Energy, Mines and Resources Canada

Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

Mining Research Laboratories

Laboratoires de recherche minière

[redacted]

Canada

CALCULATION OF THE REDUCED SECOND VIRIAL COEFFICIENT AND ITS DERIVATIVES

D.E.G. Jones

MRL 90-066 (OP) JUNE 1990

Presented at the Canadian Chemical Conference, Halifax, Nova Scotia July 16-20, 1990

CALCULATION OF REDUCED SECOND VIRIAL COEFFICIENT AND ITS DERIVATIVES

by

D.E.G. Jones*

ABSTRACT

For a given potential energy function applicable to a particular, non-quantum, gaseous component, both the potential function parameters and the thermodynamic properties of that component can be calculated. The former are obtained by comparison of B^*, the reduced second virial coefficient with experimental values of the second virial coefficient and the latter by determination of the first and second derivatives, B_1^* and B_2^* of B^*, with respect to the reduced temperature, T^*. This report will discuss numerical methods for determining B^*, B_1^* and B_2^* as a function of T^* for simple angle independent, potential energy functions.

---

*Research Scientist, Canadian Explosives Research Laboratory, Mining Research Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa.

KEYWORDS:
Second, virial, coefficient, potential, energy, functions, derivatives, reduced, TIGER, code, numerical, integration, differentiation

TABLE OF CONTENTS

INTRODUCTION

Prediction of both the detonation parameters and products of an explosive composition requires knowledge of certain fundamental properties of the possible components in the detonation products. A thermohydrodynamic treatment may be used for the predictive process and the treatment embodied in a computer code, such as TIGER (1). In such codes, a potential energy function (PEF) or equation of state (EOS) is selected to (i) describe the intermolecular interactions of the components and (ii) aid in determining the thermodynamic functions of the components (2).

For simple, angle-independent, non-quantum components, the PEF is expressed as

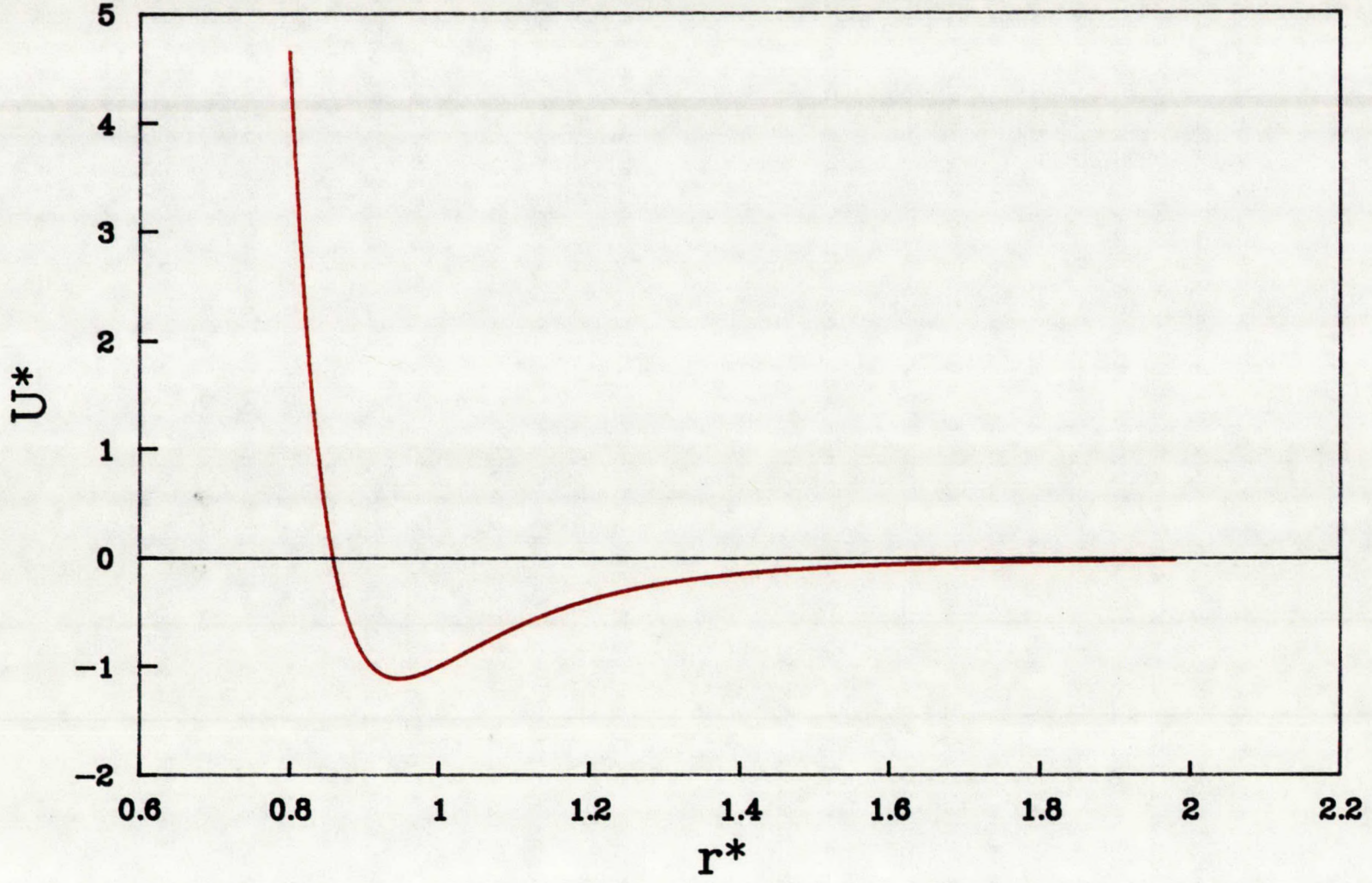
$$U^* = U^* (r^*) \qquad [1]$$

where $U^* (= U/\epsilon)$, is the reduced potential energy, relative to the depth of the potential energy well, ϵ. The term r^* is the reduced distance, r/σ (or r/r_m), where σ is the distance at which $U = 0$ and r_m is the distance at which $U = \epsilon$ (Figure 1).

In the two parameter relation for U^*, there is an "attractive term" and a "repulsive term", the latter term increasing rapidly as $r^* \rightarrow 0$ (3). The parameters, ϵ and σ (or r_m) are determined by comparing an experimental quantity to a predicted quantity obtained from a particular PEF. For example, the experimental second virial coefficient, B_e may be compared with the reduced second virial coefficient, B^* $(=B/2\pi N_A \sigma^3 (r_m^3))$ obtained from (3)

Figure 1

Reduced Potential Function U* vs Reduced Radial Distance r*



$$B^* = -(1/T^*) \int_0^\infty r^{*3} \{d[U^*(r^*)]/dr^*\} f \, dr^* \qquad [2]$$

or

$$B^* = 3 \int_0^\infty r^{*2}(1-f)dr^* \qquad [3]$$

where N_A is Avogadro's constant,

$f = \exp\{-U^*/T^*\}$ and $T^* = kT/\epsilon$.

The PEF parameters may be determined analytically if the form of $U^*(r^*)$ allows integration of either [2] or [3]. Conversely, more complex forms of $U^*(r^*)$ do not permit analytical integration of [2] and [3] and, in these cases, B^* may generally be obtained by numerical integration.

In an earlier report (4), an analytical expression was obtained for B^* for the Lennard-Jones PEF(5) and the results calculated from this expression compared with those obtained previously (6). Additionally, a numerical technique was used to determine B^* both for the Lennard-Jones and the modified Buckingham (exp-6) PEF. These results were compared, respectively, with those obtained analytically and those found in the literature (6).

In a later report (7) analytical expressions for B_1^* ($T^* \, dB^*/dT^*$) and B_2^* ($T^{*2} \, d^2B^*/dT^{*2}$) for the Lennard-Jones PEF were derived and used to calculate B_1^* and B_2^*. It was demonstrated that the numerical technique previously used (4) is capable of significantly improving the accuracy of the B^* values previously reported. Moreover, the accuracy in B_1^* and B_2^* determined by the numerical differentiation of B^* values is significantly improved as a result. This has been clearly demonstrated for B_1^* over the published results in reference (9). For many PEFs, values of B_2^*

The thermodynamic functions of the components are directly related to B^*, B_1^*, and B_2^*, as illustrated by the following:

$$\text{(i)} \quad \mu C_p^\circ/b = B_1^* - B^* \qquad [4]$$

where μ is the Joule - Thomson coefficient and b is the collision diameter, which is proportional to σ^3,

$$\text{(ii)} \quad (C_p - C_p^\circ)/R = -B_2^*/V^* \qquad [5]$$

where $V^* = V/b$ and V is the molar volume of the component, and, for the speed of sound, c

$$\text{(iii)} \quad c^2 = L[1 + \{2B^* + 2(\delta^\circ - 1)B_1^* + (\delta^\circ - 1)^2 B_2^*/\delta^\circ\}/V^*] \qquad [6]$$

where $\delta^\circ = C_p^\circ/C_v^\circ$, $L = \delta^\circ RT/M$ and M is the molar mass. The superscript "°" refers to the ideal gas state.

This report is intended to assess the utility of the numerical techniques previously employed (4) (7), in determining B^*, B_1^* and B_2^* for different PEFs. The results will be compared with those obtained previously, when available. Additionally, the results will be determined using a series of different constants in each PEF. Finally the calculated values of B^*, B_1^*, $B_1^* - B^*$ and B_2^* for a series of PEFs will be compared.

POTENTIAL ENERGY FUNCTIONS

Table 1 presents the various PEFs studied in this report, along with their properties. A comparison of these PEFs is shown in Figure 2. The results for B^* obtained by numerical integration of [2] and/or [3] and subsequent numerical differentiation to obtain B_1^* and B_2^* are listed in the Appendix. Figure 3 shows the variation of the integrand of [3] with r^*. As expected the

integrand reduces to r^{*3} at small values of r^* since, in the repulsive region, U^* is very large and hence f is negligibly small.

For each PEF, calculations have been performed using a range of values of n. In the Tables in the Appendix, only calculations for m = 6 have been shown, since there are theoretical grounds for assuming a reciprocal 6th power dependence of the attractive term in $U^*(r^*)$ (3). The numerical techniques are not, however, restricted to this particular case.

TABLE 1

POTENTIAL ENERGY FUNCTIONS AND THEIR PROPERTIES

PEF	U^*	σ/r_m determined from	$d[U^*(r^*)]/dr^*$	Reference
Morse [1]	$[1-\exp\{n(1-r^*)/2\}]^2$	$1 - \ln 2/n$	$-n[U^*(r^*)+\exp\{n(1-r^*)/2\}]$	(8)
Lennard [2] - Jones	$f(n,m)\{1/r^{*n}-1/r^{*m}\}$	$(n/m)^{(1/(n-m))}$	$f(n,m)\{m/r^{*m} - n/r^{*n}\}/r^*$	(5)(6)
exp-6 [1]	$[m\exp\{f(r^*)\}/n-1/r^{*m}]/A$	$n(1-\sigma/r_m)=\ln(n/m)$ $-m\ln(\sigma/r_m)$	$m[1/r^{*(m+1)}-n \exp\{f(r^*)\}]/A$	(6)(9)
Bae [1]	$m\{(1/r^*)^n\ln(1/r^*)\}-1/r^{*m}$	$\ln(r_m/\sigma)=(\sigma/r_m)^{n-m}/m$	$m[1-\{n\ln(1/r^*)+1\}/r^{*(n-m)}]$	(10)(11)
Carra [1] -Konowalow	$[mg(r^*)/n-1]/Ar^{*m}$	$1-\ln(n/m)/(n-m)$	$m[\{1-mg(r^*)/n\}/r^*-Ag(r^*)]/Ar^{*m}$	(12)
Patel -Viswanath -Seshadri	$2.1336/r^{*18}+0.7296/r^{*12}$ $-2.8632/r^{*6}$	K	$-6(2.1336x3/r^{*18}+0.7296x2/r^{*12}$ $-2.8632/r^{*6})/r^*$	(13)

$f(r^*) = n(1-r^*)$

$A = 1-m/n$

$g(r^*) = \exp\{Af(r^*)\}$

$f(n,m) = (n/m)^{m/(n-m)}n/(n-m)$

[1] $r^* = r/\sigma$

[2] $r^* = r/r_m$

K constant (13)

Figure 2

Comparison of Potential Functions

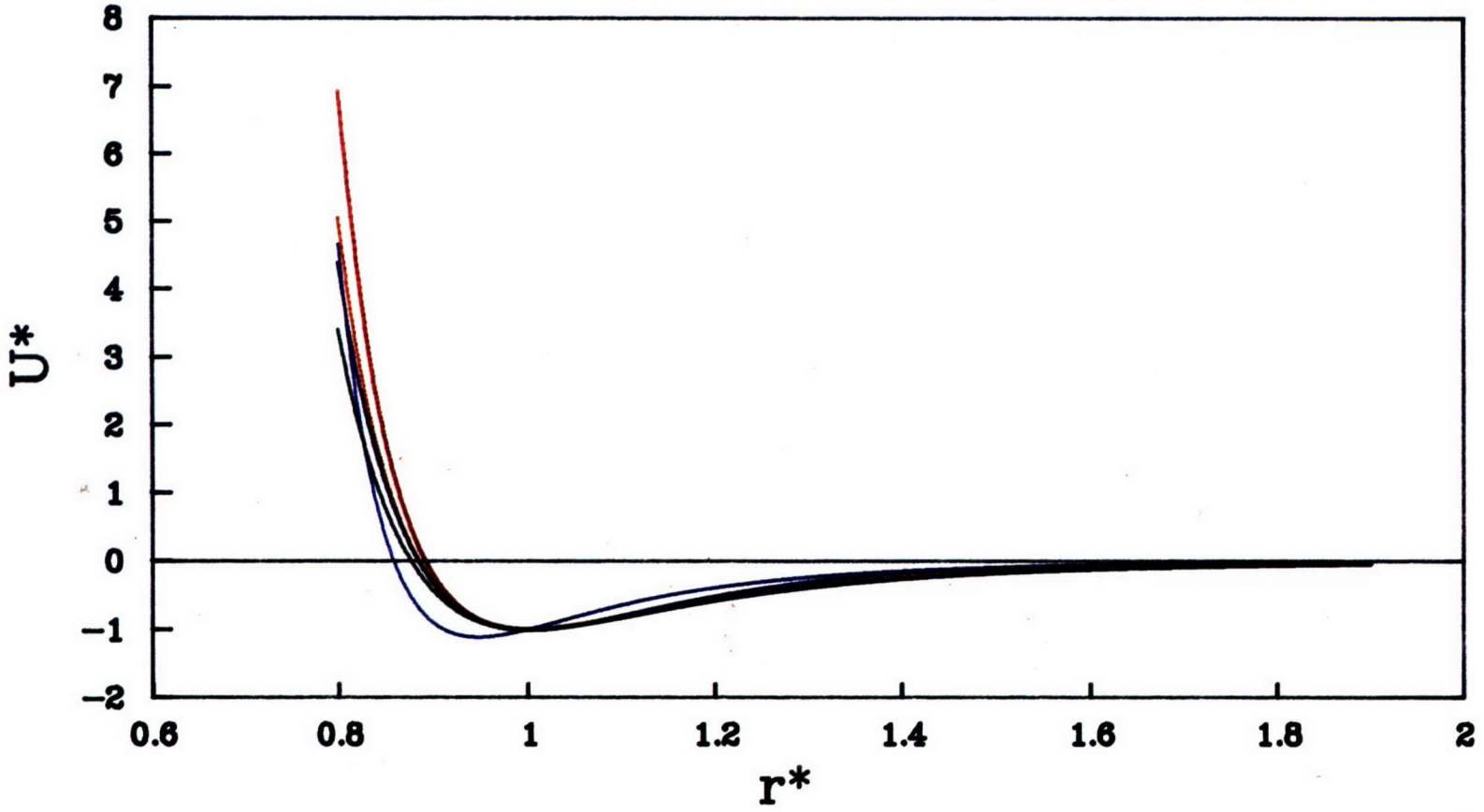
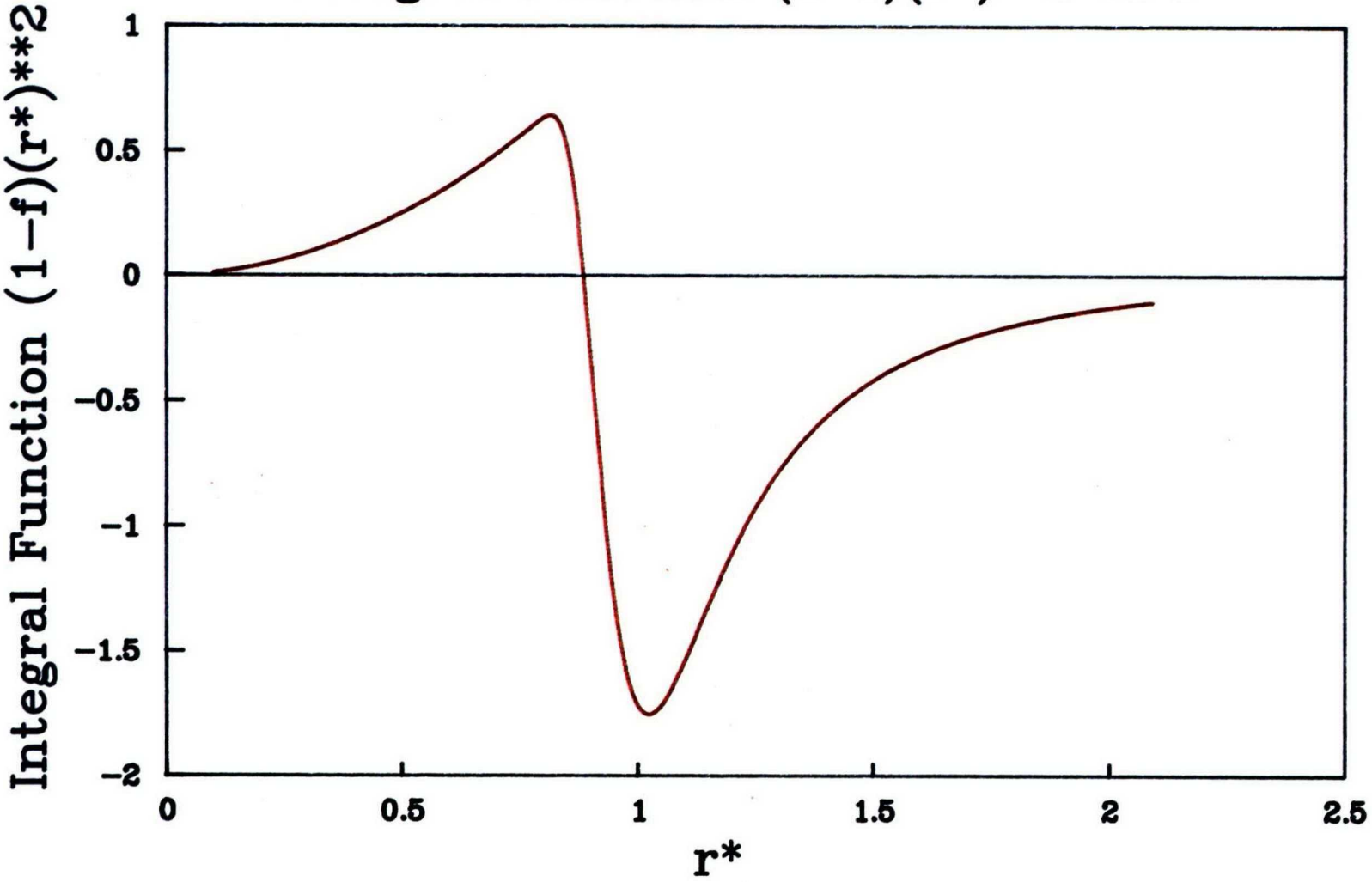


Figure 3


Integral Function (1−f)(r*)**2 vs r*
Integral Function (1−f)(r*)**2
1
0.5
0
−0.5
−1
−1.5
−2
0
0.5
1
1.5
2
2.5
r*

Morse PEF

Tables 1 to 7 in the Appendix present B^*, B_1^*, $B_1^* - B^*$ and B_2^* for the Morse PEF for a series of values of n. No comparable calculations have been found in the literature. It is known that the Morse PEF is not, on its own, a suitable choice to represent even the simplest component (3). The Morse PEF has, however, been used in spline function form combined with other PEFs to represent inert gas data (3).

Table 2 shows the variation in B^*, B_1^*, and B_2^* with n at $T^* = 0.4$.

TABLE 2

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF $T^* = 0.4$

n	B^*	B_1^*	$B_1^* - B^*$	B_2^*
10.0	-10.0206850982	23.112449	33.133134	-91.52606
10.5	-9.3967454982	21.847849	31.244595	-86.62704
11.0	-8.8392780775	20.714056	29.553334	-82.23897
11.5	-8.3382591859	19.691840	28.030099	-78.27171
12.0	-7.8855728948	18.765551	26.651124	-74.66513
12.5	-7.4745800651	17.922327	25.396907	-71.34914
13.0	-7.0997986443	17.151498	24.251297	-68.34369
13.5	-6.7566632152	16.444146	23.200809	-65.56868
14.0	-6.4413418728	15.792753	22.234095	-63.02408

$$B_1^* = T^* dB^*/dT^* \qquad B_2^* = T^{*2} d^2B^*/dT^{*2}$$

Lennard-Jones PEF

Values of B^*, B_1^*, and B_2^* determined both analytically and numerically have been given elsewhere (7). These results have been discussed and compared with results published previously (6).

Modified Buckingham PEF (exp-6)

Results for B^*, B_1^*, and B_2^* for the exp-6 PEF have been published in Reference (7) and compared with the results from (6) and (9) for B^* and B_1^* respectively.

Bae PEF

Tables 8 to 12 in the Appendix list B^*, B_1^*, $B_1^* - B^*$ and B_2^* for the Bae PEF for a series of n values. Table 3 shows a comparison of the results at $T^* = 0.4$. Results for B^* and B_1^* for the particular case n = 12 have been published previously (11) and are compared with those calculated here in Table 4.

TABLE 3

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
BAE PEF $T^* = 0.4$

n	B^*	B_1^*	$B_1^* - B^*$	B_2^*
10.0	-8.3716596649	18.962283	27.333943	-73.62912
10.5	-8.0426643024	18.287813	26.330477	-70.98433
11.0	-7.7589160876	17.697890	25.456806	-68.67017
11.5	-7.5115440324	17.177073	24.688617	-66.60652
12.0	-7.2938574564	16.713516	24.007373	-64.75329
12.5	-7.1007168787	16.297978	23.398695	-63.09041
13.0	-6.9281098961	15.923135	22.851245	-61.57782
13.5	-6.7728584973	15.583107	22.355965	-60.20547
14.0	-6.6324128204	15.273114	21.905527	-58.93334

$$B_1^* = T^* dB^*/dT^* \qquad B_2^* = T^{*2} d^2B^*/dT^{*2}$$

TABLE 4

COMPARISON OF B^* AND B_1^* VALUES WITH LITERATURE RESULTS

BAE PEF n = 12.0

T^*	B^*		B_1^*	
	Calculated	Reference 11	Calculated	Reference 11
0.4	-7.2938574564	-7.29384	16.713516	16.71348
1.0	-1.1402514745	-1.14025	2.377808	2.37779
2.0	-0.1216342117	-0.12163	0.860193	0.86019
3.0	0.1472985217	0.14730	0.500040	0.50004
4.0	0.2667108723	0.26671	0.339793	0.33979
5.0	0.3319702015	0.33197	0.249130	0.24913
10.0	0.4380269640	0.43803	0.078674	0.07867
100.0	0.4001828688	0.40018	-0.057254	-0.05725

$$B_1^* = T^* dB^*/dT^*$$

Carra - Konowalow PEF

Table 13 in the Appendix lists B^*, B_1^*, and B_2^* values for the Carra - Konowalow PEF and n = 12. Results of B^* have been published (12) and are compared with B^* values calculated here in Table 5. Note that the results published by Carra and Konowalow are consistently more negative than those obtained in this work.

It was found that numerical integration of equation [2] and [3] resulted in virtually identical results. Additionally, integration using some of the procedures described by Press, Flannery, Teukolsky and Vetterling (13) gave results consistent with the calculations in Table 13 in the Appendix. Table 6 compares the results determined at $T^* = 1.0$. Therefore, it appears that the results published by Carra and Konwalow (12) are erroneous but the source of this error is presently unknown.

TABLE 5

COMPARISON OF B^* VALUES WITH LITERATURE RESULTS
CARRA - KONOWALOW PEF n = 12.0

T^*	B^* Calculated	B^* Reference 12
.40	-10.0516014047	-10.2374
1.00	-1.8644250812	-1.9386
2.00	-0.4847648106	-0.5218
3.00	-0.1161220537	-0.1408
4.00	0.0493472601	0.0308
5.00	0.1408621222	0.1260
10.00	0.2952691330	0.2879
100.00	0.2900445126	0.2893

TABLE 6

COMPARISON OF B* VALUES FOR CARRA - KONOWALOW

PEF AT $T^* = 1.0$

SOURCE	B^*
Reference 12	-1.9386
This work	-1.8644251
Reference 13	
Trapezoid	-1.86543
Romberg	-1.8644251
Gauss-Legendre	-1.8644231

Patel - Viswanath - Seshadri (PVS) PEF

The PVS PEF (14) is a three term function in which the constants of the equation are dependant on the constant, K in

$$r_m = K\sigma$$

For K = 1.10, the constants are as given in column 2 of Table 1 and the PVS PEF reduces to the Lennard-Jones PEF when K = 1.12. It has been found that this PEF reproduces experimental data as well as more complex, five-term functions and significantly better than the Lennard-Jones PEF. Additionally, there is sufficient flexibility by using different values of K to allow the PVS PEF to fit B_e over a wide temperature range.

Table 14 in the Appendix lists B^*, B_1^*, and B_2^* for the Patel-Viswarath-Seshardi PEF. The calculated values of B^* are compared with the published values (14) in Table 7.

TABLE 7

COMPARISON OF B^* VALUES WITH LITERATURE RESULTS

PATEL-VISWANATH-SESHARDI PEF

T^*	B^*	
	Calculated	Reference 14
.40	-11.0490754014	-11.04975
1.00	-1.8977744900	-1.89783
2.00	-.3341733072	-0.33419
3.00	.0863992156	0.08638
4.00	.2759701054	0.27596
5.00	.3811980264	0.38119
10.00	.5602536017	0.56025
100.00	.5585630945	0.55856

CONCLUSIONS

The results obtained in this report clearly indicate that the numerical techniques used give both accurate and precise values for B^*, B_1^*, and B_2^* for angle independent PEFs. For the most part, these results agree with published results, where available, and are believed to be more precise. The only exception where agreement was not obtained was the Carra - Konowalow PEF, for which the literature results appear to be in error. For many PEFs, the results for B_1^* and B_2^* determined here are the first values reported.

Table 8 gives a comparison of the reduced second virial coefficient parameters for the PEFs examined. The thermodynamic functions given by [4] and [5] may be obtained directly from this data.

Further effort will be extended toward testing these numerical techniques on other, more current PEFs, and, in particular angle dependent PEFs. Additionally, values of B_e will be used to determine σ (or r_m) and ϵ and these parameters used in the TIGER code.

TABLE 8

COMPARISON OF REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS FOR DIFFERENT PEFs AT $T^* = 0.4$ AND $n = 12.0$

PEF	$-B^*$	B_1^*	$B_1^* - B^*$	$-B_2^*$
Morse	7.8855728948	18.765551	26.651124	74.66513
Lennard -Jones	13.7988347340	30.267080	44.065915	116.38405
exp-6	10.34807767778	22.756451	33.104528	87.93689
Bae	7.2938574564	16.713516	24.007373	64.75329
Carra -Konowalow	10.0516014047	22.071463	32.123065	85.02227
Patel -Viswanath -Seshardi	11.0490754014	24.516616	35.565692	93.91788

$$B_1^* = T^* dB^*/dT^* \qquad B_2^* = T^{*2} d^2B^*/dT^{*2}$$

References

1. Cowperthwaite, M. and Zisler, W.H. "TIGER computer program documentation". SIR Publication No. Z 106; 1973.
2. Cowperthwaite, M. and Zisler, W.H. "JCZ equations of state for detonation products and their incorporation into the TIGER Code"; Proc. Sixth Symposium Detonation; Office of Naval Research; 1976.
3. Rigby, M., Smith, E.B., Wakeham, W.A. and Maitland, G.C., "The Forces Between Molecules"; Clarendon Press, Oxford; 1986.
4. Jones, D.E.G. and Triebe, R. "Fundamental information for TIGER Code calculations(2) Determination of Potential energy function parameters"; CANMET ACEA/MRL-87-130(OP), October 1987.
5. Jones, J.E., "On the determination of molecular fields - II. From the equation of state of a gas"; Proc. Roy. Soc. (London); A106; 463; 1924.
6. Hirschfelder, J.O., Curtiss, C.F. and Bird, R.B. "Molecular theory of gases and liquids"; John Wiley and Sons, New York, 1959.
7. Jones, D.E.G. "Calculation of the reduced second virial coefficient and its derivatives" CANMET ACEA/MRL 89-30 (TR), March 1989.
8. Moelwyn - Hughes, "Physical Chemistry", Pergamon Press, New York, 1961.
9. Xiong, W. and Jian, S. "Calculation of derivative of second virial coefficient based on the exp-6 intermolecular potential"; Propellants, explosives, pyrotechnics; 13; 48, 1988.
10. Bae, J.H. "A simple intermolecular potential energy function for nonpolar molecules"; Chemical Physics letters; 4; 139, 1969.

11. Bae, J.H. "Second virial coefficients from a two-parameter intermolecular potential"; Z Phys. Chemie, Leipzig; Z47; 17, 1971.

12. Carra, S. and Konowalow, D.D. "An improved intermolecular potential function"; Il. Nuovo Cimento; 34; 205, 1964.

13. Press, W.H., Flannery, B.P., Teukolsky, S.A. and Vetterling, W.T. "Numerical Recipes: The art of scientific computing" Cambridge University Press, New York, 1987.

14. Patel, H.R., Viswanath, D.S. and Seshardri, D.N. " A new three term potential energy function"; Proceedings Symposium Thermophysical Properties; 197; 1973.

APPENDIX

TABLE 1

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 8.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-13.4888427873	30.062583	43.551426	-118.17585
.45	-10.4802457013	21.616191	32.096436	-79.44988
.50	-8.4889300113	16.481647	24.970577	-57.30314
.55	-7.0862769616	13.116755	20.203032	-43.52236
.60	-6.0508352142	10.781799	16.832634	-34.39514
.65	-5.2581349546	9.087389	14.345524	-28.02710
.70	-4.6334395495	7.812977	12.446417	-23.39973
.75	-4.1294285662	6.826050	10.955478	-19.93304
.80	-3.7148087786	6.043031	9.757839	-17.26098
.85	-3.3681222614	5.409027	8.777149	-15.15039
.90	-3.0741977859	4.886725	7.960923	-13.45181
.95	-2.8220244280	4.450002	7.272026	-12.06111
1.00	-2.6034278550	4.080099	6.683527	-10.90798
1.05	-2.4122186453	3.763241	6.175460	-9.93815
1.10	-2.2436282929	3.489115	5.732744	-9.11060
1.15	-2.0939261223	3.249860	5.343786	-8.40024
1.20	-1.9601531616	3.039394	4.999547	-7.78519
1.25	-1.8399335128	2.852944	4.692877	-7.24635
1.30	-1.7313382203	2.686717	4.418055	-6.77277
1.35	-1.6327854117	2.537666	4.170451	-6.35226
1.40	-1.5429659584	2.403314	3.946280	-5.97955
1.45	-1.4607873841	2.281634	3.742422	-5.64349
1.50	-1.3853310179	2.170948	3.556279	-5.33957
1.55	-1.3158188940	2.069855	3.385674	-5.06674
1.60	-1.2515879132	1.977182	3.228770	-4.81847
1.65	-1.1920694779	1.891937	3.084006	-4.59208
1.70	-1.1367732992	1.813274	2.950047	-4.38540
1.75	-1.0852744127	1.740471	2.825745	-4.19188
1.80	-1.0372026878	1.672905	2.710107	-4.01792
1.85	-.9922342908	1.610038	2.602273	-3.85514
1.90	-.9500846899	1.551403	2.501488	-3.70779
1.95	-.9105028884	1.496593	2.407096	-3.56346
2.00	-.8732666418	1.445247	2.318514	-3.43370
2.10	-.8050623075	1.351731	2.156793	-3.19791
2.20	-.7441323892	1.268744	2.012877	-2.99147
2.30	-.6893999109	1.194619	1.884019	-2.80829
2.40	-.6399891699	1.128020	1.768009	-2.64408
2.50	-.5951809482	1.067864	1.663045	-2.49813
2.60	-.5543791532	1.013266	1.567645	-2.36633
2.70	-.5170856284	.963494	1.480580	-2.24742
2.80	-.4828808942	.917940	1.400821	-2.13968
2.90	-.4514092537	.876094	1.327503	-2.04064
3.00	-.4223671525	.837521	1.259889	-1.95000

3.10	-.3954939935	.801856	1.197350	-1.86571
3.20	-.3705648238	.768783	1.139348	-1.78865
3.30	-.3473844636	.738030	1.085415	-1.71706
3.40	-.3257827564	.709364	1.035147	-1.65071
3.50	-.3056106987	.682579	.988190	-1.58898
3.60	-.2867372651	.657498	.944236	-1.53127
3.70	-.2690467872	.633964	.903011	-1.47773
3.80	-.2524367775	.611839	.864275	-1.42709
3.90	-.2368161123	.591000	.827816	-1.38014
4.00	-.2221035060	.571339	.793442	-1.33557
4.10	-.2082262247	.552760	.760986	-1.29330
4.20	-.1951189962	.535176	.730295	-1.25376
4.30	-.1827230814	.518510	.701233	-1.21617
4.40	-.1709854817	.502692	.673677	-1.18079
4.50	-.1598582578	.487659	.647517	-1.14705
4.60	-.1492979438	.473355	.622653	-1.11519
4.70	-.1392650400	.459729	.598994	-1.08498
4.80	-.1297235735	.446733	.576456	-1.05605
4.90	-.1206407156	.434325	.554966	-1.02817
5.00	-.1119864474	.422467	.534453	-1.00195
6.00	-.0439280175	.327568	.371496	-.79309
7.00	.0013541397	.261924	.260570	-.65010
8.00	.0330399062	.213904	.180864	-.54616
9.00	.0560304004	.177317	.121286	-.46710
10.00	.0731671194	.148565	.075398	-.40501
20.00	.1282531418	.026842	-.101411	-.13938
30.00	.1312937225	-.008709	-.140003	-.05726
40.00	.1263991872	-.024210	-.150610	-.01835
50.00	.1200507968	-.032175	-.152226	.00315
60.00	.1137553669	-.036605	-.150360	.01711
70.00	.1079036976	-.039150	-.147053	.02450
80.00	.1025720123	-.040600	-.143172	.03360
90.00	.0977399764	-.041377	-.139117	.03645
100.00	.0933595197	-.041723	-.135083	.03987
200.00	.0651901717	-.038168	-.103358	.04877
300.00	.0506551850	-.033331	-.083986	.04767
400.00	.0416259162	-.029404	-.071030	.04318

$B_1^* = T^* dB^*/dT^*$ $\qquad$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 2

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 9.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-11.5213825700	26.135793	37.657176	-103.17767
.45	-8.9082802165	18.754582	27.662862	-69.22544
.50	-7.1820593821	14.274210	21.456269	-49.85243
.55	-5.9681966390	11.342008	17.310205	-37.81929
.60	-5.0734675965	9.309831	14.383299	-29.84256
.65	-4.3894122242	7.836815	12.226227	-24.28245
.70	-3.8509869834	6.730071	10.581058	-20.25309
.75	-3.4170557073	5.873806	9.290862	-17.24035
.80	-3.0604436088	5.195048	8.255491	-14.91139
.85	-2.7625350779	4.645904	7.408439	-13.07985
.90	-2.5101804669	4.193846	6.704026	-11.60458
.95	-2.2938441707	3.816114	6.109958	-10.39566
1.00	-2.1064527146	3.496377	5.602830	-9.39522
1.05	-1.9426541853	3.222650	5.165304	-8.55342
1.10	-1.7983281726	2.985964	4.784293	-7.83675
1.15	-1.6702531384	2.779489	4.449742	-7.22294
1.20	-1.5558754910	2.597941	4.153817	-6.68967
1.25	-1.4531460104	2.437178	3.890324	-6.22370
1.30	-1.3604018678	2.293909	3.654311	-5.81459
1.35	-1.2762801316	2.165489	3.441769	-5.45226
1.40	-1.1996534116	2.049775	3.249428	-5.12806
1.45	-1.1295813261	1.945007	3.074588	-4.83786
1.50	-1.0652734472	1.849731	2.915005	-4.57730
1.55	-1.0060606885	1.762738	2.768799	-4.34291
1.60	-.9513729801	1.683011	2.634384	-4.12721
1.65	-.9007216806	1.609691	2.510413	-3.93181
1.70	-.8536855977	1.542047	2.395733	-3.74955
1.75	-.8098997837	1.479455	2.289355	-3.58699
1.80	-.7690464863	1.421376	2.190423	-3.43670
1.85	-.7308477870	1.367347	2.098195	-3.29681
1.90	-.6950595712	1.316963	2.012023	-3.16626
1.95	-.6614665596	1.269871	1.931338	-3.04771
2.00	-.6298781876	1.225764	1.855642	-2.93367
2.10	-.5720566242	1.145445	1.717502	-2.73038
2.20	-.5204472325	1.074186	1.594633	-2.55291
2.30	-.4741276089	1.010549	1.484676	-2.39562
2.40	-.4323480874	.953382	1.385730	-2.25467
2.50	-.3944932368	.901752	1.296245	-2.12935
2.60	-.3600531983	.854898	1.214952	-2.01614
2.70	-.3286020510	.812190	1.140793	-1.91424
2.80	-.2997812797	.773105	1.072886	-1.82136
2.90	-.2732869929	.737202	1.010489	-1.73534
3.00	-.2488599385	.704110	.952970	-1.65838

3.10	-.2262776277	.673512	.899790	-1.58579
3.20	-.2053480664	.645139	.850487	-1.51931
3.30	-.1859047243	.618757	.804662	-1.45813
3.40	-.1678024660	.594165	.761967	-1.40156
3.50	-.1509142368	.571186	.722100	-1.34886
3.60	-.1351283446	.549669	.684797	-1.29894
3.70	-.1203462167	.529478	.649824	-1.25285
3.80	-.1064805376	.510494	.616975	-1.21011
3.90	-.0934536944	.492614	.586068	-1.16985
4.00	-.0811964728	.475744	.556941	-1.13155
4.10	-.0696469566	.459801	.529448	-1.09491
4.20	-.0587495961	.444711	.503461	-1.06102
4.30	-.0484544146	.430408	.478863	-1.02882
4.40	-.0387163310	.416832	.455548	-.99854
4.50	-.0294945784	.403929	.433424	-.96971
4.60	-.0207522028	.391650	.412403	-.94232
4.70	-.0124556310	.379952	.392408	-.91639
4.80	-.0045742950	.368795	.373369	-.89159
4.90	.0029196950	.358141	.355221	-.86804
5.00	.0100518347	.347958	.337906	-.84553
6.00	.0657899959	.266427	.200637	-.66621
7.00	.1023773637	.209968	.107590	-.54375
8.00	.1275828125	.168618	.041035	-.45463
9.00	.1455436761	.137076	-.008468	-.38699
10.00	.1586523797	.112259	-.046393	-.33371
20.00	.1949897524	.006689	-.188301	-.10488
30.00	.1908399306	-.024453	-.215293	-.03341
40.00	.1816988021	-.038133	-.219832	.00005
50.00	.1723508946	-.045200	-.217550	.02002
60.00	.1637279672	-.049144	-.212872	.03241
70.00	.1559660820	-.051412	-.207378	.03920
80.00	.1490084564	-.052701	-.201709	.04480
90.00	.1427570851	-.053383	-.196141	.05062
100.00	.1371147103	-.053675	-.190790	.05227
200.00	.1006846377	-.050104	-.150788	.06037
300.00	.0813123351	-.045231	-.126544	.05847
400.00	.0688780956	-.041154	-.110032	.05598

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 3

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 10.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-10.0206850982	23.112449	33.133134	-91.52606
.45	-7.7116370991	16.558151	24.269788	-61.32443
.50	-6.1886291490	12.584397	18.773026	-44.11116
.55	-5.1191249914	9.986561	15.105686	-33.42699
.60	-4.3317581515	8.187899	12.519657	-26.34531
.65	-3.7304396479	6.885323	10.615763	-21.42958
.70	-3.2576014315	5.907452	9.165054	-17.86126
.75	-2.8768682854	5.151470	8.028338	-15.17934
.80	-2.5642308404	4.552623	7.116854	-13.12199
.85	-2.3032548177	4.068443	6.371698	-11.49714
.90	-2.0823398980	3.670097	5.752437	-10.19688
.95	-1.8930797191	3.337428	5.230508	-9.12740
1.00	-1.7292424422	3.055976	4.785218	-8.24753
1.05	-1.5861157557	2.815136	4.401252	-7.50366
1.10	-1.4600736996	2.606976	4.067050	-6.87228
1.15	-1.3482828056	2.425457	3.773740	-6.33005
1.20	-1.2484981968	2.265911	3.514409	-5.85970
1.25	-1.1589192285	2.124678	3.283598	-5.45012
1.30	-1.0780854179	1.998854	3.076939	-5.08883
1.35	-1.0048001812	1.886103	2.890904	-4.77100
1.40	-.9380741172	1.784535	2.722609	-4.48607
1.45	-.8770822513	1.692598	2.569680	-4.23069
1.50	-.8211314057	1.609011	2.430142	-4.00067
1.55	-.7696350128	1.532706	2.302341	-3.79178
1.60	-.7220934706	1.462788	2.184881	-3.60395
1.65	-.6780786718	1.398500	2.076579	-3.43321
1.70	-.6372217106	1.339200	1.976422	-3.27627
1.75	-.5992030342	1.284338	1.883541	-3.13140
1.80	-.5637444895	1.233438	1.797183	-3.00130
1.85	-.5306028562	1.186095	1.716697	-2.87538
1.90	-.4995645511	1.141950	1.641515	-2.76236
1.95	-.4704412650	1.100696	1.571137	-2.65556
2.00	-.4430663458	1.062060	1.505126	-2.55615
2.10	-.3929856881	.991714	1.384700	-2.37930
2.20	-.3483194678	.929314	1.277633	-2.22375
2.30	-.3082617811	.873595	1.181857	-2.08560
2.40	-.2721578969	.823548	1.095706	-1.96261
2.50	-.2394705159	.778353	1.017823	-1.85245
2.60	-.2097546617	.737341	.947096	-1.75450
2.70	-.1826387368	.699961	.882600	-1.66490
2.80	-.1578100506	.665753	.823563	-1.58222
2.90	-.1350036343	.634331	.769335	-1.50741
3.00	-.1139935070	.605370	.719363	-1.43967

3.10	-.0945857873	.578592	.673178	-1.37651
3.20	-.0766132131	.553760	.630373	-1.31884
3.30	-.0599307438	.530671	.590602	-1.26508
3.40	-.0444120058	.509148	.553560	-1.21543
3.50	-.0299463962	.489036	.518982	-1.16938
3.60	-.0164367094	.470203	.486639	-1.12591
3.70	-.0037971778	.452529	.456326	-1.08582
3.80	.0080481531	.435912	.427864	-1.04801
3.90	.0191667823	.420260	.401093	-1.01241
4.00	.0296188909	.405491	.375872	-.97874
4.10	.0394583024	.391533	.352074	-.94728
4.20	.0487332952	.378320	.329587	-.91768
4.30	.0574872946	.365796	.308309	-.88967
4.40	.0657594638	.353907	.288148	-.86301
4.50	.0735852105	.342607	.269022	-.83770
4.60	.0809966236	.331853	.250856	-.81389
4.70	.0880228505	.321606	.233583	-.79115
4.80	.0946904239	.311832	.217141	-.76946
4.90	.1010235467	.302498	.201475	-.74888
5.00	.1070443396	.293576	.186532	-.72927
6.00	.1538187400	.222102	.068283	-.57238
7.00	.1841226947	.172552	-.011571	-.46539
8.00	.2046759915	.136219	-.068457	-.38749
9.00	.2190494559	.108469	-.110581	-.32818
10.00	.2293032196	.086609	-.142695	-.28150
20.00	.2526717534	-.006871	-.259542	-.08058
30.00	.2437470244	-.034778	-.278525	-.01744
40.00	.2318367390	-.047173	-.279010	.01285
50.00	.2205430160	-.053650	-.274193	.02940
60.00	.2104075338	-.057312	-.267720	.04051
70.00	.2013975861	-.059452	-.260849	.04778
80.00	.1933700243	-.060695	-.254065	.05440
90.00	.1861772416	-.061380	-.247558	.05669
100.00	.1796909895	-.061701	-.241392	.05987
200.00	.1375276362	-.058693	-.196221	.06797
300.00	.1145891270	-.054226	-.168815	.06567
400.00	.0995319230	-.050384	-.149916	.06558

$B_1^* = T^* dB^*/dT^*$ $\quad B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 4

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 11.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-8.8392780775	20.714056	29.553334	-82.23897
.45	-6.7711406934	14.820189	21.591330	-55.03456
.50	-5.4087571331	11.250262	16.659019	-39.54872
.55	-4.4531200068	8.918476	13.371596	-29.93678
.60	-3.7502843356	7.305315	11.055599	-23.58640
.65	-3.2140041368	6.137942	9.351946	-19.15575
.70	-2.7926497455	5.262162	8.054811	-15.95956
.75	-2.4536224269	4.585525	7.039147	-13.55586
.80	-2.1754203181	4.049837	6.225257	-11.71032
.85	-1.9433349629	3.616948	5.560283	-10.25771
.90	-1.7469904426	3.260973	5.007963	-9.08895
.95	-1.5788718733	2.963819	4.542691	-8.13671
1.00	-1.4334111956	2.712519	4.145930	-7.34487
1.05	-1.3064000828	2.497560	3.803960	-6.67999
1.10	-1.1946018568	2.311834	3.506436	-6.11507
1.15	-1.0954883380	2.149931	3.245419	-5.63061
1.20	-1.0070573331	2.007667	3.014725	-5.21156
1.25	-.9277034707	1.881768	2.809472	-4.84552
1.30	-.8561251220	1.769633	2.625758	-4.52364
1.35	-.7912562183	1.669173	2.460430	-4.23898
1.40	-.7322155606	1.578697	2.310912	-3.98375
1.45	-.6782686210	1.496815	2.175084	-3.75757
1.50	-.6287983992	1.422385	2.051183	-3.55202
1.55	-.5832829350	1.354450	1.937733	-3.36829
1.60	-.5412777731	1.292213	1.833491	-3.19911
1.65	-.5024021582	1.234996	1.737398	-3.04521
1.70	-.4663280683	1.182224	1.648552	-2.90596
1.75	-.4327714312	1.133408	1.566179	-2.77536
1.80	-.4014850330	1.088124	1.489609	-2.65702
1.85	-.3722527538	1.046007	1.418260	-2.54808
1.90	-.3448848477	1.006741	1.351625	-2.44872
1.95	-.3192140556	.970048	1.289262	-2.35134
2.00	-.2950923830	.935687	1.230780	-2.26363
2.10	-.2509850704	.873132	1.124117	-2.10717
2.20	-.2116724937	.817650	1.029323	-1.96866
2.30	-.1764395318	.768115	.944554	-1.84541
2.40	-.1447053934	.723625	.868330	-1.73564
2.50	-.1159936020	.683451	.799444	-1.63868
2.60	-.0899096670	.646997	.736907	-1.55033
2.70	-.0661242424	.613773	.679897	-1.47097
2.80	-.0443602636	.583369	.627729	-1.39797
2.90	-.0243830109	.555441	.579824	-1.33248
3.00	-.0059923499	.529701	.535693	-1.27045

3.10	.0109833847	.505901	.494917	-1.21504
3.20	.0266922556	.483830	.457138	-1.16369
3.30	.0412626259	.463308	.422045	-1.11615
3.40	.0548063143	.444176	.389370	-1.07207
3.50	.0674211641	.426300	.358878	-1.03033
3.60	.0791931495	.409558	.330365	-.99242
3.70	.0901981123	.393846	.303648	-.95678
3.80	.1005032043	.379073	.278570	-.92310
3.90	.1101680894	.365157	.254989	-.89149
4.00	.1192459532	.352026	.232780	-.86153
4.10	.1277843533	.339614	.211829	-.83349
4.20	.1358259400	.327864	.192038	-.80719
4.30	.1434090691	.316726	.173317	-.78218
4.40	.1505683251	.306152	.155584	-.75869
4.50	.1573349709	.296100	.138765	-.73656
4.60	.1637373336	.286534	.122797	-.71509
4.70	.1698011390	.277418	.107617	-.69505
4.80	.1755498011	.268722	.093172	-.67571
4.90	.1810046737	.260417	.079412	-.65749
5.00	.1861852708	.252477	.066292	-.63989
6.00	.2262076290	.188840	-.037368	-.50062
7.00	.2518122534	.144674	-.107138	-.40566
8.00	.2689111911	.112252	-.156660	-.33647
9.00	.2806400548	.087459	-.193181	-.28370
10.00	.2888042595	.067904	-.220900	-.24240
20.00	.3029588883	-.016151	-.319110	-.06308
30.00	.2908313530	-.041557	-.332388	-.00619
40.00	.2771234566	-.052981	-.330105	.02125
50.00	.2645857621	-.059032	-.323618	.03690
60.00	.2534878174	-.062509	-.315997	.04681
70.00	.2436826674	-.064584	-.308267	.05390
80.00	.2349702847	-.065828	-.300798	.05760
90.00	.2271711852	-.066549	-.293720	.06074
100.00	.2201376193	-.066926	-.287064	.06447
200.00	.1741269525	-.064646	-.238773	.07277
300.00	.1486647321	-.060722	-.209387	.07287
400.00	.1316843252	-.057253	-.188938	.07038

$B_1^* = T^* dB^*/dT^*$ $\qquad$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 5

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 12.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-7.8855728948	18.765551	26.651124	-74.66513
.45	-6.0129570423	13.411258	19.424215	-49.90737
.50	-4.7806719184	10.170719	14.951391	-35.84222
.55	-3.9170998626	8.055620	11.972720	-27.10950
.60	-3.2825050784	6.593342	9.875847	-21.34255
.65	-2.7986580359	5.535803	8.334462	-17.32992
.70	-2.4187590567	4.742868	7.161627	-14.42056
.75	-2.1132772599	4.130553	6.243830	-12.24469
.80	-1.8627454860	3.646017	5.508763	-10.57074
.85	-1.6538542393	3.254635	4.908489	-9.25677
.90	-1.4772191574	2.932920	4.410139	-8.19774
.95	-1.3260466626	2.664465	3.990512	-7.33333
1.00	-1.1953053279	2.437510	3.632816	-6.61975
1.05	-1.0811939611	2.243438	3.324632	-6.01761
1.10	-.9807901349	2.075807	3.056597	-5.50689
1.15	-.8918119529	1.929716	2.821528	-5.06925
1.20	-.8124528782	1.801378	2.613831	-4.69036
1.25	-.7412648810	1.687829	2.429094	-4.35910
1.30	-.6770742595	1.586715	2.263789	-4.06938
1.35	-.6189199954	1.496147	2.115067	-3.81063
1.40	-.5660079392	1.414592	1.980600	-3.58312
1.45	-.5176762941	1.340799	1.858475	-3.37644
1.50	-.4733692904	1.273729	1.747099	-3.19339
1.55	-.4326168766	1.212523	1.645140	-3.02440
1.60	-.3950188881	1.156457	1.551476	-2.87428
1.65	-.3602325853	1.104919	1.465152	-2.73550
1.70	-.3279627579	1.057391	1.385354	-2.60971
1.75	-.2979537989	1.013430	1.311384	-2.49205
1.80	-.2699833085	.972653	1.242637	-2.38970
1.85	-.2438568948	.934733	1.178590	-2.28710
1.90	-.2194039185	.899381	1.118785	-2.19601
1.95	-.1964739878	.866349	1.062823	-2.11129
2.00	-.1749340547	.835418	1.010352	-2.03112
2.10	-.1355645838	.779112	.914677	-1.88885
2.20	-.1004953105	.729178	.829673	-1.76438
2.30	-.0690837582	.684599	.753682	-1.65389
2.40	-.0408082759	.644563	.685371	-1.55476
2.50	-.0152410155	.608413	.623654	-1.46679
2.60	.0079721660	.575612	.567640	-1.38740
2.70	.0291268608	.545717	.516590	-1.31641
2.80	.0484716819	.518360	.469889	-1.25135
2.90	.0662172007	.493232	.427015	-1.19118
3.00	.0825429240	.470071	.387528	-1.13635

3.10	.0976027931	.448656	.351053	-1.08625
3.20	.1115295576	.428797	.317267	-1.03977
3.30	.1244382829	.410329	.285891	-.99716
3.40	.1364291856	.393113	.256684	-.95791
3.50	.1475899412	.377026	.229436	-.92099
3.60	.1579975756	.361959	.203961	-.88646
3.70	.1677200255	.347818	.180098	-.85444
3.80	.1768174326	.334522	.157704	-.82417
3.90	.1853432239	.321996	.136652	-.79566
4.00	.1933450171	.310175	.116830	-.76873
4.10	.2008653843	.299001	.098136	-.74323
4.20	.2079424984	.288423	.080481	-.71975
4.30	.2146106832	.278395	.063784	-.69735
4.40	.2209008828	.268873	.047972	-.67628
4.50	.2268410647	.259822	.032981	-.65606
4.60	.2324565663	.251206	.018750	-.63706
4.70	.2377703944	.242996	.005226	-.61897
4.80	.2428034854	.235163	-.007640	-.60154
4.90	.2475749305	.227682	-.019893	-.58530
5.00	.2521021729	.220529	-.031573	-.56957
6.00	.2868933735	.163169	-.123724	-.44406
7.00	.3088838783	.123319	-.185565	-.35871
8.00	.3233462281	.094032	-.229315	-.29660
9.00	.3330721707	.071611	-.261461	-.24920
10.00	.3396662814	.053907	-.285759	-.21190
20.00	.3471337443	-.022571	-.369705	-.04988
30.00	.3328534889	-.045967	-.378820	.00146
40.00	.3179989420	-.056617	-.374616	.02685
50.00	.3046907999	-.062336	-.367026	.04127
60.00	.2930045957	-.065677	-.358681	.04951
70.00	.2827149341	-.067713	-.350428	.05758
80.00	.2735841660	-.068972	-.342556	.06080
90.00	.2654124612	-.069736	-.335149	.06479
100.00	.2580400284	-.070174	-.328214	.06707
200.00	.2095515705	-.068623	-.278174	.07517
300.00	.1823655016	-.065255	-.247620	.07647
400.00	.1640230747	-.062188	-.226211	.07358

$B_1^* = T^* dB^*/dT^*$ $\quad B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 6

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 13.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-7.0997986443	17.151498	24.251297	-68.34369
.45	-5.3890039226	12.246288	17.635292	-45.65066
.50	-4.2642080754	9.279522	13.543730	-32.76642
.55	-3.4765873884	7.344298	10.820885	-24.77261
.60	-2.8982153508	6.007129	8.905344	-19.48768
.65	-2.4575167900	5.040568	7.498085	-15.81686
.70	-2.1116968356	4.316189	6.427886	-13.15603
.75	-1.8337657032	3.757057	5.590823	-11.16425
.80	-1.6059399679	3.314783	4.920723	-9.63443
.85	-1.4160667671	2.957667	4.373734	-8.43290
.90	-1.2555808704	2.664219	3.919800	-7.46452
.95	-1.1182841275	2.419427	3.537711	-6.67437
1.00	-.9995877824	2.212536	3.212124	-6.02215
1.05	-.8960262719	2.035668	2.931694	-5.47377
1.10	-.8049360695	1.882933	2.687869	-5.00839
1.15	-.7242380683	1.749854	2.474093	-4.60792
1.20	-.6522867485	1.632972	2.285259	-4.26367
1.25	-.5877635018	1.529579	2.117342	-3.96059
1.30	-.5295998027	1.437523	1.967123	-3.69751
1.35	-.4769209639	1.355083	1.832004	-3.46202
1.40	-.4290043425	1.280859	1.709863	-3.25355
1.45	-.3852478637	1.213707	1.598955	-3.06628
1.50	-.3451460169	1.152682	1.497828	-2.89663
1.55	-.3082713436	1.096998	1.405270	-2.74658
1.60	-.2742600084	1.045996	1.320256	-2.60865
1.65	-.2428004445	.999119	1.241919	-2.48365
1.70	-.2136243381	.955893	1.169517	-2.36584
1.75	-.1864994096	.915914	1.102413	-2.26235
1.80	-.1612235884	.878834	1.040057	-2.16491
1.85	-.1376202789	.844353	.981973	-2.07532
1.90	-.1155344868	.812210	.927745	-1.99293
1.95	-.0948296285	.782179	.877008	-1.91402
2.00	-.0753848886	.754058	.829443	-1.84361
2.10	-.0398584908	.702873	.742732	-1.71198
2.20	-.0082288985	.657484	.665713	-1.59738
2.30	.0200869672	.616965	.596878	-1.49781
2.40	.0455624200	.580577	.535015	-1.40844
2.50	.0685855770	.547722	.479137	-1.32866
2.60	.0894776275	.517912	.428435	-1.25625
2.70	.1085066042	.490743	.382237	-1.19174
2.80	.1258978976	.465881	.339983	-1.13296
2.90	.1418423744	.443044	.301201	-1.07848
3.00	.1565027148	.421995	.265492	-1.02744

3.10	.1700184056	.402531	.232513	-.98197
3.20	.1825097118	.384482	.201972	-.93966
3.30	.1940808600	.367697	.173616	-.90105
3.40	.2048226124	.352049	.147226	-.86513
3.50	.2148143608	.337425	.122611	-.83187
3.60	.2241258428	.323729	.099603	-.80027
3.70	.2328185579	.310874	.078056	-.77093
3.80	.2409469408	.298786	.057839	-.74403
3.90	.2485593418	.287398	.038838	-.71808
4.00	.2556988478	.276650	.020951	-.69352
4.10	.2624039745	.266490	.004086	-.67041
4.20	.2687092529	.256871	-.011839	-.64896
4.30	.2746457277	.247750	-.026895	-.62869
4.40	.2802413829	.239091	-.041151	-.60936
4.50	.2855215071	.230858	-.054664	-.59113
4.60	.2905090077	.223021	-.067488	-.57397
4.70	.2952246824	.215552	-.079673	-.55725
4.80	.2996874542	.208426	-.091262	-.54163
4.90	.3039145763	.201619	-.102296	-.52692
5.00	.3079218105	.195110	-.112812	-.51269
6.00	.3385648274	.142892	-.195673	-.39851
7.00	.3577106928	.106578	-.251132	-.32102
8.00	.3701139971	.079863	-.290251	-.26460
9.00	.3782885072	.059390	-.318899	-.22149
10.00	.3836767476	.043206	-.340471	-.18750
20.00	.3862076664	-.027032	-.413239	-.04008
30.00	.3704915422	-.048763	-.419254	.00731
40.00	.3549336787	-.058771	-.413705	.03045
50.00	.3411785046	-.064216	-.405395	.04377
60.00	.3291609028	-.067447	-.396608	.05311
70.00	.3186012352	-.069455	-.388057	.06003
80.00	.3092371387	-.070730	-.379967	.06240
90.00	.3008561209	-.071536	-.372392	.06479
100.00	.2932912986	-.072029	-.365320	.06837
200.00	.2433109039	-.071142	-.314453	.07677
300.00	.2149993681	-.068295	-.283294	.07647
400.00	.1957269149	-.065614	-.261341	.07678

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 7

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
MORSE PEF n = 14.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-6.4413418728	15.792753	22.234095	-63.02408
.45	-4.8666704844	11.267127	16.133798	-42.06150
.50	-3.8321603294	8.531494	12.363654	-30.17616
.55	-3.1082523754	6.747969	9.856221	-22.80201
.60	-2.5769896143	5.516208	8.093197	-17.92455
.65	-2.1724086775	4.626231	6.798639	-14.54470
.70	-1.8550888136	3.959517	5.814606	-12.09245
.75	-1.6001792583	3.445085	5.045265	-10.25403
.80	-1.3913127451	3.038307	4.429620	-8.84857
.85	-1.2173084990	2.709956	3.927264	-7.74091
.90	-1.0702892436	2.440221	3.510510	-6.85081
.95	-.9445565776	2.215270	3.159827	-6.12600
1.00	-.8358930594	2.025195	2.861088	-5.52706
1.05	-.7411144948	1.862739	2.603854	-5.01886
1.10	-.6577742880	1.722479	2.380253	-4.59159
1.15	-.5839631639	1.600292	2.184256	-4.22513
1.20	-.5181703896	1.492996	2.011166	-3.90720
1.25	-.4591856473	1.398097	1.857283	-3.62947
1.30	-.4060283806	1.313618	1.719646	-3.38692
1.35	-.3578960799	1.237973	1.595869	-3.17037
1.40	-.3141258658	1.169875	1.484001	-2.97911
1.45	-.2741655595	1.108274	1.382439	-2.80607
1.50	-.2375516274	1.052299	1.289851	-2.65192
1.55	-.2038921734	1.001228	1.205120	-2.51381
1.60	-.1728536864	.954456	1.127310	-2.38463
1.65	-.1441506121	.911469	1.055620	-2.27263
1.70	-.1175370752	.871834	.989371	-2.16714
1.75	-.0928002515	.835179	.927979	-2.06901
1.80	-.0697550214	.801184	.870939	-1.97859
1.85	-.0482396250	.769574	.817813	-1.89776
1.90	-.0281121069	.740109	.768221	-1.81919
1.95	-.0092473894	.712580	.721828	-1.75003
2.00	.0084651520	.686805	.678340	-1.68110
2.10	.0408157291	.639891	.599076	-1.56423
2.20	.0696045664	.598292	.528688	-1.45943
2.30	.0953653012	.561159	.465793	-1.36714
2.40	.1185310254	.527812	.409281	-1.28632
2.50	.1394568069	.497704	.358247	-1.21239
2.60	.1584364312	.470386	.311950	-1.14740
2.70	.1757150202	.445490	.269775	-1.08676
2.80	.1914986636	.422706	.231208	-1.03182
2.90	.2059618563	.401779	.195817	-.98260
3.00	.2192533007	.382489	.163236	-.93923
3.10	.2315004799	.364653	.133152	-.89547

3.30	.2532869697	.332728	.079441	-.82154
3.40	.2630044258	.318386	.055382	-.78854
3.50	.2720381801	.304983	.032945	-.75775
3.60	.2804519243	.292429	.011977	-.72898
3.70	.2883018187	.280646	-.007656	-.70213
3.80	.2956375660	.269565	-.026073	-.67688
3.90	.3025033077	.259125	-.043379	-.65343
4.00	.3089383750	.249271	-.059668	-.63152
4.10	.3149779220	.239955	-.075023	-.60999
4.20	.3206534622	.231135	-.089518	-.59041
4.30	.3259933237	.222772	-.103221	-.57183
4.40	.3310230388	.214831	-.116192	-.55430
4.50	.3357656779	.207281	-.128485	-.53746
4.60	.3402421361	.200093	-.140150	-.52185
4.70	.3444713822	.193242	-.151230	-.50658
4.80	.3484706731	.186704	-.161766	-.49224
4.90	.3522557410	.180460	-.171796	-.47874
5.00	.3558409564	.174488	-.181353	-.46581
6.00	.3831296950	.126559	-.256571	-.36106
7.00	.3999924418	.093198	-.306795	-.29025
8.00	.4107563061	.068631	-.342125	-.23854
9.00	.4177060242	.049786	-.367920	-.19897
10.00	.4221508417	.034874	-.387277	-.16790
20.00	.4209882211	-.030122	-.451110	-.03228
30.00	.4043344749	-.050444	-.454778	.01136
40.00	.3883792573	-.059905	-.448284	.03245
50.00	.3744001700	-.065114	-.439514	.04565
60.00	.3622288523	-.068249	-.430477	.05311
70.00	.3515481608	-.070232	-.421780	.05880
80.00	.3420798520	-.071520	-.413599	.06400
90.00	.3336039876	-.072360	-.405964	.06479
100.00	.3259499318	-.072901	-.398851	.06867
200.00	.2751857873	-.072596	-.347782	.07717
300.00	.2461919948	-.070215	-.316407	.07827
400.00	.2263164407	-.067888	-.294204	.07838

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 8

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
BAE PEF n = 10.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-8.3716596649	18.962283	27.333943	-73.62912
.45	-6.4690922225	13.709258	20.178350	-49.66790
.50	-5.2031427726	10.505644	15.708787	-35.98388
.55	-4.3070921008	8.399320	12.706412	-27.53998
.60	-3.6427048148	6.932980	10.575685	-21.76430
.65	-3.1320386996	5.865532	8.997571	-17.81194
.70	-2.7281481688	5.060223	7.788371	-14.93041
.75	-2.4012185261	4.434743	6.835961	-12.74005
.80	-2.1314750809	3.937094	6.068569	-11.07021
.85	-1.9053198001	3.533067	5.438387	-9.74647
.90	-1.7131124970	3.199370	4.912483	-8.67783
.95	-1.5478384297	2.919690	4.467528	-7.72152
1.00	-1.4042771106	2.682221	4.086498	-6.93484
1.05	-1.2784664352	2.478353	3.756820	-6.45050
1.10	-1.1673470703	2.301616	3.468963	-5.92674
1.15	-1.0685204396	2.147052	3.215572	-5.47603
1.20	-.9800802955	2.010825	2.990905	-5.08285
1.25	-.9004930799	1.889922	2.790415	-4.74102
1.30	-.8285114556	1.781945	2.610456	-4.39688
1.35	-.7631107463	1.684963	2.448073	-4.17177
1.40	-.7034415523	1.597406	2.300848	-3.92739
1.45	-.6487939247	1.517986	2.166780	-3.72734
1.50	-.5985699709	1.445634	2.044204	-3.51686
1.55	-.5522626479	1.379460	1.931723	-3.34577
1.60	-.5094391884	1.318717	1.828156	-3.18631
1.65	-.4697280151	1.262769	1.732497	-3.03841
1.70	-.4328083233	1.211077	1.643886	-2.89873
1.75	-.3984017295	1.163177	1.561579	-2.74856
1.80	-.3662654826	1.118674	1.484939	-2.65499
1.85	-.3361869716	1.077215	1.413402	-2.55878
1.90	-.3079791747	1.038506	1.346485	-2.46677
1.95	-.2814769749	1.002285	1.283762	-2.37035
2.00	-.2565340071	.968318	1.224852	-2.28613
2.10	-.2108191019	.906366	1.117185	-2.10408
2.20	-.1699505479	.851286	1.021237	-1.99382
2.30	-.1332163831	.802002	.935218	-1.87291
2.40	-.1000368007	.757647	.857684	-1.76732
2.50	-.0699349237	.717515	.787450	-1.69743
2.60	-.0425149577	.681046	.723561	-1.58548
2.70	-.0174457591	.647749	.665194	-1.50596
2.80	.0055518742	.617231	.611679	-1.44736
2.90	.0267149376	.589159	.562444	-1.37032
3.00	.0462459027	.563253	.517007	-1.30195

3.10	.0643187544	.539266	.474947	-1.25444
3.20	.0810838213	.516997	.435914	-1.20286
3.30	.0966716482	.496268	.399596	-1.15617
3.40	.1111961336	.476923	.365727	-1.11167
3.50	.1247570999	.458829	.334072	-1.07076
3.60	.1374423866	.441867	.304425	-1.03259
3.70	.1493295954	.425936	.276606	-.99580
3.80	.1604875258	.410944	.250457	-.95558
3.90	.1709773960	.396808	.225830	-.93179
4.00	.1808538408	.383459	.202605	-.90153
4.10	.1901657758	.370833	.180667	-.87372
4.20	.1989571256	.358872	.159915	-.84710
4.30	.2072674371	.347526	.140258	-.82159
4.40	.2151324119	.336746	.121614	-.78931
4.50	.2225843587	.326496	.103911	-.77136
4.60	.2296525788	.316731	.087078	-.75410
4.70	.2363637199	.307424	.071060	-.73081
4.80	.2427420634	.298536	.055793	-.71459
4.90	.2488097620	.290045	.041235	-.69650
5.00	.2545870937	.281924	.027337	-.67848
6.00	.2998300188	.216671	-.083159	-.53719
7.00	.3296233045	.171200	-.158423	-.44025
8.00	.3501920694	.137705	-.212487	-.36994
9.00	.3648656721	.112015	-.252851	-.31335
10.00	.3755764323	.091693	-.283883	-.27340
20.00	.4046420176	.003233	-.401409	-.08838
30.00	.3999016895	-.024493	-.424395	-.02914
40.00	.3908671388	-.037559	-.428426	-.00035
50.00	.3816266166	-.044907	-.426534	.01627
60.00	.3730056414	-.049467	-.422472	.02791
70.00	.3651391845	-.052476	-.417615	.03553
80.00	.3579887046	-.054544	-.412533	.04160
90.00	.3514752312	-.056003	-.407479	.04454
100.00	.3455174869	-.057051	-.402568	.04817
200.00	.3047776869	-.059361	-.364139	.06037
300.00	.2808957934	-.058219	-.339115	.06207
400.00	.2643499729	-.056734	-.321084	.06238

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 9

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
BAE PEF n = 11.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-7.7589160876	17.697890	25.456806	-68.67017
.45	-5.9830753828	12.797268	18.780343	-46.33234
.50	-4.8012454764	9.808470	14.609715	-33.57381
.55	-3.9645907498	7.843255	11.807846	-25.70559
.60	-3.3441400860	6.475035	9.819175	-20.30563
.65	-2.8671704599	5.478915	8.346085	-16.62008
.70	-2.4898764854	4.727334	7.217211	-13.93055
.75	-2.1844353079	4.143519	6.327954	-11.89454
.80	-1.9323915617	3.678964	5.611356	-10.34036
.85	-1.7210531755	3.301762	5.022816	-9.10146
.90	-1.5414213204	2.990183	4.531605	-8.10664
.95	-1.3869472757	2.729013	4.115960	-7.19797
1.00	-1.2527568834	2.507230	3.759987	-6.46976
1.05	-1.1351505216	2.316809	3.451959	-6.02729
1.10	-1.0312712577	2.151711	3.182983	-5.53717
1.15	-.9388789917	2.007310	2.946189	-5.11639
1.20	-.8561932631	1.880028	2.736221	-4.75068
1.25	-.7817815827	1.767052	2.548834	-4.42944
1.30	-.7144787217	1.666144	2.380623	-4.10425
1.35	-.6533273777	1.575502	2.228829	-3.89949
1.40	-.5975339386	1.493662	2.091196	-3.66888
1.45	-.5464350349	1.419420	1.965855	-3.46976
1.50	-.4994719617	1.351780	1.851252	-3.28902
1.55	-.4561708767	1.289911	1.746082	-3.12652
1.60	-.4161273235	1.233113	1.649240	-2.97669
1.65	-.3789940107	1.180795	1.559789	-2.83931
1.70	-.3444710829	1.132453	1.476924	-2.71267
1.75	-.3122983216	1.087654	1.399952	-2.56862
1.80	-.2822488022	1.046028	1.328277	-2.48083
1.85	-.2541237653	1.007247	1.261371	-2.39192
1.90	-.2277483638	.971035	1.198784	-2.30883
1.95	-.2029682233	.937149	1.140117	-2.21586
2.00	-.1796464940	.905369	1.085016	-2.13862
2.10	-.1369045179	.847400	.984304	-1.96691
2.20	-.0986959039	.795855	.894550	-1.86555
2.30	-.0643548554	.749727	.814081	-1.75123
2.40	-.0333391224	.708208	.741547	-1.65384
2.50	-.0052026882	.670636	.675839	-1.58930
2.60	.0204246527	.636491	.616066	-1.48340
2.70	.0438526495	.605312	.561459	-1.40827
2.80	.0653424811	.576732	.511389	-1.35484
2.90	.0851158539	.550439	.465324	-1.28285
3.00	.1033621863	.526174	.422812	-1.21825

3.10	.1202442527	.503702	.383458	-1.17323
3.20	.1359027007	.482840	.346937	-1.12502
3.30	.1504596722	.463416	.312957	-1.08129
3.40	.1640217371	.445289	.281267	-1.03999
3.50	.1766822981	.428332	.251650	-1.00185
3.60	.1885235471	.412435	.223911	-.96616
3.70	.1996180984	.397502	.197884	-.93145
3.80	.2100303306	.383445	.173415	-.90865
3.90	.2198175302	.370196	.150378	-.87171
4.00	.2290308227	.357680	.128650	-.84313
4.10	.2377159831	.345841	.108125	-.81740
4.20	.2459141161	.334625	.088711	-.79219
4.30	.2536622301	.323985	.070322	-.76830
4.40	.2609937356	.313875	.052881	-.73739
4.50	.2679388677	.304260	.036321	-.72149
4.60	.2745250473	.295100	.020575	-.70543
4.70	.2807772122	.286369	.005592	-.68345
4.80	.2867180866	.278030	-.008688	-.66822
4.90	.2923684007	.270063	-.022305	-.65133
5.00	.2977471321	.262443	-.035304	-.63441
6.00	.3398164288	.201189	-.138627	-.50194
7.00	.3674422829	.158475	-.208967	-.41119
8.00	.3864495316	.126989	-.259460	-.34530
9.00	.3999528179	.102823	-.297130	-.29196
10.00	.4097593471	.083695	-.326064	-.25470
20.00	.4352500190	.000217	-.435033	-.08078
30.00	.4295983295	-.026103	-.455701	-.02531
40.00	.4201925602	-.038576	-.458768	.00285
50.00	.4107602859	-.045630	-.456390	.01815
60.00	.4020226857	-.050034	-.452057	.03061
70.00	.3940756777	-.052960	-.447036	.03798
80.00	.3868636374	-.054986	-.441850	.04000
90.00	.3802992943	-.056428	-.436727	.04454
100.00	.3742970241	-.057473	-.431770	.04857
200.00	.3332097097	-.059993	-.393203	.06037
300.00	.3090271805	-.059076	-.368103	.06297
400.00	.2922093505	-.057769	-.349979	.06398

$B_1^* = T^* dB^*/dT^*$ $\quad B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 10

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
BAE PEF n = 12.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-7.2938574563	16.713516	24.007373	-64.75329
.45	-5.6163464736	12.092297	17.708643	-43.70502
.50	-4.4993436609	9.272972	13.772315	-31.69184
.55	-3.7081858189	7.418566	11.126751	-24.19213
.60	-3.1212085274	6.127056	9.248264	-19.17831
.65	-2.6697865002	5.186479	7.856266	-15.71563
.70	-2.3125693136	4.476578	6.789147	-13.17576
.75	-2.0232850657	3.924968	5.948253	-11.25304
.80	-1.7845018181	3.485911	5.270413	-9.78018
.85	-1.5842277992	3.129312	4.713540	-8.61545
.90	-1.4139582936	2.834673	4.248631	-7.66915
.95	-1.2675024989	2.587616	3.855118	-6.89556
1.00	-1.1402514736	2.377797	3.518049	-6.25221
1.05	-1.0287060436	2.197607	3.226313	-5.70816
1.10	-.9301634432	2.041337	2.971501	-5.24594
1.15	-.8425039934	1.904630	2.747134	-4.84605
1.20	-.7640425822	1.784103	2.548146	-4.49953
1.25	-.6934231910	1.677103	2.370526	-4.19795
1.30	-.6295425582	1.581516	2.211059	-3.92993
1.35	-.5714941453	1.495637	2.067131	-3.70126
1.40	-.5185262928	1.418088	1.936615	-3.48021
1.45	-.4700106003	1.347729	1.817739	-3.27525
1.50	-.4254177291	1.283611	1.709029	-3.12166
1.55	-.3842986805	1.224957	1.609256	-2.96733
1.60	-.3462701469	1.171105	1.517375	-2.82308
1.65	-.3110029561	1.121492	1.432495	-2.69466
1.70	-.2782128629	1.075644	1.353857	-2.57358
1.75	-.2476531563	1.033151	1.280805	-2.46143
1.80	-.2191086758	.993679	1.212787	-2.28642
1.85	-.1923909379	.956867	1.149258	-2.28710
1.90	-.1673341331	.922511	1.089845	-2.18698
1.95	-.1437918261	.890354	1.034146	-2.10653
2.00	-.1216342113	.860193	.981828	-2.03112
2.10	-.0810236176	.805169	.886192	-1.89237
2.20	-.0447181591	.756234	.800952	-1.77116
2.30	-.0120860330	.712433	.724519	-1.66605
2.40	.0173874001	.673002	.655615	-1.57031
2.50	.0441255131	.637320	.593194	-1.48492
2.60	.0684797405	.604877	.536397	-1.41039
2.70	.0907441995	.575251	.484507	-1.33974
2.80	.1111668863	.548087	.436920	-1.29369
2.90	.1299583620	.523105	.393146	-1.21893
3.00	.1472985217	.500038	.352739	-1.16515

3.10	.1633419825	.478678	.315336	-1.11388
3.20	.1782223529	.458842	.280620	-1.07075
3.30	.1920556687	.440374	.248318	-1.02765
3.40	.2049431872	.423135	.218192	-.98883
3.50	.2169736546	.407007	.190034	-.95223
3.60	.2282251752	.391887	.163661	-.91853
3.70	.2387667524	.377681	.138915	-.88559
3.80	.2486595748	.364308	.115649	-.86424
3.90	.2579580829	.351701	.093743	-.82950
4.00	.2667108724	.339793	.073082	-.80113
4.10	.2749614560	.328526	.053565	-.77747
4.20	.2827489064	.317852	.035103	-.75338
4.30	.2901084051	.307724	.017615	-.73144
4.40	.2970717120	.298101	.001029	-.70992
4.50	.3036675734	.288947	-.014721	-.68972
4.60	.3099220636	.280227	-.029695	-.67051
4.70	.3158588909	.271912	-.043947	-.65294
4.80	.3214996552	.263973	-.057527	-.63639
4.90	.3268640785	.256387	-.070477	-.61921
5.00	.3319702017	.249130	-.082840	-.60316
6.00	.3718861903	.190773	-.181113	-.47739
7.00	.3980645658	.150050	-.248015	-.39095
8.00	.4160460495	.120013	-.296033	-.32770
9.00	.4287937305	.096944	-.331850	-.27989
10.00	.4380269637	.078674	-.359353	-.24200
20.00	.4614455678	-.001250	-.462696	-.07628
30.00	.4554173839	-.026589	-.482007	-.02261
40.00	.4459337914	-.038664	-.484598	.00325
50.00	.4365042902	-.045532	-.482037	.01940
60.00	.4277933658	-.049847	-.477641	.02971
70.00	.4198785623	-.052735	-.472613	.03553
80.00	.4126977110	-.054748	-.467446	.04000
90.00	.4061612382	-.056195	-.462356	.04657
100.00	.4001828689	-.057254	-.457437	.04817
200.00	.3591696554	-.060038	-.419208	.06037
300.00	.3349226806	-.059355	-.394277	.06207
400.00	.3179991791	-.058227	-.376226	.06238

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 11

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
BAE PEF n = 13.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-6.9281098961	15.923135	22.851245	-61.57782
.45	-5.3293294837	11.529614	16.858944	-41.58699
.50	-4.2639375328	8.847835	13.111772	-30.16779
.55	-3.5088168852	7.083013	10.591830	-23.13568
.60	-2.9482321171	5.853302	8.801534	-18.28871
.65	-2.5168705698	4.957312	7.474182	-14.98447
.70	-2.1753593919	4.280767	6.456126	-12.56801
.75	-1.8986718806	3.754856	5.653527	-10.73674
.80	-1.6701952021	3.336089	5.006284	-9.33844
.85	-1.4784964108	2.995842	4.474339	-8.22700
.90	-1.3154640066	2.714615	4.030079	-7.33292
.95	-1.1751912698	2.478750	3.653942	-6.50968
1.00	-1.0532792431	2.278344	3.331623	-5.84966
1.05	-.9463871028	2.106185	3.052572	-5.46072
1.10	-.8519336035	1.956848	2.808781	-5.02052
1.15	-.7678937817	1.826170	2.594064	-4.64018
1.20	-.6926573979	1.710933	2.403590	-4.31049
1.25	-.6249283261	1.608604	2.233533	-4.02116
1.30	-.5636518053	1.517170	2.080822	-3.72499
1.35	-.5079609343	1.435006	1.942967	-3.54063
1.40	-.4571367664	1.360794	1.817930	-3.33441
1.45	-.4105781222	1.293447	1.704026	-3.15434
1.50	-.3677784973	1.232070	1.599848	-2.98805
1.55	-.3283081787	1.175910	1.504218	-2.84419
1.60	-.2918002607	1.124339	1.416139	-2.70786
1.65	-.2579396002	1.076821	1.334761	-2.58405
1.70	-.2264540200	1.032902	1.259356	-2.46881
1.75	-.1971072574	.992191	1.189299	-2.33317
1.80	-.1696932231	.954354	1.124047	-2.25806
1.85	-.1440313625	.919094	1.063125	-2.17800
1.90	-.1199628031	.886162	1.006125	-2.09898
1.95	-.0973472451	.855337	.952684	-2.02097
2.00	-.0760602860	.826423	.902484	-1.94861
2.10	-.0370413947	.773664	.810705	-1.79005
2.20	-.0021544067	.726732	.728886	-1.70048
2.30	.0292064428	.684716	.655510	-1.59516
2.40	.0575346852	.646886	.589351	-1.50867
2.50	.0832363968	.612640	.529404	-1.45241
2.60	.1066487358	.581508	.474859	-1.35427
2.70	.1280538776	.553071	.425017	-1.28506
2.80	.1476898167	.526998	.379308	-1.23723
2.90	.1657586279	.503005	.337246	-1.16931
3.00	.1824329983	.480856	.298423	-1.11024

3.10	.1978613564	.460339	.262477	-1.07039
3.20	.2121719810	.441285	.229113	-1.02773
3.30	.2254762945	.423543	.198067	-.98790
3.40	.2378715313	.406980	.169109	-.95010
3.50	.2494429277	.391484	.142041	-.91548
3.60	.2602655015	.376953	.116688	-.88257
3.70	.2704055396	.363301	.092895	-.85102
3.80	.2799218193	.350447	.070525	-.83139
3.90	.2888666508	.338329	.049462	-.79679
4.00	.2972867245	.326880	.029594	-.77072
4.10	.3052238500	.316048	.010824	-.74742
4.20	.3127155758	.305784	-.006931	-.72438
4.30	.3197957125	.296045	-.023750	-.70266
4.40	.3264947875	.286791	-.039704	-.67349
4.50	.3328404294	.277988	-.054853	-.65909
4.60	.3388576976	.269600	-.069258	-.64499
4.70	.3445693852	.261604	-.082966	-.62449
4.80	.3499962641	.253965	-.096032	-.61119
4.90	.3551572845	.246666	-.108492	-.59580
5.00	.3600697964	.239683	-.120386	-.58050
6.00	.3984706048	.183516	-.214955	-.45931
7.00	.4236497711	.144295	-.279354	-.37629
8.00	.4409377533	.115350	-.325588	-.31605
9.00	.4531861104	.093108	-.360078	-.26701
10.00	.4620499138	.075483	-.386566	-.23290
20.00	.4843127257	-.001781	-.486094	-.07318
30.00	.4782299613	-.026401	-.504631	-.02171
40.00	.4688449248	-.038193	-.507038	.00365
50.00	.4595356928	-.044938	-.504473	.01815
60.00	.4509386576	-.049200	-.500138	.02881
70.00	.4431252858	-.052070	-.495195	.03430
80.00	.4360330890	-.054087	-.490120	.04160
90.00	.4295737116	-.055548	-.485122	.04454
100.00	.4236623906	-.056629	-.480291	.04737
200.00	.3829982366	-.059689	-.442687	.05917
300.00	.3588483337	-.059230	-.418079	.06117
400.00	.3419360910	-.058274	-.400210	.06238

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 12

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
BAE PEF n = 14.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-6.6324128204	15.273114	21.905527	-58.93334
.45	-5.0982278520	11.069189	16.167417	-39.83218
.50	-4.0749761112	8.501535	12.576511	-28.92153
.55	-3.3491521148	6.810803	10.159956	-22.19431
.60	-2.8099394666	5.632043	8.441982	-17.55039
.65	-2.3947650927	4.772711	7.167476	-14.38855
.70	-2.0658867197	4.123516	6.189402	-12.07788
.75	-1.7993014596	3.618624	5.417926	-10.32033
.80	-1.5790681668	3.216415	4.795483	-8.98313
.85	-1.3942110121	2.889484	4.283695	-7.91624
.90	-1.2369393835	2.619156	3.856096	-7.05948
.95	-1.1015778823	2.392351	3.493929	-6.26596
1.00	-.9838981825	2.199573	3.183472	-5.63212
1.05	-.8806878753	2.033915	2.914603	-5.26221
1.10	-.7894640826	1.890173	2.679638	-4.83746
1.15	-.7082783797	1.764356	2.472634	-4.47401
1.20	-.6355809205	1.653375	2.288955	-4.15566
1.25	-.5701238330	1.554800	2.124924	-3.87856
1.30	-.5108913507	1.466699	1.977590	-3.59188
1.35	-.4570484082	1.387512	1.844561	-3.41646
1.40	-.4079022942	1.315974	1.723876	-3.21925
1.45	-.3628736343	1.251041	1.613915	-3.04395
1.50	-.3214741900	1.191851	1.513325	-2.88538
1.55	-.2832896593	1.137683	1.420973	-2.74658
1.60	-.2479662258	1.087933	1.335899	-2.61506
1.65	-.2151999327	1.042084	1.257284	-2.49896
1.70	-.1847282173	.999702	1.184430	-2.38571
1.75	-.1563231246	.960409	1.116732	-2.25469
1.80	-.1297857794	.923885	1.053671	-2.18111
1.85	-.1049419210	.889843	.994785	-2.10313
1.90	-.0816381916	.858046	.939684	-2.03129
1.95	-.0597391435	.828279	.888018	-1.95205
2.00	-.0391246593	.800353	.839478	-1.88361
2.10	-.0013333862	.749388	.750722	-1.73050
2.20	.0324616751	.704043	.671582	-1.64482
2.30	.0628457350	.663440	.600594	-1.54490
2.40	.0902956815	.626874	.536579	-1.45971
2.50	.1152039750	.593767	.478563	-1.40678
2.60	.1378965304	.563666	.425770	-1.31033
2.70	.1586461596	.536166	.377520	-1.24496
2.80	.1776829984	.510948	.333265	-1.19960
2.90	.1952024786	.487739	.292536	-1.13314
3.00	.2113716350	.466310	.254939	-1.07604

3.10	.2263340574	.446458	.220124	-1.03795
3.20	.2402138588	.428021	.187807	-.99547
3.30	.2531188568	.410850	.157731	-.95713
3.40	.2651431508	.394819	.129675	-.92062
3.50	.2763692383	.379818	.103448	-.88730
3.60	.2868697344	.365750	.078880	-.85567
3.70	.2967088094	.352532	.055823	-.82432
3.80	.3059433694	.340085	.034142	-.80576
3.90	.3146240641	.328350	.013726	-.77283
4.00	.3227961059	.317263	-.005533	-.74712
4.10	.3304999841	.306771	-.023729	-.72451
4.20	.3377720648	.296830	-.040942	-.70232
4.30	.3446450966	.287395	-.057250	-.68127
4.40	.3511486498	.278430	-.072719	-.65268
4.50	.3573094897	.269901	-.087409	-.63897
4.60	.3631518934	.261779	-.101373	-.61271
4.70	.3686979448	.254025	-.114673	-.60557
4.80	.3739677708	.246622	-.127345	-.59290
4.90	.3789797336	.239549	-.139431	-.57794
5.00	.3837506469	.232782	-.150969	-.56316
6.00	.4210551489	.178326	-.242729	-.44570
7.00	.4455277349	.140280	-.305247	-.36532
8.00	.4623380223	.112187	-.350151	-.30696
9.00	.4742527338	.090590	-.383663	-.25956
10.00	.4828783105	.073469	-.409410	-.22640
20.00	.5045659008	-.001729	-.506295	-.07148
30.00	.4986275798	-.025799	-.524426	-.02126
40.00	.4894491550	-.037380	-.526829	.00325
50.00	.4803321571	-.044037	-.524369	.01877
60.00	.4719026781	-.048267	-.520170	.02881
70.00	.4642336447	-.051133	-.515367	.03553
80.00	.4572660147	-.053161	-.510427	.04000
90.00	.4509147612	-.054640	-.505555	.04454
100.00	.4450979188	-.055745	-.500843	.04627
200.00	.4049637670	-.059071	-.464035	.05837
300.00	.3810224706	-.058823	-.439845	.06117
400.00	.3642044875	-.058027	-.422231	.06078

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 13

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
CARRA - KONOWALOW PEF n = 12.0

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-10.0516014047	22.071463	32.123065	-85.02227
.45	-7.8332030453	16.016164	23.849367	-57.54593
.50	-6.3519041586	12.313735	18.665639	-41.79576
.55	-5.3001613920	9.873531	15.173692	-31.98403
.60	-4.5181822438	8.170876	12.689058	-25.48137
.65	-3.9156562736	6.928821	10.844477	-20.69027
.70	-3.4380669394	5.989884	9.427951	-17.50854
.75	-3.0507187740	5.259296	8.310015	-14.99385
.80	-2.7305547583	4.677034	7.407589	-13.03570
.85	-2.4616906933	4.203564	6.665255	-11.51891
.90	-2.2328463184	3.811944	6.044790	-10.24961
.95	-2.0358003217	3.483237	5.519037	-9.26059
1.00	-1.8644250812	3.203829	5.068254	-8.36258
1.05	-1.7140634869	2.963673	4.677737	-7.64639
1.10	-1.5811148136	2.755234	4.336349	-7.03873
1.15	-1.4627525481	2.572769	4.035522	-6.48799
1.20	-1.3567276979	2.411779	3.768507	-6.04246
1.25	-1.2612290289	2.268778	3.530007	-5.64256
1.30	-1.1747818079	2.140957	3.315738	-5.29801
1.35	-1.0961733872	2.026064	3.122237	-4.96126
1.40	-1.0243976129	1.922256	2.946653	-4.68700
1.45	-.9586127917	1.828029	2.786642	-4.43309
1.50	-.8981094955	1.742134	2.640243	-4.20601
1.55	-.8422856149	1.663508	2.505794	-4.10113
1.60	-.7906268621	1.591317	2.381944	-3.85838
1.65	-.7426913548	1.524789	2.267480	-3.61019
1.70	-.6980973328	1.463276	2.161373	-3.47497
1.75	-.6565132909	1.406254	2.062767	-3.32857
1.80	-.6176499921	1.353243	1.970893	-3.20988
1.85	-.5812539499	1.303844	1.885098	-3.08503
1.90	-.5471020824	1.257701	1.804803	-2.96318
1.95	-.5149972949	1.214508	1.729505	-2.83381
2.00	-.4847648106	1.173985	1.658750	-2.74866
2.10	-.4293113300	1.100036	1.529348	-2.56631
2.20	-.3796848652	1.034251	1.413936	-2.40140
2.30	-.3350334420	.975353	1.310387	-2.25225
2.40	-.2946626535	.922315	1.216978	-2.13197
2.50	-.2580009117	.874311	1.132312	-2.01746
2.60	-.2245734944	.830658	1.055231	-1.91337
2.70	-.1939828991	.790792	.984775	-1.80561
2.80	-.1658937931	.754235	.920129	-1.73981
2.90	-.1400213371	.720602	.860623	-1.65712
3.00	-.1161220537	.689552	.805674	-1.58097
3.10	-.0939865971	.660796	.754782	-1.51659
3.20	-.0734339955	.634092	.707526	-1.45709

3.30	-.0543070071	.609229	.663536	-1.39522
3.40	-.0364683726	.586020	.622488	-1.34636
3.50	-.0197977434	.564306	.584104	-1.29863
3.60	-.0041891632	.543949	.548139	-1.25293
3.70	.0104510065	.524825	.514374	-1.21486
3.80	.0242058356	.506825	.482619	-1.16931
3.90	.0371492471	.489852	.452703	-1.13258
4.00	.0493472601	.473822	.424474	-1.09675
4.10	.0608589997	.458657	.397798	-1.06307
4.20	.0717375783	.444290	.372553	-1.03146
4.30	.0820308308	.430660	.348629	-1.00119
4.40	.0917819593	.417710	.325928	-.97324
4.50	.1010300707	.405392	.304362	-.94579
4.60	.1098106553	.393660	.283849	-.92036
4.70	.1181559860	.382473	.264317	-.89609
4.80	.1260954783	.371795	.245699	-.87228
4.90	.1336559959	.361591	.227935	-.84973
5.00	.1408621222	.351830	.210968	-.82021
6.00	.1976064627	.273392	.075785	-.65936
7.00	.2354141294	.218729	-.016686	-.54252
8.00	.2618663676	.178468	-.083399	-.45789
9.00	.2810292449	.147596	-.133434	-.39330
10.00	.2952691330	.123184	-.172085	-.34110
20.00	.3392676499	.017101	-.322167	-.11868
30.00	.3389681759	-.016026	-.354994	-.04984
40.00	.3319881032	-.031594	-.363582	-.01395
50.00	.3239158694	-.040332	-.364247	.00815
60.00	.3160475498	-.045748	-.361796	.01891
70.00	.3087092852	-.049320	-.358029	.03063
80.00	.3019535766	-.051774	-.353727	.03520
90.00	.2957498051	-.053505	-.349255	.04657
100.00	.2900445126	-.054749	-.344794	.04749
200.00	.2506621041	-.057549	-.308212	.06037
300.00	.2275323842	-.056286	-.283818	.06027
400.00	.2115677039	-.054617	-.266185	.06078

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$

TABLE 14

REDUCED SECOND VIRIAL COEFFICIENT PARAMETERS
PVS PEF

T^*	B^*	B_1^*	$B_1^* - B^*$	B_2^*
.40	-11.0490754014	24.516616	35.565692	-93.91788
.45	-8.5819851224	17.835029	26.417014	-63.75169
.50	-6.9307378356	13.741975	20.672713	-46.40525
.55	-5.7559273150	11.039629	16.795556	-35.54962
.60	-4.8808858401	9.151065	14.031951	-28.43814
.65	-4.2055973845	7.771332	11.976929	-23.26822
.70	-3.6695924257	6.726963	10.396555	-19.52776
.75	-3.2343314224	5.913315	9.147646	-16.75223
.80	-2.8741686465	5.264119	8.138288	-14.58649
.85	-2.5714147574	4.735671	7.307086	-12.88110
.90	-2.3134932445	4.298150	6.611643	-11.49114
.95	-2.0912283776	3.930594	6.021822	-10.35050
1.00	-1.8977744900	3.617897	5.515672	-9.40020
1.05	-1.7279239860	3.348926	5.076850	-8.59679
1.10	-1.5776471196	3.115313	4.692960	-7.91310
1.15	-1.4437780907	2.910662	4.354440	-7.32623
1.20	-1.3237961020	2.730001	4.053797	-6.76344
1.25	-1.2156695894	2.569432	3.785102	-6.36431
1.30	-1.1177433665	2.425828	3.543572	-5.95928
1.35	-1.0286555591	2.296678	3.325334	-5.60830
1.40	-.9472755595	2.179940	3.127215	-5.28607
1.45	-.8726570458	2.073925	2.946582	-5.00080
1.50	-.8040019906	1.977242	2.781244	-4.74604
1.55	-.7406327670	1.888725	2.629358	-4.51558
1.60	-.6819703144	1.807393	2.489363	-4.30320
1.65	-.6275168793	1.732413	2.359929	-4.11217
1.70	-.5768422566	1.663076	2.239919	-3.93016
1.75	-.5295727255	1.598775	2.128348	-3.76498
1.80	-.4853820925	1.538984	2.024366	-3.61084
1.85	-.4439843804	1.483247	1.927232	-3.47220
1.90	-.4051278276	1.431169	1.836297	-3.34675
1.95	-.3685899274	1.382405	1.750995	-3.21882
2.00	-.3341733072	1.336648	1.670821	-3.10617
2.10	-.2710199575	1.253115	1.524135	-2.90412
2.20	-.2144735332	1.178768	1.393242	-2.72327
2.30	-.1635707127	1.112177	1.275748	-2.56436
2.40	-.1175259411	1.052193	1.169719	-2.41824
2.50	-.0756923007	.997879	1.073571	-2.29184
2.60	-.0375322703	.948472	.986004	-2.17363
2.70	-.0025955798	.903334	.905930	-2.06950
2.80	.0294977677	.861939	.832441	-1.97188
2.90	.0590706650	.823837	.764767	-1.88251
3.00	.0863992156	.788652	.702253	-1.80237

3.10	.1117208934	.756062	.644341	-1.72824
3.20	.1352410552	.725789	.590548	-1.65958
3.30	.1571381781	.697595	.540457	-1.59560
3.40	.1775681077	.671273	.493705	-1.53651
3.50	.1966675239	.646643	.449976	-1.48023
3.60	.2145567922	.623547	.408990	-1.42691
3.70	.2313423195	.601844	.370501	-1.37913
3.80	.2471185122	.581413	.334294	-1.33501
3.90	.2619694189	.562140	.300170	-1.30254
4.00	.2759701054	.543943	.267973	-1.25394
4.10	.2891878217	.526723	.237535	-1.21319
4.20	.3016829871	.510405	.208722	-1.17698
4.30	.3135100342	.494921	.181411	-1.14332
4.40	.3247181290	.480208	.155490	-1.11105
4.50	.3353517893	.466210	.130859	-1.08044
4.60	.3454514202	.452877	.107426	-1.05115
4.70	.3550537753	.440161	.085108	-1.02365
4.80	.3641923582	.428022	.063829	-.99827
4.90	.3728977721	.416420	.043522	-.97217
5.00	.3811980264	.405321	.024123	-.94677
6.00	.4466758541	.316065	-.130611	-.75572
7.00	.4904585505	.253786	-.236673	-.62341
8.00	.5212051037	.207861	-.313344	-.52668
9.00	.5435665682	.172604	-.370963	-.45307
10.00	.5602536017	.144691	-.415563	-.39450
20.00	.6130446744	.022696	-.590349	-.14098
30.00	.6138155219	-.016019	-.629835	-.05951
40.00	.6063928550	-.034564	-.640957	-.01995
50.00	.5974398051	-.045204	-.642644	.00315
60.00	.5885579125	-.051967	-.640525	.01801
70.00	.5801813323	-.056556	-.636737	.03063
80.00	.5724048358	-.059816	-.632220	.03680
90.00	.5652145919	-.062207	-.627422	.04252
100.00	.5585630945	-.064004	-.622567	.04749
200.00	.5116739472	-.069789	-.581463	.06717
300.00	.4832979092	-.069887	-.553185	.07197
400.00	.4632968378	-.069062	-.532358	.07198

$B_1^* = T^* dB^*/dT^*$ $B_2^* = T^{*2} d^2B^*/dT^{*2}$