent aluminium för
aluminiserat ANFO vid ideal detonation.

Diagram 7

16.



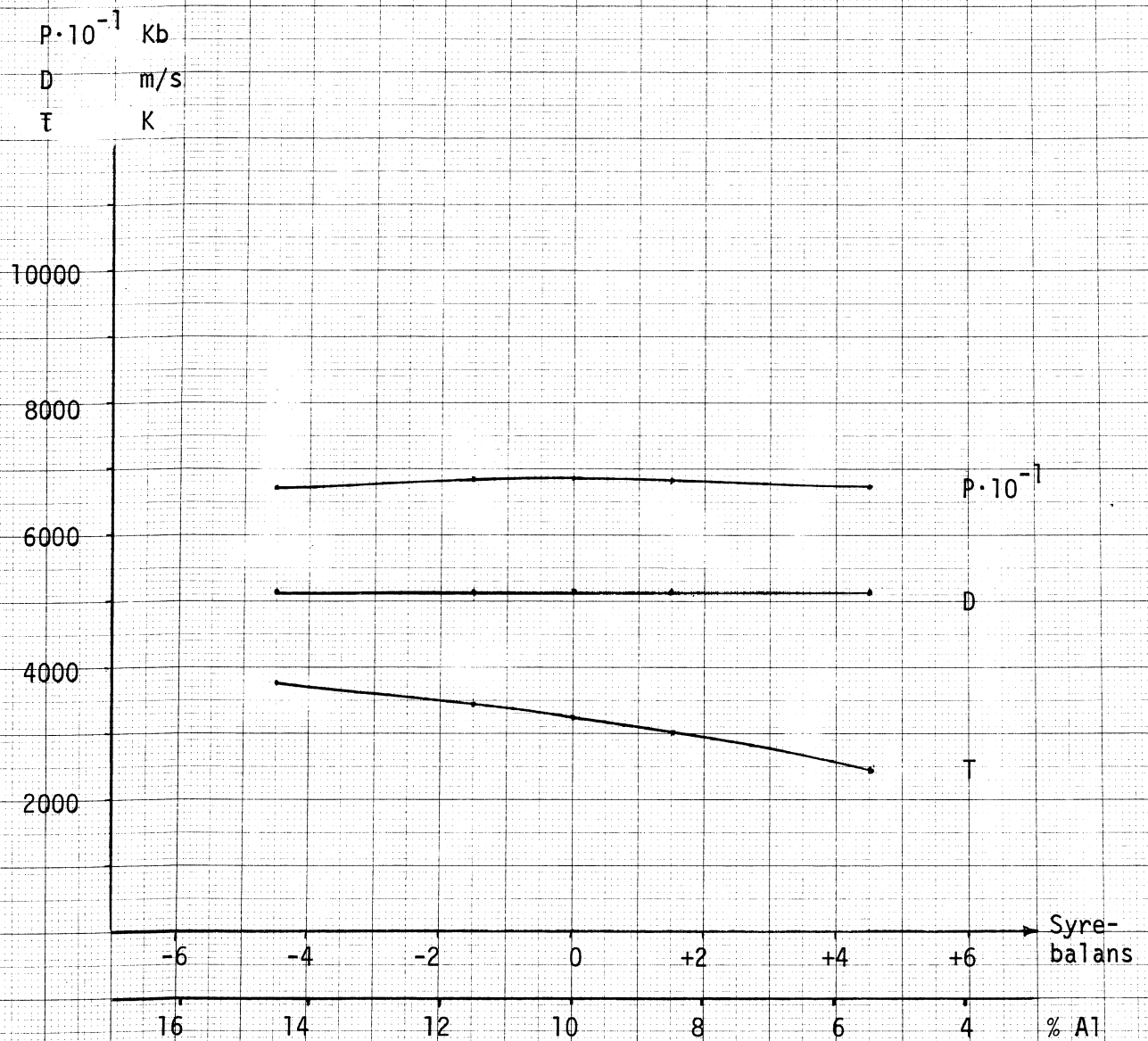
Viktstyrka, detonationsenergi och gasvolym som funktion av syrebalans för aluminiserat ANFO vid ideal detonation.



Detonationstryck, -temperatur och
-hastighet som funktion av syre-
balans för aluminiserat ANFO vid ideal
detonation.

Diagram 9

18.



A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 46-73

THE NUMBER OF ELEMENTS IS 4

THE NUMBER OF GAS SPECIES IS 11

THE NUMBER OF SOLID SPECIES IS 1

THE BKW EQUATION OF STATE PARAMETERS ARE

ALPHA= .5000000000E+00 BETA= .1600000000E+00 THETA= .4000000000E+03 KAPPA= .1090977844E+02

THE COMPOSITION OF THE EXPLOSIVE IS

.469382988E+00 MOLES OF C
.568185348E+01 MOLES OF H
.233202849E+01 MOLES OF N
.349804273E+01 MOLES OF O

THE DENSITY OF THE EXPLOSIVE IS .9000000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS .1000000000E+03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -.1002200000E+06 CALORIES PER FORMULA WEIGHT

THE SOLID COMAN EQUATION OF STATE PARAMETERS VO, AS, BS, CS, DS, ES, A1, A2, C1, C2, C3, ATOMIC WT

SOL C .444444444E+00 .8309358372E+00 -.13938180922E+01 .6725697160E+00 -.11353726251E+00 .64915588201E+02
-.2267053459E+00 .12851656952E+00 .A3160000000E-01 -.1755900000E+00 .1353100000E+00 .1201000000E+02

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

0. 2. 0. 1. 0. 2. 0. 0. 0. 0. 2. 1. 0. 0. 2. 1. 0. 0. 1.
0. 3. 1. 0. 0. 1. 0. 0. 1. 1. 0. 0. 2. 0. 0. 1. 0. 0. 1.
1. 4. 0. 0. 1. 0. 0. 0. 0.

A FORTRAN 8K^W CALCULATION FOR THE EXPLOSIVE
PROJECT 46-73

THE COMPUTED CJ PRESSURE IS .7416129586E-01 MEGABARS
THE COMPUTED DETONATION VELOCITY IS .5436197711E+00 CM/MICROSECOND
THE COMPUTED CJ TEMPERATURE IS .2074912407E+04 DEGREES KELVIN
THE COMPUTED CJ VOLUME .8013007424E+00 CC/GM OF EXPLOSIVE
THE COMPUTED GAMMA IS .2586374900E+01
THE VOLUME OF THE GAS IS .1819751462E+02 CC/MOLE OF GAS AND THERE ARE .4380734114E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
SOL C .38317159846E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME |
|--------|------------------|--|
| H2O | .28248623876E+01 | .4258842000E+02
-1.542828316E+03
-5.110700000E+05
-1.80950000E-01
-26.97181000E-03
-1.920453000E-09
0. |
| H2 | .83712687646E-02 | .2970347000E+02
1.1758961536E+04
-1.143829000E-01
-22.01222000E-05
-1.677761000E-09
0. |
| O2 | .21546473409E-09 | .4703060000E+02
1.0353764740E+04
0.1287147000E-01
-25.00217000E-05
-1.901570000E-09
0. |
| CO2 | .29457008585E+00 | .4748112000E+02
7.4628096875E+03
-9.396800000E+05
-37.21296000E-05
-2.770300000E-09
0. |
| CO | .84039387582E-01 | .4533082000E+02
1.1215883099E+04
-2.720100000E+05
-2.416403000E-05
-1.828181000E-09
0. |
| NH3 | .30854082018E-02 | .4201816000E+02
1.2069412161E+04
-9.368000000E+04
-3.164330000E-05
-2.197801000E-09
0. |
| H | .25922945912E-05 | .2639110000E+02
7.9462161719E+03
-1.911662000E-01
-4.760000000E-03
-1.316823000E-09
0. |
| NO | .51578767686E-06 | .4841498000E+02
1.2092497057E+04
-1.269386000E-01
-7.600000000E+01
-1.893213000E-09
0. |
| N2 | .11644712840E+01 | .4392340000E+02
1.1391613490E+04
-1.222501000E-01
-3.860000000E+03
-1.798322000E-09
0. |
| OH | .28090798898E-06 | .4241720000E+02
1.1391613490E+04
-1.222501000E-01
-3.860000000E+03
-1.798322000E-09
0. |
| CH4 | .13317708716E-02 | .11835175443E+04
3.560000000E+04
-4.300000000E-05
-2.226659000E-05
-1.689155000E-09
0. |
| SOL C | .89441754595E-01 | .10424279115E+04
-2.461519000E-01
-1.600000000E+05
-5.289000000E-03
-1.297550000E-10
0. |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT C_J-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 46-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .741612959E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .207491241E+04 | .139244678E+04 | .907219652E+03 | .534530127E+03 |
| VOLUME (CC/GRAM) | .801300888E+00 | .185971713E+01 | .594189392E+01 | .235098347E+02 |
| ENERGY (KCAL/KG) | .274571590E+03 | -.413363378E+03 | -.710392771E+03 | -.835331138E+03 |
| ENERGY (KJ/KG) | .114881153E+04 | -.172951839E+04 | -.29722369E+04 | -.349503764E+04 |
| GAMMA (-DLNP/DLNV) | .258821675E+01 | .219475200E+01 | .179545625E+01 | .160476287E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| H2O (MOLES) | .282486238E+01 | .268547615E+01 | .265487864E+01 | .269512675E+01 |
| H2 (MOLES) | .837126866E-02 | .880568631E-01 | .897029311E-01 | .813338912E-02 |
| O2 (MOLES) | .215464738E-09 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| CO2 (MOLES) | .294570085E+00 | .369244880E+00 | .417935458E+00 | .401451768E+00 |
| CO (MOLES) | .840393885E-01 | .740768246E-01 | .729318624E-02 | .124565518E-04 |
| NH3 (MOLES) | .308540795E-02 | .991409058E-02 | .509097618E-02 | .952705037E-03 |
| H (MOLES) | .259229469E-05 | .642021593E-09 | .100000000E-10 | .100000000E-10 |
| NO (MOLES) | .515787686E-06 | .810939754E-10 | .100000000E-10 | .100000000E-10 |
| N2 (MOLES) | .116447128E+01 | .118105720E+01 | .116346876E+01 | .116553789E+01 |
| OH (MOLES) | .280907986E-06 | .480206721E-09 | .100000000E-10 | .100000000E-10 |
| CH4 (MOLES) | .133177072E-02 | .260612943E-01 | .441543546E-01 | .679187740E-01 |
| SOL C (MOLES) | .894417547E-01 | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .911155998E+03 | .903615091E+03 | .916172573E+03 | .925101870E+03 |
| HEAT OF DETONATION (KJ/KG) | .381228995E+04 | .378073869E+04 | .383327938E+04 | .387063969E+04 |
| VOLUME OF GAS (LITRES/KG) | .981924222E+03 | .989355184E+03 | .982325292E+03 | .972599470E+03 |
| WEIGHT STRENGTH REL. LFB | .827915820E+00 | .824114328E+00 | .831492698E+00 | .835812393E+00 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 47-73

THE NUMBER OF ELEMENTS IS 4

THE NUMBER OF GAS SPECIES IS 11

THE NUMBER OF SOLID SPECIES IS 1

THE RKW EQUATION OF STATE PARAMETERS ARE

| | | | | | | | |
|--------|---------------|-------|----------------|--------|----------------|--------|----------------|
| ALPHA= | .50000000E+00 | BETA= | .160000000E+00 | THETA= | .400000000E+03 | KAPPA= | .109097784E+02 |
|--------|---------------|-------|----------------|--------|----------------|--------|----------------|

THE COMPOSITION OF THE EXPLOSIVE IS

| COMPOSITION OF THE EXPLOSIVE | MOLES OF C | MOLES OF H | MOLES OF N | MOLES OF O |
|------------------------------|------------|------------|------------|------------|
| 4118793815E+00 | | | | |
| 5597251027E+01 | | | | |
| 2352422850E+01 | | | | |
| 3528634275E+01 | | | | |

THE DENSITY OF THE EXPLOSIVE IS .900000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS 100000000 ± 03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -1.007500000E+06 CALORIES PER FORMULA WEIGHT

[illegible]

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

0. 2. 0. 1. 0. 2. 0. 0. 0. 2. 1. 0. 0. 1.
0. 3. 1. 0. 0. 1. 0. 0. 0. 1. 1. 0. 0. 1.
0. 4. 0. 0. 1. 0. 0. 0.

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 47-73

THE COMPUTED CJ PRESSURE IS .7439803901E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5451205971E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .2090167139E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .8..20207597E+00 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2594729409E+01

THE VOLUME OF THE GAS IS .1829886164E+02 CC/MOLE OF GAS AND THERE ARE .4382899743E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
SOL C .3831176216E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), CONVOLUME |
|--------|------------------|---|
| H2O | .2784499825E+01 | .4258842000E+02
1342828351E+04
2970367000E+02
1175896153E+04
4703090000E+02
1035376474E+04
4748112000E+02
7462809687E+03
4533082000E+02
1121588309E+04
4201816000E+02
1206961216E+04
2639110000E+02
7946316171E+03
4841498000E+02
1209249705E+04
4392340000E+02
1139161349E+04
4241792000E+02
3500595238E+06
3875686000E+02
1042427911E+04
2461519000E+00
2582043893E+03 |
| H2 | .7109739721E-02 | .1480805000E-01
5710700000E+05
1143829000E-01
1800000000E+03
2500217000E-05
3500000000E+03
3721296000E-05
6000000000E+03
2416403000E-05
3900000000E-03
3164330000E-05
4760000000E+03
1690740000E-05
7600000000E+02
2446000000E-03
3860000000E+03
2379005000E-05
3800000000E+03
2226659000E-03
4130000000E+03
3707957000E-05
5280000000E+03
1297550000E-05 |
| O2 | .2638150537E-09 | .2639181000E-05
1920453000E-09
1677761000E-09
1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| CO2 | .3309647971E+00 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| CO | .4020379651E-01 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| NH3 | .2395937634E-02 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| H | .5822019734E-06 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| NO | .70R21141809E-06 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| N2 | .11750131021E+01 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| OH | .3500595238E-06 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| CH4 | .71078786928E-03 | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |
| SOL C | 0. | .1901570000E-09
2770300000E-09
1828181000E-09
2197801000E-09
1316823000E-09
1893213000E-09
1798322000E-09
1689155000E-09
2470714000E-09
9349995000E-10 |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 47-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .743980390E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .20916714E+04 | .143984165E+04 | .92999768E+03 | .543327168E+03 |
| VOLUME (CC/GRAM) | .802020754E+00 | .186263519E+01 | .599283094E+01 | .237999344E+02 |
| ENERGY (KCAL/KG) | .274908081E+03 | -.414044670E+03 | -.714305740E+03 | -.840934887E+03 |
| ENERGY (KJ/KG) | .114980101E+04 | -.173236892E+04 | -.298866561E+04 | -.351848380E+04 |
| GAMMA (-DLNP/DLNV) | .258872120E+01 | .218770838E+01 | .178485189E+01 | .161523035E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| H2O (MOLES) | .278649982E+01 | .274661915E+01 | .272106050E+01 | .274764618E+01 |
| H2 (MOLES) | .710973986E-02 | .455330339E-01 | .629242517E-01 | .720912955E-02 |
| O2 (MOLES) | .263815048E-09 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| CO2 (MOLES) | .330964798E+00 | .371051313E+00 | .401100591E+00 | .390487946E+00 |
| CO (MOLES) | .802037955E-01 | .399124649E-01 | .537258976E-02 | .122002291E-04 |
| NH3 (MOLES) | .239593790E-02 | .309472865E-02 | .255223771E-02 | .674485964E-03 |
| H (MOLES) | .582201954E-06 | .282273219E-07 | .100000000E-10 | .100000000E-10 |
| NO (MOLES) | .708211399E-06 | .700782364E-09 | .100000000E-10 | .100000000E-10 |
| N2 (MOLES) | .117501310E+01 | .117466406E+01 | .117493531E+01 | .117587418E+01 |
| OH (MOLES) | .350059529E-06 | .373678234E-07 | .100000000E-10 | .100000000E-10 |
| CH4 (MOLES) | .710787985E-03 | .915603726E-03 | .540620074E-02 | .213792353E-01 |
| SOL C (MOLFS) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .916941403E+03 | .920974278E+03 | .925887709E+03 | .932019202E+03 |
| HEAT OF DETONATION (KJ/KG) | .383649617E+04 | .385336978E+04 | .387392765E+04 | .389958190E+04 |
| VOLUME OF GAS (LITRES/KG) | .982409420E+03 | .982160795E+03 | .980269286E+03 | .973529593E+03 |
| WEIGHT STRENGTH REL. LFB | .832045327E+00 | .834808844E+00 | .837864272E+00 | .840818472E+00 |

A FORTRAN RKW CALCULATION FOR THE EXPLOSIVE
PROJECT 48-73

THE NUMBER OF ELEMENTS IS 4

THE NUMBER OF GAS SPECIES IS 11

THE NUMBER OF SOLID SPECIES IS 1

THE RKW EQUATION OF STATE PARAMETERS ARE

ALPHA = .5000000000E+00 BETA = .1600000000E+00 THETA = .4000000000E+03 KAPPA = .1090977844E+02

THE COMPOSITION OF THE EXPLOSIVE IS

.383127524E+00 MOLES OF C
.5555349800E+01 MOLES OF H
.2362620030E+01 MOLES OF N
.35439330045E+01 MOLES OF O

THE DENSITY OF THE EXPLOSIVE IS .9000000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS .1000000000E+03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -.10102000000E+06 CALORIES PER FORMULA WEIGHT

THE SOLID COWAN EQUATION OF STATE PARAMETERS VO, AS, BS, CS, DS, ES, A1, A2, C1, C2, C3, ATOMIC WT

SOL C .4444444444E+00 .8309358372E+00 -.13938180922E+01 .67256971602E+00 -.11353726251E+00 .64915988201E-02
-.22670534595E+00 .12051656952E+00 .83160000000E-01 -.17559000000E+00 .15531000000E+00 .12010000000E+02

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

0. 2. 0. 1. 0. 2. 0. 0. 0. 0. 2. 1. 0. 0. 2. 1. 0. 0. 1.
0. 3. 1. 0. 0. 1. 0. 0. 0. 0. 1. 1. 0. 0. 2. 0. 0. 1. 0. 1.
1. 4. 0. 0. 1. 0. 0. 0. 0.

A FORTRAN 8KW CALCULATION FOR THE EXPLOSIVE
PROJECT 48-73

THE COMPUTED CJ PRESSURE IS .742A+28609E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5442299922E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .2134894888E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .8014824570E+00 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2588479745E+01

THE VOLUME OF THE GAS IS .1845728785E+02 CC/MOLE OF GAS AND THERE ARE .4342363101E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
SOL C .3833826766E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIF | NO OF MOLES | COEFFICIENTS A+B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME |
|--------|------------------|--|
| H2O | .2776330433E+01 | .4258842000E+02
-1490805000E-01
-5710788888E-05
-2939181000E-03
-1920453000E-09
0. |
| H2 | .38646979581E-04 | .2970347000E+02
-1143829000E-01
-2261222000E-05
-1677761000E-09
0. |
| O2 | .13415603077E-03 | .1758961536E+04
-4703090000E+02
-1800000000E+03
-2900217000E-05
-1901570000E-09
0. |
| CO2 | .3826668564E+00 | .4748112000E+02
-1035376470E-04
-3500000000E+03
-3721296000E-05
-2770300000E-09
0. |
| CO | .46071548054E-03 | .74628096875E+03
-4533082000E+02
-2416403000E-05
-1628181000E-09
0. |
| NH3 | .81002791126E-06 | .1121588309E+04
-4201816000E+02
-3900000000E+03
-3164330000E-05
-2197801000E-09
0. |
| H | .23911404717E-06 | .12069612161E+04
-2639110000E+02
-4760000000E+03
-1690740000E-05
-1316823000E-09
0. |
| NO | .22647996411E-03 | .7946316171E+03
-8414980000E+02
-7600000000E+01
-2944600000E-05
-1893213000E-09
0. |
| N2 | .11411663750E+01 | .12092497057E+04
-4392340000E+02
-3860000000E+03
-2944600000E-05
-1798322000E-09
0. |
| OH | .77A+2815372E-05 | .1139161349E+04
-4241792000E+02
-3800000000E+03
-2226659000E-05
-1689155000E-09
0. |
| CH4 | .10000000000E-10 | .11835175443E+04
-3875686000E+02
-4130000000E+03
-3707957000E-05
-2470714000E-09
0. |
| SOL C | 0. | .10424279115E+04
-2441519000E+00
-1600000000E+05
-528030000E+03
-1297550000E-05
-9349995000E-10
0. |

THE ISENTROPIC STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 48-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .742842861E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .213489489E+04 | .147721754E+04 | .954766993E+03 | .546156443E+03 |
| VOLUME (CC/GRAM) | .801482456E+00 | .186422737E+01 | .603601140E+01 | .238733636E+02 |
| ENERGY (KCAL/KG) | .274865805E+03 | -.414827951E+03 | -.717402081E+03 | -.844648787E+03 |
| ENERGY (KJ/KG) | .115004253E+04 | -.173564618E+04 | -.300162075E+04 | -.353402281E+04 |
| GAMMA (-DLNP/DLNP) | .258831658E+01 | .217809499E+01 | .17735235E+01 | .163705760E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| H2O (MOLES) | .27776304E+01 | .277766200E+01 | .277767490E+01 | .277767490E+01 |
| H2 (MOLES) | .366469796E-04 | .105956196E-04 | .349277813E-08 | .863983125E-10 |
| O2 (MOLES) | .134156030E-03 | .586669792E-05 | .258537977E-09 | .100000000E-10 |
| CO2 (MOLES) | .382666857E+00 | .383117700E+00 | .383127573E+00 | .383127573E+00 |
| CO (MOLES) | .460715480E-03 | .987231683E-05 | .305106787E-09 | .357429354E-10 |
| NH3 (MOLES) | .800027915E-06 | .960145383E-08 | .100000000E-10 | .100000000E-10 |
| H (MOLES) | .239114046E-06 | .119232238E-08 | .100000000E-10 | .100000000E-10 |
| NO (MOLES) | .226479964E-03 | .646418897E-05 | .732729933E-09 | .100000000E-10 |
| N2 (MOLES) | .118119638E+01 | .118130678E+01 | .118131001E+01 | .118131002E+01 |
| OH (MOLES) | .778028155E+05 | .456993335E+05 | .172651011E+08 | .100000000E-10 |
| CH4 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|-----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .935683647E+03 | .936048616E+03 | .936064120E+03 | .936064123E+03 |
| HEAT OF DETONATION (KJ/KG) | .391491399E+04 | .391644103E+04 | .391650590E+04 | .391650591E+04 |
| VOLUME OF GAS (LITRES/KG) | .973323318E+03 | .973269695E+03 | .973267146E+03 | .973267146E+03 |
| WEIGHT STRENGTH REL. LFB | .8433333375E+00 | .843577367E+00 | .843587679E+00 | .843587680E+00 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 49-73

THE NUMBER OF ELEMENTS IS 4

THE NUMBER OF GAS SPECIES IS 11

THE NUMBER OF SOLID SPECIES IS 1

THE BKW EQUATION OF STATE PARAMETERS ARE

ALPHA= .5000000000E+00 BETA= .1600000000E+00 THETA= .4000000000E+03 KAPPA= .1090977844E+02

THE COMPOSITION OF THE EXPLOSIVE IS

.3543757639E+00 MOLES OF C
.5513448575E+01 MOLES OF H
.2372817210E+01 MOLES OF N
.3559225515E+01 MOLES OF O

THE DENSITY OF THE EXPLOSIVE IS .9000000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS .1000000000E+03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -.1012800000E+06 CALORIES PER FORMULA WEIGHT

THE SOLID COWAN EQUATION OF STATE PARAMETERS VO, AS, BS, CS, DS, ES, A1, A2, C1, C2, C3, ATOMIC WT

SOL C .4444444444E+00 .8309358372E+00 -.13938180922E+01 .6725697160E+00 -.11353726251E+00 .64915588201E+02
-.22670534595E+00 .12051656952E+00 .8316000000E-01 -.1759000000E+00 .15531000000E+00 .12010000000E+02

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

0. 2. 0. 1. 0. 2. 0. 0. 0. 0. 2. 1. 0. 0. 2. 1. 0. 0. 1.
0. 3. 1. 0. 0. 1. 0. 0. 0. 1. 0. 0. 2. 0. 0. 1. 0. 1.
1. 4. 0. 0. 1. 0. 0. 0. 0.

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 49-73

THE COMPUTED CJ PRESSURE IS .7282137178E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5393298843E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .2061311682E+04 DEGREES KELVIN

| THE COMPUTED C _J VOLUME | .8020396519E+00 | CC/GM OF EXPLOSIVE |
|------------------------------------|-----------------|--------------------|
| 1 | 0.8020396519 | 0.00 |

THE COMPUTED GAMMA IS .2594948094E+01

| THE VOLUME OF THE GAS IS | CC/MOLE OF GAS AND THERE ARE | MOLES OF GAS |
|--------------------------|------------------------------|--------------|
| 0.1846147440E+02 | 0.4344396523E+01 | |

SOL IN
SOL C

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

[illegible]

THE ISENTROPIC STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CUTOFF PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MPARS FOR
PROJECT 4973

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MPARS) | .728213718E+01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .206131168E+04 | .142350271E+04 | .909768039E+03 | .504286364E+03 |
| VOLUME (CC/GRAM) | .802039651E+00 | .183951659E+01 | .587111087E+01 | .224000842E+02 |
| ENERGY (KCAL/KG) | .268867782E+03 | -.398762046E+03 | -.691316459E+03 | -.811092768E+03 |
| ENERGY (KJ/KG) | .112536511E+04 | -.166842620E+04 | -.289247812E+04 | -.339362394E+04 |
| GAMMA (-DLNP/DLNP) | .260019740E+01 | .219857998E+01 | .180907166E+01 | .169105925E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| H2O (MOLES) | .275671181E+01 | .275672416E+01 | .275672429E+01 | .275672429E+01 |
| H2 (MOLES) | .111445962E-05 | .523693246E-07 | .100000000E-10 | .100000000E-10 |
| O2 (MOLES) | .451586909E-01 | .466511441E-01 | .468716707E-01 | .468749959E-01 |
| CO2 (MOLES) | .354362515E+00 | .354375721E+00 | .354375765E+00 | .354375766E+00 |
| CO (MOLES) | .132485612E-04 | .428230427E-07 | .100000000E-10 | .100000000E-10 |
| NH3 (MOLES) | .376135225E-09 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| H (MOLES) | .401117449E-09 | .242340230E-10 | .100000000E-10 | .100000000E-10 |
| NO (MOLES) | .343562149E-02 | .434638215E-03 | .652542391E-05 | .155775095E-09 |
| N2 (MOLES) | .118469079E+01 | .118619129E+01 | .118640534E+01 | .118640861E+01 |
| OH (MOLES) | .227228211E-04 | .263341275E-04 | .259118044E-06 | .100000000E-10 |
| CH4 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .893727708E+03 | .894380495E+03 | .894480874E+03 | .894482361E+03 |
| HEAT OF DETONATION (KJ/KG) | .373936973E+04 | .374210100E+04 | .374252099E+04 | .374252721E+04 |
| VOLUME OF GAS (LITRES/KG) | .973779102E+03 | .973777705E+03 | .973776234E+03 | .973776220E+03 |
| WEIGHT STRENGTH REL. LFB | .814165348E+00 | .814620306E+00 | .814690015E+00 | .814691049E+00 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 50-73

THE NUMBER OF ELEMENTS IS 4

THE NUMBER OF GAS SPECIES IS 11

THE NUMBER OF SOLID SPECIES IS 1

THE BKW EQUATION OF STATE PARAMETERS ARE

ALPHA= .5000000000E+00 BETA= .1600000000E+00 THETA= .4000000000E+03 KAPPA= .1090977844E+02

THE COMPOSITION OF THE EXPLOSIVE IS

.2968721466E+00 MOLES OF C
.5429646124E+01 MOLES OF H
.2393211570E+01 MOLES OF N
.3589817355E+01 MOLES OF O

THE DENSITY OF THE EXPLOSIVE IS .9000000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS .1000000000E+03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -.10181000000E+06 CALORIES PER FORMULA WEIGHT

THE SOLID COWAN EQUATION OF STATE PARAMETERS VO, AS, BS, CS, DS, ES, A1, A2, C1, C2, C3, ATOMIC WT

| | | | | | | |
|-------|-------------------|------------------|-------------------|-------------------|-------------------|------------------|
| SOL C | .4444444444E+00 | .8309358372E+00 | -.13938180922E+01 | .67256971602E+00 | -.11353726251E+00 | .64915588201E+02 |
| | -.22670534595E+00 | .12051656952E+00 | .83160000000E+01 | -.17559000000E+00 | .15531000000E+00 | .12010000000E+02 |

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

| | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0. | 2. | 0. | 1. | 0. | 2. | 0. | 0. | 0. | 0. | 2. | 1. | 0. | 0. | 1. |
| 0. | 3. | 1. | 0. | 0. | 1. | 0. | 0. | 0. | 1. | 0. | 0. | 2. | 0. | 0. |
| 1. | 4. | 0. | 0. | 1. | 0. | 0. | 0. | 0. | 1. | 0. | 0. | 1. | 0. | 1. |

THE ISENTROPIC STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 50-73

| | | | | |
|---|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .695633084E+01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .191272174E+04 | .131400171E+04 | .811564791E+03 | .417472282E+03 |
| VOLUME (CC/GRAM) | .804455022E+00 | .178826149E+01 | .550702533E+01 | .193284527E+02 |
| ENERGY (KCAL/KG) | .254926269E+03 | -.366113498E+03 | -.639485617E+03 | -.741912564E+03 |
| ENERGY (KJ/KG) | .106661522E+04 | -.153182420E+04 | -.267561713E+04 | -.310417296E+04 |
| GAMMA (-DLNP/DLNV) | .262638432E+01 | .224432962E+01 | .188817147E+01 | .184314039E+01 |
| COMPOSITION OF THE
DETONATION PRODUCTS | | | | |
| H2O (MOLES) | .271481641E+01 | .271481745E+01 | .271482305E+01 | .271482307E+01 |
| H2 (MOLES) | .175041986E+06 | .369638917E-09 | .100000000E-10 | .100000000E-10 |
| O2 (MOLES) | .138657283E+00 | .140424832E+00 | .140623663E+00 | .140624995E+00 |
| CO2 (MOLES) | .296870362E+00 | .296872147E+00 | .296872148E+00 | .296872149E+00 |
| CO (MOLES) | .178507683E-05 | .314872727E-09 | .100000000E-10 | .100000000E-10 |
| NH3 (MOLES) | .150465447E-09 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| H (MOLES) | .203443978E-09 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| NO (MOLES) | .393091941E-02 | .394723474E-03 | .265138476E-05 | .100000000E-10 |
| N2 (MOLES) | .119464033E+01 | .119640842E+01 | .119660446E+01 | .119660579E+01 |
| OH (MOLES) | .129478274E-04 | .112207709E-04 | .355530868E-07 | .100000000E-10 |
| CH4 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |
| HEAT OF DETONATION (KCAL/KG) | | | | |
| | .810369132E+03 | .811130447E+03 | .811218246E+03 | .811218830E+03 |
| HEAT OF DETONATION (KJ/KG) | | | | |
| | .339059624E+04 | .339378159E+04 | .339414894E+04 | .339415139E+04 |
| VOLUME OF GAS (LITRES/KG) | | | | |
| | .974795311E+03 | .974794995E+03 | .974794368E+03 | .974794367E+03 |
| WEIGHT STRENGTH REL. LFB | | | | |
| | .756235708E+00 | .756766539E+00 | .756827641E+00 | .756828048E+00 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 51-73

THE NUMBER OF ELEMENTS IS 5

THE NUMBER OF GAS SPECIES IS 13

THE NUMBER OF SOLID SPECIES IS 2

THE RKW EQUATION OF STATE PARAMETERS ARE
ALPHA= .500000000E+00 BETA= .160000000E+00 THETA= .400000000E+03 KAPPA= .1090977844E+02

THE COMPOSITION OF THE EXPLOSIVE IS
.2605628510E+00 MOLES OF C
.4877030874E+01 MOLES OF H
.2156239015E+01 MOLES OF N
.3234358522E+01 MOLES OF O
.3706449220E+00 MOLES OF AL

THE DENSITY OF THE EXPLOSIVE IS .900000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS .100000000E+03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -.9169300000E+05 CALORIES PER FORMULA WEIGHT

| THE SOLID | COMAN | EQUATION OF STATE PARAMETERS | VO, AS, BS, CS, DS, ES, | AL, A2, C1, C2, C3, ATOMIC WT |
|-----------|-------------------|------------------------------|-------------------------|-------------------------------|
| AL2O3 | .25220680960E+00 | 0. | 0. | 0. |
| SOL C | .4444444444E+00 | .83093583727E+00 | .13938180922E+01 | .10196000000E+03 |
| | -.22670534595E+00 | .12051656952E+00 | .83160000000E-01 | .64915588201E-02 |
| | | | .67256971602E+00 | .15531000000E+02 |
| | | | -.17559000000E+00 | .12010000000E+02 |

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

| | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0. | 0. | 0. | 1. | 0. | 0. | 0. | 3. | 2. | 0. | 2. | 0. | 1. | 0. | 0. | 2. | 0. | 0. | 0. |
| 0. | 0. | 0. | 2. | 0. | 0. | 1. | 0. | 0. | 2. | 0. | 1. | 0. | 0. | 1. | 0. | 0. | 3. | 1. |
| 0. | 1. | 0. | 0. | 0. | 0. | 0. | 1. | 1. | 0. | 0. | 0. | 2. | 0. | 0. | 0. | 1. | 0. | 0. |
| 7. | 4. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 2. | 1. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 51-73

THE ISENTROPIC STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 51-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .702541083E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .314728278E+04 | .229810462E+04 | .16502247E+04 | .118112560E+04 |
| VOLUME (CC/GRAM) | .794479684E+00 | .190885474E+01 | .736437531E+01 | .400983075E+02 |
| ENERGY (KCAL/KG) | .265833050E+03 | -.422619269E+03 | -.799257003E+03 | -.101660011E+04 |
| ENERGY (KJ/KG) | .111224939E+04 | -.176824517E+04 | -.334410293E+04 | -.425346966E+04 |
| GAMMA (-DLNP/DLNP) | .250142340E+01 | .198047775E+01 | .149075989E+01 | .129463939E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|-----------------|----------------|
| AL G (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .120345883E-09 | .214283976E-09 | .100000000E-10 | .100000000E-10 |
| H2O (MOLES) | .233057576E+01 | .227047850E+01 | .222390829E+01 | .218794312E+01 |
| H2 (MOLES) | .869342849E-01 | .163534387E+00 | .213253834E+00 | .249715879E+00 |
| O2 (MOLES) | .214867063E-05 | .810276860E-07 | .565461336E-10 | .100000000E-10 |
| CO2 (MOLES) | .883617599E-01 | .147245989E+00 | .193926435E+00 | .229933635E+00 |
| CO (MOLES) | .170761660E+00 | .113265964E+00 | .666230861E-01 | .305807432E-01 |
| NH3 (MOLES) | .119393175E-01 | .286351788E-02 | .881099265E-03 | .506324975E-03 |
| H (MOLES) | .271363871E-03 | .671067935E-04 | .3176333154E-05 | .515615208E-09 |
| NO (MOLES) | .162161108E-03 | .106887353E-04 | .574248080E-07 | .100000000E-10 |
| N2 (MOLES) | .107206877E+01 | .107668240E+01 | .107767893E+01 | .107786635E+01 |
| OH (MOLES) | .163738847E-03 | .143846498E-03 | .683907754E-05 | .480421293E-09 |
| CH4 (MOLES) | .143943121E-02 | .508982956E-04 | .133301119E-04 | .484725576E-04 |
| AL2O3 (MOLES) | .185322461E+00 | .185322461E+00 | .185322461E+00 | .185322461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .127851756E+04 | .128295703E+04 | .128738797E+04 | .129085312E+04 |
| HEAT OF DETONATION (KJ/KG) | .534933606E+04 | .536791088E+04 | .538644999E+04 | .540094824E+04 |
| VOLUME OF GAS (LITRES/KG) | .843389760E+03 | .846003972E+03 | .846441435E+03 | .846508557E+03 |
| WEIGHT STRENGTH REL. LFB | .105692655E+01 | .106053494E+01 | .106371057E+01 | .106614011E+01 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 52-73

THE NUMBER OF ELEMENTS IS 5

THE NUMBER OF GAS SPECIES IS 13

THE NUMBER OF SOLID SPECIES IS 2

THE BKW EQUATION OF STATE PARAMETERS ARE
ALPHA= .500000000E+00 BETA= .160000000E+00 THETA= .200000000E+03 KAPPA= .109097784E+02

THE COMPOSITION OF THE EXPLOSIVE IS
.203059234E+00 MOLES OF C
.479322842E+01 MOLES OF H
.2176633374E+01 MOLES OF N
.3264950862E+01 MOLES OF O
.3706449220E+00 MOLES OF AL

THE DENSITY OF THE EXPLOSIVE IS .900000000E+00, GRAMS/CC

THE MOLECULAR WEIGHT IS .100000000E+03 GRAMS

THE ENTHALPY OF FORMATION AT 0 DEG K IS -.9222300000E+05 CALORIES PER FORMULA WEIGHT

| THE SOLID | COMAN | EQUATION OF STATE PARAMETERS | VO, AS, BS, CS, DS, ES, | AL, A2, C1, C2, C3, ATOMIC WT |
|-----------|-------------------|------------------------------|-------------------------|-------------------------------|
| AL2O3 | .25220680960E+00 | 0. | 0. | 0. |
| SOL C | .4444444444E+00 | .83093583727E+00 | .67256971602E+00 | .10196000000E+03 |
| | -.22670534595E+00 | .12051656952E+00 | -.17559000000E+00 | .64915588201E-02 |
| | | .83160000000E-01 | .15531000000E+00 | .12010000000E+02 |

THE INPUT DETONATION PRODUCT ELEMENTAL COMPOSITION MATRIX

| | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0. | 0. | 0. | 1. | 0. | 0. | 0. | 3. | 2. | 0. | 2. | 0. | 1. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 2. | 0. | 0. | 1. | 0. | 0. | 1. | 0. | 0. | 1. | 0. | 0. | 3. | 1. |
| 0. | 1. | 0. | 0. | 0. | 0. | 1. | 1. | 0. | 0. | 2. | 0. | 0. | 0. | 1. | 0. | 1. |
| 1. | 4. | 0. | 0. | 0. | 0. | 3. | 2. | 1. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

A FORTRAN 8KW CALCULATION FOR THE EXPLOSIVE
PROJECT 52-73

THE COMPUTED CJ PRESSURE IS .692035464E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5189396661E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .3259590383E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .7938598766E+00 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2502256050E+01

THE VOLUME OF THE GAS IS .2023599192E+02 CC/MOLE OF GAS AND THERE ARE .3687509844E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
AL2O3 .25226880960E+00
SOL C .39130590282E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A*B*C*D*E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME | AL G | AL2O3 | H2O | H2 | O2 | CO2 | CO | NH3 | H | NO | N2 | OH | CH4 | AL2O3 | SOL C |
|--------|------------------|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| AL | 1.000000000E-10 | .38323150000E+02 | .81697810000E-02 | .17049470000E-05 | .76900000000E+03 | .39248930000E-01 | .24000000000E+06 | .42588420000E+02 | .13428283516E+04 | .29703470000E+02 | .11758961536E+04 | .47030900000E+02 | .10353764740E+04 | .47481120000E+02 | .74628096875E+03 | .45330820000E+02 | .11215883099E+04 |
| AL2O3 | .22580379794E-09 | .65122380000E+02 | .76900000000E+03 | .35000000000E+03 | .79254210000E-05 | .13500000000E+04 | .14808050000E-01 | .25000000000E+03 | .22012220000E-05 | .18000000000E+03 | .25002170000E+05 | .35000000000E+03 | .37212960000E-05 | .60000000000E+03 | .24164030000E-05 | .39000000000E+03 | |
| H2O | .23690821035E+01 | .7418046875E+03 | .24000000000E+06 | .13500000000E+04 | .13500000000E+04 | .13500000000E+04 | .14808050000E-01 | .25000000000E+03 | .22012220000E-05 | .18000000000E+03 | .25002170000E+05 | .35000000000E+03 | .37212960000E-05 | .60000000000E+03 | .24164030000E-05 | .39000000000E+03 | |
| H2 | .24611636400E-01 | .13428283516E+04 | .29703470000E+02 | .14808050000E-01 | .25000000000E+03 | .22012220000E-05 | .18000000000E+03 | .25002170000E+05 | .35000000000E+03 | .37212960000E-05 | .60000000000E+03 | .24164030000E-05 | .39000000000E+03 | .24164030000E-05 | .39000000000E+03 | .24164030000E-05 | |
| O2 | .67165470750E-04 | .11758961536E+04 | .47030900000E+02 | .22012220000E-05 | .18000000000E+03 | .25002170000E+05 | .35000000000E+03 | .37212960000E-05 | .60000000000E+03 | .24164030000E-05 | .39000000000E+03 | .24164030000E-05 | .39000000000E+03 | .24164030000E-05 | .39000000000E+03 | .24164030000E-05 | |
| CO2 | .13512843120E+00 | .47481120000E+02 | .74628096875E+03 | .45330820000E+02 | .11215883099E+04 | .42018160000E+02 | .12069612161E+04 | .26391100000E+02 | .79463161719E+03 | .48414980000E+02 | .12092497057E+04 | .43923400000E+02 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | |
| CO | .67923321458E-01 | .11215883099E+04 | .42018160000E+02 | .12069612161E+04 | .26391100000E+02 | .79463161719E+03 | .48414980000E+02 | .12092497057E+04 | .43923400000E+02 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | |
| NH3 | .15839598632E-02 | .42018160000E+02 | .12069612161E+04 | .26391100000E+02 | .79463161719E+03 | .48414980000E+02 | .12092497057E+04 | .43923400000E+02 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | |
| H | .51492180993E-03 | .12069612161E+04 | .26391100000E+02 | .79463161719E+03 | .48414980000E+02 | .12092497057E+04 | .43923400000E+02 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | |
| NO | .10418452198E-02 | .48414980000E+02 | .12092497057E+04 | .43923400000E+02 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | |
| N2 | .10870037845E+01 | .43923400000E+02 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | |
| OH | .54421547838E-03 | .11391613490E+04 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | |
| CH4 | .74813404326E-05 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | |
| AL2O3 | .18532246078E+00 | .42417920000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | .11835175443E+04 | .38756860000E+02 | |
| SOL C | 0. | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | .24615190000E+00 | |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 52-73

| | | | | |
|---|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .692035465E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .325959038E+04 | .239790786E+04 | .174570019E+04 | .124678924E+04 |
| VOLUME (CC/GRAM) | .793859969E+00 | .190307283E+01 | .743384489E+01 | .411296253E+02 |
| ENERGY (KCAL/KG) | .262370349E+03 | -.416938440E+03 | -.797520164E+03 | -.102071696E+04 |
| ENERGY (KJ/KG) | .109776136E+04 | -.17447508E+04 | -.33368357E+04 | -.427069461E+04 |
| GAMMA (-DLNP/DLNV) | .250278358E+01 | .196228656E+01 | .147848269E+01 | .126131760E+01 |
| COMPOSITION OF THE
DETONATION PRODUCTS | | | | |
| AL G (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .225804101E-09 | .375090790E-09 | .254841638E-10 | .100000000E-10 |
| H2O (MOLES) | .236908209E+01 | .234250277E+01 | .232471518E+01 | .231267865E+01 |
| H2 (MOLES) | .246116425E-01 | .531112829E-01 | .716613755E-01 | .838194949E-01 |
| O2 (MOLES) | .671654159E-04 | .258981403E-05 | .344969594E-09 | .100000000E-10 |
| CO2 (MOLES) | .135128441E+00 | .162849515E+00 | .181177886E+00 | .193244893E+00 |
| CO (MOLES) | .679233117E-01 | .402093641E-01 | .218812696E-01 | .981415728E-02 |
| NH3 (MOLES) | .158396214E-02 | .472877163E-03 | .146568242E-03 | .771046642E-04 |
| H (MOLES) | .514921470E-03 | .882652376E-04 | .419826829E-05 | .607076425E-09 |
| NO (MOLES) | .104184467E-02 | .743348092E-04 | .558870670E-06 | .901229654E-10 |
| N2 (MOLES) | .108700378E+01 | .108804308E+01 | .108824292E+01 | .108827813E+01 |
| OH (MOLES) | .544215592E-03 | .491998154E-03 | .298980582E-04 | .845065556E-07 |
| CH4 (MOLES) | .748135633E-05 | .354576167E-06 | .780599541E-07 | .183328644E-06 |
| AL2O3 (MOLES) | .185322461E+00 | .185322461E+00 | .185322461E+00 | .185322461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |
| HEAT OF DETONATION (KCAL/KG) | | | | |
| | .130965262E+04 | .131330910E+04 | .131543363E+04 | .131661350E+04 |
| HEAT OF DETONATION (KJ/KG) | | | | |
| | .547960564E+04 | .549490438E+04 | .550379346E+04 | .550873005E+04 |
| VOLUME OF GAS (LITRES/KG) | | | | |
| | .826540362E+03 | .826616027E+03 | .826619143E+03 | .826630881E+03 |
| WEIGHT STRENGTH REL. LFB | | | | |
| | .107533434E+01 | .107789997E+01 | .107938109E+01 | .108020616E+01 |

A FORTRAN 8KW CALCULATION FOR THE EXPLOSIVE
PROJECT 53-73

THE COMPUTED CJ PRESSURE IS .6862992115E+01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5165295379E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .3292500448E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .7935466975E+00 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2498801734E+01

THE VOLUME OF THE GAS IS .2042506821E+02 CC/MOLE OF GAS AND THERE ARE .3651840999E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
AL2O3 .2522068094E+00
SOL C .3917675785E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME |
|--------|-----------------|--|
| AL | 6 | .3823316000E+03 .6169781000E-02 -.170947000E-05 .1329577000E-09 -0. |
| AL2O3 | .2661139820E-09 | .9629084115E+03 .7890000000E+05 .3500000000E+03 .6074396000E-09 -0. |
| H2O | .2370869983E+01 | .6512380000E+02 .3924893000E-01 -.7925421000E-05 .1920453000E-09 0. |
| H2 | .3790773056E-02 | .7418084687E+03 -.2400000000E+06 .1350000000E+04 .1677761000E-09 0. |
| O2 | .3675453541E-02 | .4258842000E+02 .1480805000E-01 -.5639181000E-05 .1901570000E-09 0. |
| CO2 | .1620936940E+00 | .1342828351E+04 .571070000E+05 .2500000000E+03 .2770300000E-09 0. |
| CO | .1221373057E-01 | .2970347000E+02 .1143829000E-01 -.2201222000E-05 .1828181000E-09 0. |
| NH3 | .9234868097E-04 | .1175896153E+04 0. .1287147000E-01 .1901570000E-09 0. |
| H | .8664771509E-04 | .1035376474E+04 0. .1954463000E-01 .2770300000E-09 0. |
| NO | .8014451353E-02 | .4748112000E+02 .9396800000E+05 .3721296000E-05 .2770300000E-09 0. |
| N2 | .1089361877E+01 | .7462809687E+03 .4533082000E+02 .1230161000E-01 .2416403000E-05 .1828181000E-09 0. |
| OH | .1641986905E-02 | .1121588309E+04 .4201816000E+02 .2720100000E+05 .3900000000E-03 .2197801000E-09 0. |
| CH4 | .3560140117E-09 | .1206961216E+04 .4201816000E+02 .2720100000E+05 .3900000000E-03 .2197801000E-09 0. |
| AL2O3 | .1953224607E+00 | .2639110000E+02 .7946316171E+03 .5161900000E+05 .7600000000E-02 .1316823000E-09 0. |
| SOL C | 0. | .4841498000E+02 .1209249705E+04 .1269386400E+01 .2494600000E-05 .1893213000E-09 0. |
| | | .4392340000E+02 .1139161349E+04 .3800000000E+03 .2379005000E-05 .1798322000E-09 0. |
| | | .4241792000E+02 .1183517544E+04 .3560000000E+05 .2226659000E-05 .1689155000E-09 0. |
| | | .3875860000E+02 .1042427911E+04 .4130000000E+03 .3707957000E-05 .2470714000E-09 0. |
| | | .5158191000E+01 .4452086000E-01 .5280000000E+03 .6805743000E-09 -0. |
| | | .1219760612E+04 .3960000000E+06 -.0. .1297550000E-05 .9349995000E-10 0. |
| | | .2461519000E+00 .7179855000E-02 .0. .1297550000E-05 .9349995000E-10 0. |
| | | -.2582043893E+03 .0. .0. .0. .0. |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 53-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .686299212E+01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .329250045E+04 | .244094149E+04 | .178661964E+04 | .128127393E+04 |
| VOLUME (CC/GRAM) | .793546690E+00 | .189892575E+01 | .746643320E+01 | .416573314E+02 |
| ENERGY (KCAL/KG) | .260452463E+03 | -.413553369E+03 | -.795917413E+03 | -.102204699E+04 |
| ENERGY (KJ/KG) | .108973690E+04 | -.173031331E+04 | -.333013004E+04 | -.427625947E+04 |
| GAMMA (-DLNP/DLNP) | .250062031E+01 | .195341115E+01 | .147215458E+01 | .124543390E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| AL O (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .266113983E-09 | .454192492E-09 | .725921657E-10 | .100000000E-10 |
| H2O (MOLES) | .237086998E+01 | .237121003E+01 | .237485697E+01 | .237564190E+01 |
| H2 (MOLES) | .379077305E-02 | .310130836E-02 | .538508154E-03 | .154302639E-04 |
| O2 (MOLES) | .367545352E-02 | .124097732E-02 | .151046446E-03 | .442084646E-05 |
| CO2 (MOLES) | .162093694E+00 | .171842363E+00 | .174146195E+00 | .174305693E+00 |
| CO (MOLES) | .122137305E-01 | .246506215E-02 | .161230520E-03 | .173225181E-05 |
| NH3 (MOLES) | .923486822E-04 | .638536393E-05 | .890063567E-07 | .171033895E-09 |
| H (MOLES) | .866477142E-04 | .184915702E-04 | .474012854E-06 | .679180107E-09 |
| NO (MOLES) | .801445133E-02 | .176980531E-02 | .130267240E-03 | .205212262E-05 |
| N2 (MOLES) | .108936188E+01 | .109252718E+01 | .109335010E+01 | .109341425E+01 |
| OH (MOLES) | .164198690E-02 | .266686853E-02 | .535496669E-03 | .125353172E-04 |
| CH4 (MOLES) | .358014014E-09 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .185322461E+00 | .185322461E+00 | .185322461E+00 | .185322461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .131675233E+04 | .132478722E+04 | .132884479E+04 | .132944592E+04 |
| HEAT OF DETONATION (KJ/KG) | .550931092E+04 | .554292901E+04 | .555990594E+04 | .556242109E+04 |
| VOLUME OF GAS (LITRES/KG) | .818545541E+03 | .817426498E+03 | .816758969E+03 | .816653092E+03 |
| WEIGHT STRENGTH REL. LFB | .107871761E+01 | .108410121E+01 | .108679941E+01 | .108719824E+01 |

A FORTRAN BKK CALCULATION FOR THE EXPLOSIVE
PROJECT 54-73

THE COMPUTED CJ PRESSURE IS .6740967+18E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5123078+28E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .32139932+8E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .7940311783E+00 CC/3M OF EXPLOSIVE

THE COMPUTED GAMMA IS .2504146788E+01

THE VOLUME OF THE GAS IS .20459223+4E+02 CC/MOLE OF GAS AND THERE ARE .3648112468E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM

AL2O3 .25220680960E+00

SOL C .39205091484E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E | INTEGRATION CONSTANT | ENTHALPY OF FORMATION (CAL/MOLE) | COVOLUME |
|--------|-------------|------------------------|----------------------|----------------------------------|------------------|
| AL | 0 | .38323160000E-10 | .81697810000E-02 | -.17049470000E-05 | .13295770000E-09 |
| AL2O3 | 0 | .20169543531E-09 | .76900000000E+05 | .35000000000E+03 | .60743960000E-09 |
| H2O | 0 | .23525039836E+01 | .39248930000E-01 | -.79254210000E-05 | .19204530000E-09 |
| H2 | 0 | .93298317149E-03 | .74180846875E+03 | .13500000000E+04 | .16777610000E-09 |
| O2 | 0 | .36483859300E-01 | .42588420000E+02 | -.26391810000E-05 | .19015700000E-09 |
| CO2 | 0 | .14286580759E+00 | .13428283516E+04 | .25000000000E+03 | .27703000000E-09 |
| CO | 0 | .2689808347E-02 | .29703470000E+02 | -.57107000000E+05 | .18281810000E-09 |
| NH3 | 0 | .11800208739E-04 | .11758961576E+04 | -.22012220000E-05 | .21978010000E-09 |
| H | 0 | .35025201661E-04 | .47030900000E+02 | .18000000000E+03 | .13168230000E-09 |
| NO | 0 | .23199481609E-01 | .10353764740E+04 | -.25002170000E-05 | .18932130000E-09 |
| N2 | 0 | .10849082261E+01 | .47481120000E+02 | .35000000000E+03 | .17983220000E-09 |
| OH | 0 | .24816104856E-02 | .74628096875E+03 | -.37212960000E-05 | .16891550000E-09 |
| CH4 | 0 | .17231398257E-10 | .45330820000E+02 | .60000000000E+03 | .24707140000E-09 |
| AL2O3 | 0 | .18532246083E+00 | .11215883099E+04 | -.24164030000E-05 | .68057430000E-09 |
| SOL C | 0 | .25820438932E+03 | .42018160000E+02 | .39000000000E+03 | .93499950000E-10 |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 54-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .674096742E+01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .321399325E+04 | .238394010E+04 | .174027987E+04 | .124323160E+04 |
| VOLUME (CC/GRAM) | .794031199E+00 | .187907744E+01 | .733182844E+01 | .405445658E+02 |
| ENERGY (KCAL/KG) | .255431483E+03 | -.401011048E+03 | -.776085841E+03 | -.996100954E+03 |
| ENERGY (KJ/KG) | .106872904E+04 | -.167783906E+04 | -.32715445E+04 | -.416770088E+04 |
| GAMMA (-DLNP/DLNP) | .250602353E+01 | .196308300E+01 | .148078170E+01 | .125001503E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| AL G (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .201695431E-09 | .349352101E-09 | .221541593E-10 | .100000000E-10 |
| H2O (MOLES) | .235250398E+01 | .235168784E+01 | .235383332E+01 | .235467032E+01 |
| H2 (MOLES) | .932983172E-03 | .387782168E-03 | .195491349E-04 | .731625877E-07 |
| O2 (MOLES) | .364838593E-01 | .413029941E-01 | .454950937E-01 | .467722062E-01 |
| CO2 (MOLES) | .142865808E+00 | .145295467E+00 | .145550907E+00 | .145555616E+00 |
| CO (MOLES) | .268980841E-02 | .26014885E-03 | .470954236E-05 | .404489092E-09 |
| NH3 (MOLES) | .118002086E-04 | .305194414E-06 | .186232070E-09 | .100000000E-10 |
| H (MOLES) | .350252019E-04 | .497207846E-05 | .603254252E-07 | .240247107E-10 |
| NO (MOLES) | .231994816E-01 | .916053005E-02 | .192401415E-02 | .163062765E-03 |
| N2 (MOLES) | .108690823E+01 | .109393345E+01 | .109755186E+01 | .109843234E+01 |
| OH (MOLES) | .248161047E-02 | .526883422E-02 | .172017452E-02 | .851932786E-04 |
| CH4 (MOLES) | .172313981E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .185322461E+00 | .185322461E+00 | .185322461E+00 | .185322461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |
| HEAT OF DETONATION (KCAL/KG) | .127968332E+04 | .128376781E+04 | .128684861E+04 | .128776617E+04 |
| HEAT OF DETONATION (KJ/KG) | .535421363E+04 | .537131158E+04 | .538419329E+04 | .538803240E+04 |
| VOLUME OF GAS (LITRES/KG) | .817709844E+03 | .817528220E+03 | .81758660E+03 | .817164321E+03 |
| WEIGHT STRENGTH REL. LFB | .105270420E+01 | .105551825E+01 | .105761235E+01 | .105823370E+01 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 55-73

THE COMPUTED CJ PRESSURE IS .6491017605E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5033886876E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .3035836683E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .7948730241E+00 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2513473042E+01

THE VOLUME OF THE GAS IS .2046524960E+02 CC/MOLE OF GAS AND THERE ARE .3651151861E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
AL2O3 .2522068096E+00
SOL C .39296305761E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIF | NO OF MOLES | COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME |
|--------|-------------|--|
| AL | G | .1000000000E-10 |
| AL2O3 | | .81967733412E-10 |
| H2O | | .23114120794E+01 |
| H2 | | .27015851616E-03 |
| O2 | | .12309431231E+00 |
| CO2 | | .87554802979E-01 |
| CO | | .49719605382E-03 |
| NH3 | | .20780403626E-05 |
| H | | .11372871468E-04 |
| NO | | .34716817554E-01 |
| N2 | | .10913515992E+01 |
| OH | | .22414342117E-02 |
| CH4 | | .1000000000E-10 |
| AL2O3 | | .18532246097E+00 |
| SOL C | | 0. |

| COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME | COVOLUME |
|--|------------------|
| .38323160000E+02 | .17049470000E-05 |
| .81697810000E-02 | .13295770000E-09 |
| .96290084115E+03 | .3500000000E+03 |
| .65122380000E+02 | .60743960000E-09 |
| .74180846875E+03 | .19204530000E-09 |
| .42588420000E+02 | .16777610000E-09 |
| .13428283516E+04 | .1800000000E+03 |
| .29703470000E+02 | .2500000000E+03 |
| .11758961536E+04 | .22012220000E+05 |
| .47030900000E+02 | .1800000000E+03 |
| .10353764740E+04 | .25002170000E-05 |
| .47481120000E+02 | .3500000000E+03 |
| .74628096875E+03 | .37212960000E-05 |
| .45330820000E+02 | .6000000000E+03 |
| .11215883099E+04 | .24164030000E-05 |
| .42018160000E+02 | .3900000000E+03 |
| .12069612161E+04 | .31643300000E-05 |
| .26391100000E+02 | .4760000000E+03 |
| .79463161719E+03 | .16907400000E-05 |
| .48414980000E+02 | .7800000000E+02 |
| .12092497057E+04 | .24946000000E-05 |
| .43923400000E+02 | .3860000000E+03 |
| .11391613490E+04 | .23790050000E-05 |
| .42417920000E+02 | .3800000000E+03 |
| .11835175443E+04 | .22266590000E-05 |
| .38756860000E+02 | .4130000000E+03 |
| .10424279115E+04 | .37079570000E-05 |
| .51581910000E+01 | .5280000000E+03 |
| .12197106120E+04 | .44520860000E-01 |
| .24615190000E+00 | .39600000000E+06 |
| .25820438932E+03 | .71798550000E-02 |
| | 0. |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MHARS FOR
PROJECT 55-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MHARS) | .649101761E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .303583668E+04 | .226654666E+04 | .164804055E+04 | .116586928E+04 |
| VOLUME (CC/GHAM) | .794873021E+00 | .183828318E+01 | .706229432E+01 | .382778017E+02 |
| ENERGY (KCAL/KG) | .245307205E+03 | -.375734313E+03 | -.736155622E+03 | -.943679853E+03 |
| ENERGY (KJ/KG) | .102636891E+04 | -.157207783E+04 | -.308008583E+04 | -.394837023E+04 |
| GAMMA (-DLNP/DLNV) | .251751660E+01 | .198265024E+01 | .149920583E+01 | .126192927E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| AL G (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .819477320E-10 | .364116694E-09 | .100000000E-10 | .100000000E-10 |
| H2O (MOLES) | .231141208E+01 | .231041652E+01 | .231215794E+01 | .231278880E+01 |
| H2 (MOLES) | .270158516E-03 | .104919329E-03 | .413771213E-05 | .441614161E-09 |
| O2 (MOLES) | .123094312E+00 | .133076548E+00 | .139114343E+00 | .140534174E+00 |
| CO2 (MOLES) | .875548030E-01 | .880096328E-01 | .880514460E-01 | .880519994E-01 |
| CO (MOLES) | .497196055E-03 | .423663107E-04 | .553273475E-06 | .140457966E-09 |
| NH3 (MOLES) | .207804035E-05 | .511020410E-07 | .613072161E-10 | .100000000E-10 |
| H (MOLES) | .113728715E-04 | .141115737E-05 | .481385760E-09 | .100000000E-10 |
| NO (MOLES) | .347168175E-01 | .129554371E-01 | .237632093E-02 | .158691219E-03 |
| N2 (MOLES) | .109135160E+01 | .110223330E+01 | .110752289E+01 | .110863170E+01 |
| OH (MOLES) | .224143420E-02 | .457907081E-02 | .129936682E-02 | .459194920E-04 |
| CH4 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .185322461E+00 | .185322461E+00 | .185322461E+00 | .185322461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .119589218E+04 | .120022275E+04 | .120363469E+04 | .120451623E+04 |
| HEAT OF DETONATION (KJ/KG) | .500363028E+04 | .502174933E+04 | .503602507E+04 | .503971345E+04 |
| VOLUME OF GAS (LITRES/KG) | .818391083E+03 | .818451022E+03 | .818251023E+03 | .818180259E+03 |
| WEIGHT STRENGTH REL. LFB | .994407220E+00 | .997438832E+00 | .999778888E+00 | .100037974E+01 |

A FORTRAN 8KW CALCULATION FOR THE EXPLOSIVE
PROJECT SA-73

THE COMPUTED CJ PRESSURE IS .6754967911E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5112626279E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .3797440525E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .7920721326E+03 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2482629826E+01

THE VOLUME OF THE GAS IS .2095982748E+02 CC/MOLE OF GAS AND THERE ARE .3448117406E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
AL2O3 .2522068096E+00
SOL C .39474711282E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME |
|--------|------------------|--|
| AL G | .25992559967E-09 | .38323160000E+02 |
| AL2O3 | .17931067096E-06 | .81697810000E-05 |
| H2O | .20924825320E+01 | .76900000000E+05 |
| H2 | .14163263251E+00 | .35000000000E+03 |
| O2 | .46608698017E-04 | .79254210000E-05 |
| CO2 | .44593542273E-01 | .13500000000E+04 |
| CO | .12650667510E+00 | .13500000000E+04 |
| NH3 | .12608391382E-01 | .19204530000E-09 |
| H | .18185635157E-02 | .16777610000E-09 |
| NO | .14068615767E-02 | .19015700000E-09 |
| N2 | .10310945050E+01 | .27703000000E-09 |
| OH | .15376417260E-02 | .18281810000E-09 |
| CH4 | .34943162590E-03 | .21978010000E-09 |
| AL2O3 | .26949728156E+00 | .13168230000E-09 |
| SOL C | 0. | .18932130000E-09 |
| | | .17983220000E-09 |
| | | .16891550000E-09 |
| | | .24707140000E-09 |
| | | .68057430000E-09 |
| | | .93499950000E-10 |
| | | 0. |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 56-73

| | | | | |
|---------------------------|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .675496791E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .379744053E+04 | .280148900E+04 | .206571682E+04 | .151902989E+04 |
| VOLUME (CC/GRAH) | .792072157E+00 | .190616009E+01 | .782547998E+01 | .462114235E+02 |
| ENERGY (KCAL/KG) | .257543262E+03 | -.412949590E+03 | -.815067251E+03 | -.106670313E+04 |
| ENERGY (KJ/KG) | .107756475E+04 | -.172778709E+04 | -.341025324E+04 | -.446310141E+04 |
| GAMMA (-DLNP/DLNV) | .247251027E+01 | .19166969E+01 | .141725260E+01 | .123375506E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| AL G (MOLES) | .259925598E-09 | .357553649E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .179310652E-06 | .979305997E-06 | .610967199E-09 | .100000000E-10 |
| H2O (MOLES) | .209248253E+01 | .205816669E+01 | .203316877E+01 | .201223054E+01 |
| H2 (MOLES) | .141632633E+00 | .192919190E+00 | .221463428E+00 | .243008409E+00 |
| O2 (MOLES) | .466086982E-04 | .716352900E-05 | .629583407E-07 | .175933771E-10 |
| CO2 (MOLES) | .445935418E-01 | .794364142E-01 | .106294402E+00 | .127490466E+00 |
| CO (MOLES) | .120506676E+00 | .860463375E-01 | .591945404E-01 | .379986617E-01 |
| NH3 (MOLES) | .126083911E-01 | .208725614E-02 | .457696085E-03 | .161127185E-03 |
| H (MOLES) | .181856354E-02 | .629738928E-03 | .732777195E-04 | .218914426E-05 |
| NO (MOLES) | .140686158E-02 | .235249358E-03 | .592985863E-05 | .516497626E-09 |
| N2 (MOLES) | .103109451E+01 | .103694088E+01 | .103787032E+01 | .103802157E+01 |
| OH (MOLES) | .153764171E-02 | .187858151E-02 | .255837232E-03 | .387517822E-05 |
| CH4 (MOLES) | .389430615E-03 | .689626465E-05 | .705568894E-06 | .520486303E-06 |
| AL2O3 (MOLES) | .269697282E+00 | .269696482E+00 | .269697460E+00 | .269697461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .145949619E+04 | .146307211E+04 | .146697265E+04 | .146918661E+04 |
| HEAT OF DETONATION (KJ/KG) | .610655330E+04 | .612151501E+04 | .613783491E+04 | .614709815E+04 |
| VOLUME OF GAS (LITRES/KG) | .772881760E+03 | .775176524E+03 | .775272817E+03 | .775302490E+03 |
| WEIGHT STRENGTH REL. LFB | .116930433E+01 | .117224790E+01 | .117498676E+01 | .117653645E+01 |

A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 57-73

THE COMPUTED CJ PRESSURE IS .6813898417E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5144827616E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .3469921018E+04 DEGREES KELVIN

| THE COMPUTED C _J VOLUME | CC/GM OF EXPLOSIVE |
|------------------------------------|--------------------|
| .7933047346E+00 | |

THE COMPUTED GAMMA IS .2496137544E+01

THE VOLUME OF THE GAS IS .2061335780E+02 CC/MOLE OF GAS AND THERE ARE .3582224274E+01 MOLES OF GAS

| SOLID | VOLUME IN CC/GM |
|-------|------------------|
| AL203 | .25220680960E+00 |
| SOL C | .39287037346E+00 |

[illegible]

THE ISENTROPIC STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT C_J-PRESSURE* 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 57-73

| | | | | |
|---------------------------|-----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .681389842E+01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .346992102E+04 | .256316147E+04 | .187922219E+04 | .136054622E+04 |
| VOLUME (CC/GRAM) | .7933304750E+00 | .190193897E+01 | .759303935E+01 | .432529893E+02 |
| ENERGY (KCAL/KG) | .258786601E+03 | -.413428520E+03 | -.802812229E+03 | -.103789920E+04 |
| ENERGY (KJ/KG) | .108276691E+04 | -.172979094E+04 | -.335897805E+04 | -.434258536E+04 |
| GAMMA (-DLNP/DLNP) | .249228973E+01 | .193850698E+01 | .145295856E+01 | .123487129E+01 |

COMPOSITION OF THE
DETONATION PRODUCTS

| | | | | |
|---------------|----------------|----------------|----------------|----------------|
| AL G (MOLES) | .107254379E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .466194410E-09 | .527598020E-07 | .666634674E-09 | .100000000E-10 |
| H2O (MOLES) | .230166455E+01 | .227773398E+01 | .226305712E+01 | .225268976E+01 |
| H2 (MOLES) | .305673113E-01 | .565641702E-01 | .723135530E-01 | .828370133E-01 |
| O2 (MOLES) | .178480378E-03 | .120877563E-04 | .401651624E-07 | .100000000E-10 |
| CO2 (MOLES) | .107944067E+00 | .134055347E+00 | .150055446E+00 | .160531743E+00 |
| CO (MOLES) | .634184271E-01 | .373126361E-01 | .213126922E-01 | .108363864E-01 |
| NH3 (MOLES) | .172203983E-02 | .427159899E-03 | .116097732E-03 | .511384121E-04 |
| H (MOLES) | .396888234E-03 | .135826672E-03 | .115161697E-04 | .166389244E-06 |
| NO (MOLES) | .210331444E-02 | .215221494E-03 | .284876676E-05 | .226304758E-08 |
| N2 (MOLES) | .107306488E+01 | .107465637E+01 | .107491809E+01 | .107495199E+01 |
| OH (MOLES) | .115851440E-02 | .119359362E-02 | .106665770E-03 | .672982728E-06 |
| CH4 (MOLES) | .567227650E-05 | .183362903E-06 | .274068170E-07 | .368875188E-07 |
| AL2O3 (MOLES) | .213447461E+00 | .213447408E+00 | .213447460E+00 | .213447461E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |

| | | | | |
|------------------------------|----------------|----------------|----------------|----------------|
| HEAT OF DETONATION (KCAL/KG) | .136853123E+04 | .137271717E+04 | .137513787E+04 | .137621624E+04 |
| HEAT OF DETONATION (KJ/KG) | .572595460E+04 | .574346859E+04 | .575359686E+04 | .575810879E+04 |
| VOLUME OF GAS (LITRES/KG) | .802941260E+03 | .802959703E+03 | .802867235E+03 | .802868312E+03 |
| WEIGHT STRENGTH REL. LFB | .111176523E+01 | .111468784E+01 | .111635776E+01 | .111710996E+01 |

A FORTRAN BK* CALCULATION FOR THE EXPLOSIVE
PROJECT SR-73

THE COMPUTED CJ PRESSURE IS .6834883136E-01 MEGABARS

THE COMPUTED DETONATION VELOCITY IS .5169159656E+00 CM/MICROSECOND

THE COMPUTED CJ TEMPERATURE IS .3017637320E+04 DEGREES KELVIN

THE COMPUTED CJ VOLUME .7952276462E+00 CC/GM OF EXPLOSIVE

THE COMPUTED GAMMA IS .2517420133E+01

THE VOLUME OF THE GAS IS .2011161222E+02 CC/MOLE OF GAS AND THERE ARE .3753077083E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
AL2O3 .2522060000E+00
SOL C .39061307157E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E | INTEGRATION CONSTANT | ENTHALPY OF FORMATION (CAL/MOLE) | COVOLUME |
|--------|------------------|------------------------|----------------------|----------------------------------|-----------------|
| AL | G | .3823216000E+02 | .8169781000E+02 | -.1709470000E-05 | .1329577000E-09 |
| AL2O3 | .56800712739E-10 | .96290084115E+03 | .7690000000E+05 | .3500000000E+03 | -.0 |
| H2O | .24145650979E+01 | .6512238000E+02 | .3924893000E-01 | -.77925421000E-05 | .6074396000E-09 |
| H2 | .4229047086E-03 | .74180846875E+03 | -.2400000000E+06 | .1350000000E+04 | .1920453000E-09 |
| O2 | .38129158903E-01 | .4258842000E+02 | .1480805000E-01 | -.2639181000E-05 | .1677761000E-09 |
| CO2 | .17544859451E+00 | .13428283516E+04 | -.5710700000E+05 | .2500000000E+03 | .1901570000E-09 |
| CO | .15980854964E+02 | .2970347000E+02 | .1133829000E-01 | -.2201222000E+05 | .2770300000E-09 |
| NH3 | .46990431442E-05 | .11758961536E+04 | .0 | .1800000000E+03 | .1828181000E-09 |
| H | .12645195960E-04 | .4703090000E+02 | .1287147000E-01 | -.2500217000E-05 | .2197801000E-09 |
| N2 | .11024485259E+01 | .1035376470E+04 | .0 | .3500000000E+03 | .1316823000E-09 |
| OH | .14436625554E+02 | .4748112000E+02 | .1954463000E-01 | -.3721296000E+05 | .1893213000E-09 |
| CH4 | .1000000000E-10 | .74628096875E+03 | -.9396800000E+05 | .6000000000E+03 | .1798322000E-09 |
| AL2O3 | .15719745099E+00 | .4533082000E+02 | .1238161000E-01 | -.2416403000E-05 | .1689155000E-09 |
| SOL C | .0 | .11215883099E+04 | -.2720100000E+05 | .3900000000E+03 | .2470714000E-09 |
| | | .4201816000E+02 | .1911662000E-01 | -.3164330000E-05 | .6805743000E-09 |
| | | .2639110000E+02 | .8121376000E-02 | .4760000000E+03 | .9349995000E-10 |
| | | .79463161719E+03 | .5161900000E+05 | -.1690740000E-05 | |
| | | .4841498000E+02 | .1299386000E-01 | -.2494600000E-05 | |
| | | .12092497057E+04 | .2147700000E+05 | .3860000000E+03 | |
| | | .4392340000E+02 | .1222501000E-01 | -.2379005000E-05 | |
| | | .1139161340E+04 | .0 | .3800000000E+03 | |
| | | .4241792000E+02 | .1156847000E-01 | -.2226659000E-05 | |
| | | .1183517543E+04 | .3560000000E+04 | .4130000000E+03 | |
| | | .3875686000E+02 | .2364013000E-01 | -.3707957000E-05 | |
| | | .1042479115E+04 | -.1600000000E+05 | .5280000000E+03 | |
| | | .5158191000E+01 | .4520886000E-01 | -.8918970000E-05 | |
| | | .12197406120E+04 | -.3960000000E+06 | -.0 | |
| | | -.2461519000E+00 | .7179855000E-02 | -.1297550000E-05 | |
| | | -.25824438932E+03 | .0 | .0 | |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MHARS FOR
PROJECT 58-73

| | | | | |
|---|-----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .683488314E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .301763732E+04 | .222636489E+04 | .160891680E+04 | .112901757E+04 |
| VOLUME (CC/GRAM) | .795227749E+00 | .187932158E+01 | .715969787E+01 | .382529488E+02 |
| ENERGY (KCAL/KG) | .258189084E+03 | -.404113799E+03 | -.769613085E+03 | -.976835975E+03 |
| ENERGY (KJ/KG) | .107984484E+04 | -.169081801E+04 | -.322007226E+04 | -.408709593E+04 |
| GAMMA (-DLNP/DLNP) | .251624448E+01 | .198937097E+01 | .151096321E+01 | .128100800E+01 |
| COMPOSITION OF THE
DETONATION PRODUCTS | | | | |
| AL G (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .568007071E-10 | .123321558E-09 | .100000000E-10 | .100000000E-10 |
| H2O (MOLES) | .241456510E+01 | .241404606E+01 | .241532416E+01 | .241571193E+01 |
| H2 (MOLES) | .422904703E-03 | .151056398E-03 | .486553824E-05 | .414398668E-09 |
| O2 (MOLES) | .381291590E-01 | .428703587E-01 | .460979881E-01 | .468355461E-01 |
| CO2 (MOLES) | .1756448598E+00 | .177130778E+00 | .177245491E+00 | .177246684E+00 |
| CO (MOLES) | .159808554E-02 | .115905698E-03 | .119306071E-05 | .162337104E-09 |
| NH3 (MOLES) | .469004288E-05 | .925834069E-07 | .750339461E-10 | .100000000E-10 |
| H (MOLES) | .126851963E-04 | .136823861E-05 | .442580979E-09 | .100000000E-10 |
| NO (MOLES) | .188042331E-01 | .675178080E-02 | .116588700E-02 | .676136549E-04 |
| N2 (MOLES) | .110244853E+01 | .110847706E+01 | .111127005E+01 | .111181919E+01 |
| OH (MOLES) | .144366253E-02 | .305057439E-02 | .788390285E-03 | .225850020E-04 |
| CH4 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .157197441E+00 | .157197461E+00 | .157197461E+00 | .157197462E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |
| HEAT OF DETONATION (KCAL/KG) | | | | |
| | .122229972E+04 | .122552963E+04 | .122761702E+04 | .122810240E+04 |
| HEAT OF DETONATION (KJ/KG) | | | | |
| | .511411961E+04 | .512763379E+04 | .513636747E+04 | .513839831E+04 |
| VOLUME OF GAS (LITRES/KG) | | | | |
| | .841237343E+03 | .841129165E+03 | .840972936E+03 | .840929344E+03 |
| WEIGHT STRENGTH REL. LFH | | | | |
| | .101730180E+01 | .101953292E+01 | .102095790E+01 | .102128783E+01 |

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A FORTRAN BKW CALCULATION FOR THE EXPLOSIVE
PROJECT 59-73

THE COMPUTED CJ PRESSURE IS .6757399560E-01 MEGABARS
THE COMPUTED DETONATION VELOCITY IS .5165380966E+00 CM/MICROSECOND
THE COMPUTED CJ TEMPERATURE IS .2491228312E+04 DEGREES KELVIN
THE COMPUTED CJ VOLUME .7984431098E+00 CC/GM OF EXPLOSIVE
THE COMPUTED GAMMA IS .2553592512E+01

THE VOLUME OF THE GAS IS .1945563912E+02 CC/MOLE OF GAS AND THERE ARE .3960451582E+01 MOLES OF GAS

SOLID VOLUME IN CC/GM
AL2O3 .25220680960E+00
SOL C .38858634258E+00

THE C-J COMPOSITION OF THE DETONATION PRODUCTS AND THE INPUT COEFFICIENTS TO THE THERMODYNAMIC FITS FOR EACH SPECIE

| SPECIE | NO OF MOLES | COEFFICIENTS A,B,C,D,E, INTEGRATION CONSTANT, ENTHALPY OF FORMATION (CAL/MOLE), COVOLUME |
|--------|------------------|--|
| AL | G | |
| AL2O3 | .10000000000E-10 | .3823190000E+02 .8199781000E-02 .1704947000E-05 .1329577000E-09 0. |
| H2O | .24956623297E+01 | .96290084115E+03 .7690000000E+05 .3500000000E+03 .6074396000E-09 0. |
| H2 | .17048245491E-04 | .6512238000E+02 .3924893000E-01 .1350000000E+04 .1920453000E-09 0. |
| O2 | .13272209038E+00 | .74180846815E+03 .2400000000E+06 .2639181000E-05 .1677761000E-09 0. |
| CO2 | .18304456359E+00 | .4258842000E+02 .1480805000E-01 .2500000000E+03 .1901570000E-09 0. |
| CO | .80638507113E-04 | .13428283516E+04 .5710700000E+05 .2201222000E-05 .2770300000E-09 0. |
| NH3 | .84868466991E-07 | .2970347000E+02 .11758961536E+04 .1800000000E+03 .1828181000E-09 0. |
| H | .31934176740E-06 | .10353764740E+04 .1287147000E-01 .3500000000E+03 .2197801000E-09 0. |
| NO | .15740976918E-01 | .4748112000E+02 .1954463000E-01 .3721296000E+05 .1316823000E-09 0. |
| N2 | .11408578916E+01 | .4533082000E+02 .74628096875E+03 .6000000000E+03 .1893213000E-09 0. |
| OH | .32563063845E-03 | .11215883099E+04 .2720100000E+05 .3900000000E+03 .1798322000E-09 0. |
| CH4 | .10000000000E-10 | .4201816000E+02 .1911662000E-01 .4760000000E+03 .1689155000E-09 0. |
| AL2O3 | .10094746116E+00 | .12092497057E+04 .2147700000E+05 .3860000000E+03 .2470714000E-09 0. |
| SOL C | 0. | .4392340000E+02 .1222501000E-01 .3800000000E+03 .6805743000E-09 0. |
| | | .11391613490E+04 .1156847000E-01 .2226659000E+05 .9349995000E-10 0. |
| | | .4241792000E+02 .1183517543E+04 .3500000000E+03 .1297550000E-05 0. |
| | | .3875686000E+02 .2384013000E-01 .4130000000E+03 .1689155000E-09 0. |
| | | .10424279115E+04 .2984013000E-01 .3707957000E+05 .2470714000E-09 0. |
| | | .5158191000E+01 .4452086000E+05 .5280000000E+03 .6805743000E-09 0. |
| | | .12197606120E+04 .3960000000E+06 .8918897000E+05 .9349995000E-10 0. |
| | | .2461519000E+00 .7179855000E-02 .1297550000E-05 .1689155000E-09 0. |
| | | .25820438932E+03 .0. .0. .0. .0. |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MBARS FOR
PROJECT 59-73

| | | | | |
|---|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .675739956E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .249122831E+04 | .181409132E+04 | .125979205E+04 | .823645622E+03 |
| VOLUME (CC/GRAM) | .798443105E+00 | .183020865E+01 | .646789808E+01 | .306450592E+02 |
| ENERGY (KCAL/KG) | .252491108E+03 | -.379675196E+03 | -.706929807E+03 | -.871976146E+03 |
| ENERGY (KJ/KG) | .105642647E+04 | -.158856655E+04 | -.295780460E+04 | -.364836088E+04 |
| GAMMA (-DLNP/DLNV) | .255502296E+01 | .207785961E+01 | .161782885E+01 | .139399382E+01 |
| COMPOSITION OF THE
DETONATION PRODUCTS | | | | |
| AL O (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| H2O (MOLES) | .249566233E+01 | .249554699E+01 | .249581414E+01 | .249584241E+01 |
| H2 (MOLES) | .170482455E+04 | .331030112E-05 | .527505855E-09 | .100000000E-10 |
| O2 (MOLES) | .132722090E+00 | .138501342E+00 | .140453887E+00 | .140623301E+00 |
| CO2 (MOLES) | .183044564E+00 | .183123045E+00 | .183125202E+00 | .183125203E+00 |
| CO (MOLES) | .806385077E-04 | .215735724E-05 | .288879112E-09 | .100000000E-10 |
| NH3 (MOLES) | .848684661E-07 | .183845559E-09 | .100000000E-10 | .100000000E-10 |
| H (MOLES) | .319341770E-06 | .486610921E-09 | .100000000E-10 | .100000000E-10 |
| NO (MOLES) | .157409769E-01 | .396060739E-02 | .313882797E-03 | .332528155E-05 |
| N2 (MOLES) | .114085789E+01 | .114674812E+01 | .114857148E+01 | .114872676E+01 |
| OH (MOLES) | .325630637E-03 | .584350498E-03 | .566819409E-04 | .135147448E-06 |
| CH4 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .100947461E+00 | .100947461E+00 | .100947461E+00 | .100947462E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |
| HEAT OF DETONATION (KCAL/KG) | | | | |
| | .102191264E+04 | .102442020E+04 | .102537619E+04 | .102546105E+04 |
| HEAT OF DETONATION (KJ/KG) | | | | |
| | .427569737E+04 | .428618900E+04 | .429018889E+04 | .429054395E+04 |
| VOLUME OF GAS (LITRES/KG) | | | | |
| | .889512546E+03 | .88951660E+03 | .889486479E+03 | .889483310E+03 |
| WEIGHT STRENGTH REL. LFB | | | | |
| | .887030453E+00 | .888779965E+00 | .889440595E+00 | .889499150E+00 |

THE ISENTROPE STATE VARIABLES, ENERGIES AND DETONATION
PRODUCTS AT CJ-PRESSURE, 0.1, 0.01, 0.001 AND 0.0001 MHARS FOR
PROJECT 62-73

| | | | | |
|---|----------------|-----------------|-----------------|-----------------|
| PRESSURE (MBARS) | .819849819E-01 | .100000000E-01 | .100000000E-02 | .100000000E-03 |
| TEMPERATURE (DEG. KELVIN) | .268802250E+04 | .193337984E+04 | .138400790E+04 | .951153500E+03 |
| VOLUME (CC/GRAM) | .724749202E+00 | .179590167E+01 | .656479217E+01 | .333415703E+02 |
| ENERGY (KCAL/KG) | .269676989E+03 | -.448389603E+03 | -.782109343E+03 | -.961800715E+03 |
| ENERGY (KJ/KG) | .112833245E+04 | -.187606862E+04 | -.327235687E+04 | -.402418819E+04 |
| GAMMA (-DLNP/DLNV) | .263906800E+01 | .204397783E+01 | .156308594E+01 | .129604397E+01 |
| COMPOSITION OF THE
DETONATION PRODUCTS | | | | |
| AL G (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .100000000E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| H2O (MOLES) | .266374952E+01 | .266385752E+01 | .266426629E+01 | .266429605E+01 |
| H2 (MOLES) | .472595828E-03 | .337239611E-03 | .218619113E-04 | .779273700E-07 |
| O2 (MOLES) | .663120009E-03 | .131275365E-03 | .632497559E-05 | .251333433E-07 |
| CO2 (MOLES) | .156182290E+00 | .158270784E+00 | .158458240E+00 | .158461293E+00 |
| CO (MOLES) | .227900466E-02 | .190511527E-03 | .305484212E-05 | .223146431E-08 |
| NH3 (MOLES) | .129933240E-04 | .490385485E-06 | .150628684E-08 | .100000000E-10 |
| H (MOLES) | .325175967E-05 | .311472400E-06 | .103438965E-08 | .100000000E-10 |
| NO (MOLES) | .139355567E-02 | .165597036E-03 | .427320312E-05 | .770584924E-08 |
| N2 (MOLES) | .993310614E+00 | .993930845E+00 | .994011751E+00 | .994013885E+00 |
| OH (MOLES) | .105844432E-03 | .200991205E-03 | .159929520E-04 | .417064252E-07 |
| CH4 (MOLES) | .682319568E-10 | .100000000E-10 | .100000000E-10 | .100000000E-10 |
| AL2O3 (MOLES) | .168474965E+00 | .168474965E+00 | .168474965E+00 | .168474965E+00 |
| SOL C (MOLES) | 0. | 0. | 0. | 0. |
| HEAT OF DETONATION (KCAL/KG) | .115704606E+04 | .115876285E+04 | .115916279E+04 | .115918331E+04 |
| HEAT OF DETONATION (KJ/KG) | .484109755E+04 | .484828063E+04 | .484995399E+04 | .485003985E+04 |
| VOLUME OF GAS (LITRES/KG) | .855828157E+03 | .85584462E+03 | .855517716E+03 | .855514039E+03 |
| WEIGHT STRENGTH REL. LFB | .974659034E+00 | .975808431E+00 | .976074237E+00 | .976087826E+00 |