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Final Report

DEVELOPMENT OF TECHNIQUES FOR ADVANCED OPTICAL CONTAMINATION MEASUREMENT WITH INTERNAL REFLECTION SPECTROSCOPY (PHASE I)

Volume I

December 1972

BROWN ENGINEERING

Research Park • Huntsville, Alabama 35807

FINAL REPORT
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VOLUME I

DEVELOPMENT OF TECHNIQUES FOR ADVANCED OPTICAL CONTAMINATION MEASUREMENT WITH INTERNAL REFLECTION SPECTROSCOPY (PHASE I)

By

J. D. Hayes

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Prepared By

SCIENCE AND ENGINEERING
TELEDYNE BROWN ENGINEERING
HUNTSVILLE, ALABAMA

EXECUTIVE SUMMARY

The feasibility of monitoring volatile contaminants in a large space simulation chamber using techniques of internal reflection spectroscopy has been demonstrated analytically and experimentally. The analytical results of the Phase I study are documented in Volume I of this report and the experimental results obtained in the Phase II study are reported in Volume II. The infrared spectral region was selected as the operational spectral range in order to provide unique identification of the contaminants along with sufficient sensitivity to detect trace contaminant concentrations. It was determined theoretically that a monolayer of the contaminants of interest could be detected and identified using optimized experimental procedures. This ability was verified experimentally. Procedures were developed to correct the attenuated total reflectance spectra for thick sample distortion. However, by using two different element designs the need for such correction can be avoided.

The analysis of spectra of multicomponent samples was considered analytically and procedures were selected to determine both qualitatively and quantitatively the contents of such samples. Experimentally, one multicomponent sample was analyzed and the results were accurate to within ±50 percent overall.

To provide sufficient sensitivity for the variety of experimental conditions anticipated, the use of two different internal reflection elements is recommended. For normal thin film (>200 Å) measurements and for thick film or bulk sample measurements, a 35-degree, 26 reflection germanium element is recommended. For high sensitivity measurements for thin films between 20 Å and approximately 6,000 Å,

a 30-degree, 46 reflection KRS-5 element is recommended. Some hardware considerations for an ATR real-time contaminant monitor are also discussed in Volume II.

Submitted By:

J D Hayes

J. D. Hayes
Principal Investigator

Approved:

N E Chatterton

N. E. Chatterton, Ph. D.
Manager,
Research Department

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1. INTRODUCTION

Internal reflection spectroscopy (IRS) has been used for several years to identify qualitatively minute quantities of organic compounds. The feasibility of this method for thick films has been widely demonstrated. The feasibility for very thin films has been shown only for a few selected compounds.

The study effort detailed in this final report, Volume I, was directed primarily at determining the feasibility of using IRS techniques to identify, both qualitatively and quantitatively, six specific components known or suspected of contaminating surfaces tested in the space simulation chamber A at the National Aeronautics and Space Administration Manned Spacecraft Center (NASA-MSC). In performing this study, the method of approach was to optimize the sensitivity of the technique together with the measurement precision in order to select internal reflection elements that would not be so sensitive to small experimental variations as to complicate the analysis, but yet could theoretically detect samples a few monolayers thick. In addition, procedures and data necessary for correcting the spectra of samples with rapidly varying refractive indices and of thick samples were developed and documented.

2. PRINCIPLES OF INTERNAL REFLECTION SPECTROSCOPY

The optical properties of absorbing media may be described quantitatively by the complex refractive index, $\tilde{N} = n + ik$, where n, the real part of the refractive index, is defined as the ratio of the velocity of light in vacuum (c) to the phase velocity (v) in the dielectric of a plane electromagnetic wave having constant amplitude along a wave front,

$$n = c/v \ . \tag{1}$$

The imaginary part of the complex refractive index, k, often called the extinction coefficient, describes the damping of the wave as it traverses the absorbing medium, and is defined by the relation

$$E = E_o \exp\left(-\frac{2\pi kz}{\lambda}\right) \tag{2}$$

where

z - coordinate in the direction of propagation

E_o - amplitude of the electromagnetic wave at $z = 0$

E - amplitude at z

λ - wavelength of the electromagnetic wave in vacuum.

The theory of reflection and transmission of light by thin films has been discussed in many texts. Expressions for the reflectance (R) at a given wavelength are obtained by the application of boundary conditions to Maxwell's equations for a plane electromagnetic wave incident on the boundary between two media.

When a plane wave falls onto a boundary between two homogeneous media of different optical properties, it is split into two waves: a transmitted wave proceeding into the second medium and a reflected wave propagated back into the first medium. The existence of these two waves can be demonstrated from the boundary conditions, since it is easily seen that these conditions cannot be satisfied without postulating both the transmitted and the reflected wave. The transmitted beam is refracted according to Snell's law:

$$n_1 \sin \theta = n_2 \sin \phi \tag{3}$$

where

n_1 - the refractive index in medium 1

n_2 - the refractive index in medium 2

θ - the angle of incidence in medium 1

ϕ - the angle of refraction in medium 2.

For the reflected beam, the angle of reflection is equal to the angle of incidence. The reflected amplitudes for unit incident amplitudes for light with the electric field vector perpendicular and parallel to the plane of incidence, respectively, are given by Fresnel's equations,

$$R_{\perp} = \frac{n_1 \cos \theta - n_2 \cos \phi}{n_1 \cos \theta + n_2 \cos \phi} \tag{4}$$

$$R_{\parallel} = \frac{n_2 \cos \theta - n_1 \cos \phi}{n_2 \cos \theta + n_1 \cos \phi} . \tag{5}$$

For internal reflection, i.e., when the light approaches the interface from the denser medium, both $R_{\perp}$ and $R_{\parallel}$ become 100 percent at the critical angle θ_c, given by

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1} n_{21} \tag{6}$$

where $n_{21} \equiv n_2/n_1$.

For angles of incidence larger than θ_c, ϕ becomes imaginary. In this case, the refracted angle ϕ may be obtained from the relation

$$\cos\phi = \left(1 - \sin^2\phi\right)^{\frac{1}{2}}$$

or

$$\cos\phi = i\,\frac{(\sin^2\theta - n_{21}^2)^{\frac{1}{2}}}{n_{21}}\ . \tag{7}$$

Substituting Equation 7 into Equations 4 and 5, the Fresnel reflection equations become

$$R_\perp = \frac{\cos\theta - i(\sin^2\theta - n_{21}^2)^{\frac{1}{2}}}{\cos\theta + i(\sin^2\theta - n_{21}^2)^{\frac{1}{2}}} \tag{8}$$

and

$$R_{\parallel} = \frac{n_{21}^2\cos\theta - i(\sin^2\theta - n_{21}^2)^{\frac{1}{2}}}{n_{21}^2\cos\theta + i(\sin^2\theta - n_{21}^2)^{\frac{1}{2}}}\ . \tag{9}$$

Then, when n_{21} is real (i.e., when the media are transparent, or nonabsorbing), the reflection is total for angles of incidence between θ_c and 90 degrees.

If the rarer medium is absorbing, the reflectivity can be calculated by substituting in Equations 8 and 9 the complex refractive index for n_2, i.e.,

$$\tilde{N}_2 = n_2 + i k_2 \quad . \tag{10}$$

The absorption coefficient, α, is related to the extinction coefficient, k, by

$$k = \frac{\alpha \lambda}{4\pi} \tag{11}$$

where λ is the wavelength at which k is determined.

The Fresnel equations become complicated upon substitution of the complex refractive index and the use of a computer is necessary for solution of the equations.

When the rarer medium is absorbing, the critical angle is not sharply defined and the reflectivity curves become less steep in this region. The absorption loss is quite large near the critical angle; is greater for parallel polarization than it is for perpendicular polarization; and decreases with increasing angle of incidence.

This behavior is the basis for attenuated total reflectance (ATR) spectroscopy, since the internal reflection, particularly in the vicinity of the critical angle, may be extremely sensitive to changes in the absorption coefficient.

In ATR, the reflection loss is the parameter measured. Following Harrick (Ref. 1), it is convenient to define an absorption parameter, a, as the reflection loss per reflection; i.e., for a single reflection,

$$a = 1 - R \quad . \tag{12}$$

or

$$R = 1 - a \tag{13}$$

It is useful to set up the equations for ATR in such a manner as to be directly comparable to transmission spectroscopy. For a material of actual thickness, d, and with an absorption coefficient, α, the transmittance, T, is given by

$$T = e^{-\alpha d} \tag{14}$$

The absorbancy, A_s, is defined as

$$A_s \equiv \ln \left(\frac{1}{T}\right) \tag{15}$$

so that

$$A_s = \alpha d \tag{16}$$

Now, for $\alpha d << 1$, $e^{-\alpha d} \approx 1 - \alpha d$ so that Equation 14 can be rewritten as

$$T \approx 1 - \alpha d \quad \text{for} \quad \alpha d << 1 \tag{17}$$

Equations 17 and 13 are of the same form. It is convenient to define an "effective thickness", d_e, such that

$$R \equiv 1 - \alpha d_e \tag{18}$$

where

α - true absorption coefficient

d_e - parameter, dependent on the optical properties of the media involved and the angle of incidence and polarization of the radiation incident on the media interface, which gives the correct R for the specified conditions.

It is important to note that Equation 18 is exact and d_e is defined by Equation 18, whereas Equation 17 is an approximation for $\alpha d \ll 1$. Equations 17 and 18 are useful for comparing the measured quantities R and T for known film thickness and effective thickness. However, if $\alpha d \geqq 1$, it is necessary to compare R with T obtained from Equation 14. To relate the effective thickness to the actual film thickness, it is necessary to consider the establishment of standing waves at the reflecting interface.

It can be shown from Maxwell's equations that standing waves are established normal to a totally reflecting surface because of the superposition of the incoming and reflected waves (Ref. 2). For total internal reflection, there is a sinusoidal variation of the electric field amplitude with distance from the surface in the denser medium. By selecting the proper angle of incidence, it is possible to locate the antinode (the electric field maximum) at the surface and thus obtain the most efficient energy transfer across the interface. An evanescent wave exists in the rarer medium whose electric field amplitude decays exponentially with distance from the surface (see Figure 1). Consequently, one can define a depth of penetration, d_p (Ref. 1) as the distance required for the electric field, E, to fall to 1/e of its d_p value at the surface, E_o, i.e.,

$$E = E_o \exp(-z/d_p) . \qquad (19)$$

The depth of penetration is given by

$$d_p = \frac{\lambda_1}{2\pi} (\sin^2 \theta - n_{21}^2)^{-\frac{1}{2}} \qquad (20)$$

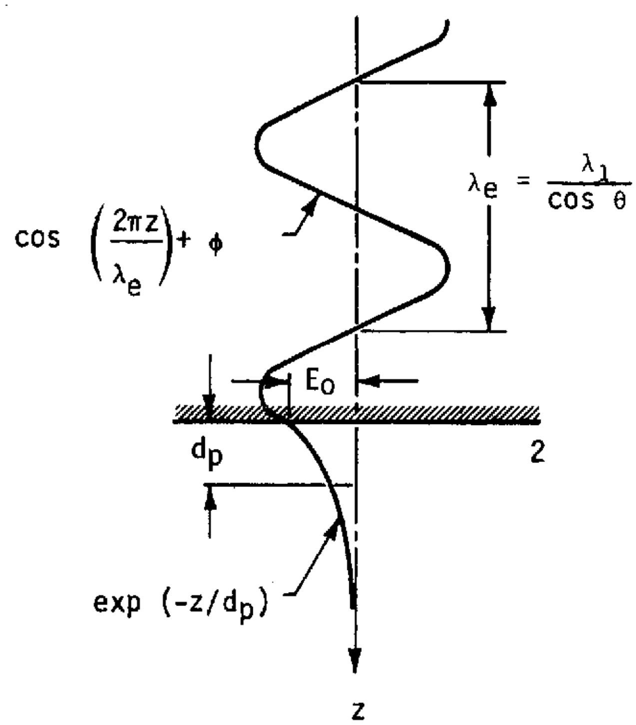


FIGURE 1. STANDING-WAVE AMPLITUDES ESTABLISHED NEAR A TOTALLY REFLECTING INTERFACE (Ref. 1)

where $\lambda_1 = \lambda / n_1$ is the wavelength in the denser medium and θ is the angle of incidence at the interface.

Assuming low absorption (i.e., $\alpha d < 0.1$), the effective thickness is calculated from the electric fields for zero absorption by (Ref. 1)

$$d_e = \frac{n_{21}}{\cos\theta} \int_0^d E^2 (z)\, dz \qquad (21)$$

where z is the distance in the rarer medium and d is the thickness of the medium, and E(z) is the electric field amplitude of the incident radiation within the sample. Substituting $E = E_o \exp(-z/d_p)$ into Equation 21 and solving, one obtains

$$d_e = \frac{n_{21}}{\cos\theta} \frac{E_o^2 d_p}{2} [1 - \exp(-2d/d_p)] \ . \qquad (22)$$

Expanding the exponential in a series, one obtains

$$d_e = \frac{n_{21} E_o^2}{\cos\theta} \frac{d_p}{2} \left\{ 1 - \left[1 - \frac{2d}{d_p} + \frac{4}{2!}\left(\frac{d}{d_p}\right)^2 - \frac{8}{3!}\left(\frac{d}{d_p}\right)^3 + \ldots \right] \right\} . \qquad (23)$$

When $d << d_p$, d_e is given by the thin film formula

$$d_e = \frac{n_{21} E_o^2 d}{\cos\theta} \qquad (24)$$

while for $d >> d_p$, d_e is given by the bulk material formula

$$d_e = \frac{n_{21} E_o^2 d_p}{2\cos\theta} \ . \qquad (25)$$

Equations 24 and 25 are the two most commonly used equations. However, when d is comparable to d_p, neither equation is valid, and Equation 22 or 23 must be used.

These equations indicate that four factors influence the strength of coupling of the evanescent wave with the absorbing medium. These four factors are the depth of penetration, d_p, the electric field strength at the interface, E_o, the sampling area and the refractive index matching.

The great advantage of ATR spectroscopy is that because of a reflectance of 1 for nonabsorbing media, many reflections can be utilized without reflection losses. Hence, small absorption losses for weakly absorbing films can be multiplied many times without a simultaneous increase in "noise" due to substrate reflection inefficiencies.

For M reflections, the measure reflectivity, R_M, becomes

$$R_M = R^M = (1 - \alpha d_e)^M \qquad (26)$$

For $\alpha d_e < 0.1$

$$R^M \approx 1 - M\alpha d_e \quad \text{for} \quad (\alpha d_e < 0.1) \qquad (27)$$

Then to maximize the absorption contrast, the product Md_e should be maximized. Since d_e depends on the polarization of the incident radiation, it is convenient to consider the components perpendicular and parallel to the angle of incidence separately. Harrick (Ref. 3) has calculated the electric field amplitudes near a totally reflecting, non-absorbing interface. The equations for a maximum amplitude of unity are:

$$E_{yo} = \frac{2 \cos \theta}{(1 - n_{21}^2)^{\frac{1}{2}}} \tag{28}$$

$$E_{xo} = E_{yo} \frac{(\sin^2 \theta - n_{21}^2)^{\frac{1}{2}}}{\left|(1 + n_{21}^2) \sin^2 \theta - n_{21}^2\right|^{\frac{1}{2}}} \tag{29}$$

and

$$E_{zo} = E_{yo} \frac{\sin \theta}{\left[(1 + n_{21}^2) \sin^2 \theta - n_{21}^2\right]^{\frac{1}{2}}} \quad . \tag{30}$$

The perpendicular and parallel components are given by

$$E_{\perp} = E_{yo} \tag{31}$$

$$E_{||} = (|E_{xo}|^2 + |E_{zo}|^2)^{\frac{1}{2}} \tag{32}$$

Substituting Equations 31 and 32 for E_o in Equation 22, one obtains

$$d_{e\perp} = \frac{4 n_{21} \cos \theta}{(1 - n_{21}^2)} \frac{d_p}{2} [1 - \exp(-2d/dp)] \tag{33}$$

and

$$d_{e||} = d_{e\perp} \frac{(2 \sin^2 \theta - n_{21}^2)}{[(1 + n_{21}^2) \sin^2 \theta - n_{21}^2]} \tag{34}$$

Note that since d_p is wavelength dependent (see Equation 20), both $d_{e\perp}$ and $d_{e||}$ will increase with wavelength when d is not small relative to the wavelength of the incident radiation. This effect is discussed in more detail in Section 3.

For most practical multiple reflection cell designs that retain the initial polarization, the number of reflections, M, is proportional to cot θ, so that

$$Md_{e\perp} \propto d_{e\perp} \cot\theta \tag{35}$$

and

$$Md_{e||} \propto d_{e||} \cot\theta \quad . \tag{36}$$

To maximize the observed change in reflectance, one should maximize Equation 35 when using perpendicularly polarized radiation and Equation 36 when using parallel polarized radiation. It should be pointed out that although $d_{e||}$ is proportional to $d_{e\perp}$, there are important cases where the last term in Equation 34 dominates and $d_{e||}$ actually increases when $d_{e\perp}$ is decreasing. This effect will be investigated in more detail in Section 5.

Equations 33 and 34 are general within the low absorption approximation. However, it must be pointed out that when medium 2 is very thin, the electric field amplitudes are determined by media 1 and 3 (Figure 2) and for this condition,

$$E_{\perp} = \frac{2\cos\theta}{(1 - n_{31}^2)^{\frac{1}{2}}} \quad \text{(Thin Film)} \tag{37}$$

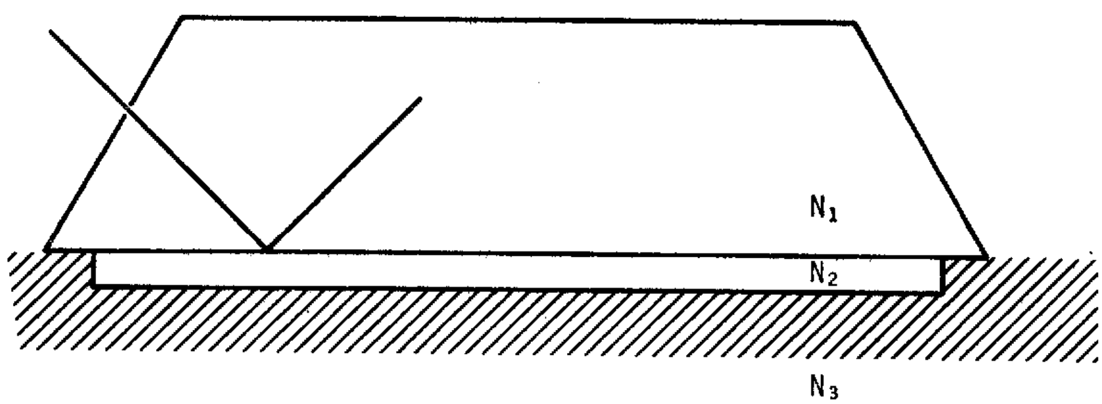


FIGURE 2. REFLECTION AT INTERFACE OF MEDIA

$$E_{||} = E_{\perp} \frac{[(1 + n_{31}^4) \sin^2 \theta - n_{31}^2]^{\frac{1}{2}}}{[(1 + n_{31}^2) \sin^2 \theta - n_{31}^2]^{\frac{1}{2}}} \quad \text{(Thin Film)} \quad (38)$$

so that

$$Md_{e\perp} \propto \frac{4\, n_{21} \cos \theta \cot \theta}{(1 - n_{31}^2)} \quad \frac{d_p}{2} \quad [1 - \exp(-2d/d_p)] \quad \text{(Thin Films)} \quad (39)$$

and

$$Md_{e||} \propto Md_{e\perp} \frac{[(1 + n_{31}^4) \sin^2 \theta - n_{31}^2]}{[(1 + n_{31}^2) \sin^2 \theta - n_{31}^2]} \quad \text{(Thin Films)} \quad (40)$$

For a given sample material N_2 is fixed. Then to obtain maximum sensitivity, one must select the combination of θ, N_3, and N_1 which will optimize Equation 35 or Equation 39 when working with perpendicularly polarized light or Equation 36 or Equation 40 when working with parallel polarized light.

3. EFFECT OF FILM THICKNESS ON ATR SPECTRA

For quantitative analysis of absorption bands, the absolute effective thickness of the sample must be known. This problem becomes particularly acute in multi-component analysis, since the absorbancies of bands located at various wavelengths must be compared.

To determine the effects of film thickness on the ATR spectra of contaminant films, it is convenient to rewrite Equation 22 as

$$d_e = \frac{n_{21}\ E_o^2\ d}{\cos\theta} \cdot \frac{d_p}{2d}\ [\,1 - \exp\,(-2d/d_p)] \qquad (41)$$

The term $E_o^2\ d_p/2\ [\,1 - \exp\,(-2d/d_p)]$ represents the interaction of the electric fields of the incident wave with the sample, and has a maximum value of $E_o^2 d$ for a material of thickness d. This can be shown by considering the regions where $d << d_p$, $d = d_p$, and $d >> d_p$.

Expanding the exponential term in a power series gives

$$\text{interaction} = E_o^2\ \frac{d_p}{2}\left[1 - 1 + \frac{2d}{d_p} - 4\left(\frac{d}{d_p}\right)^2 + \frac{16}{3!}\left(\frac{d}{d_p}\right)^3 - \ldots\right]. \qquad (42)$$

For $d << d_p$, i.e., $d \geq 0.1\ d_p$, the series can be terminated after the first-order term so that

$$\text{interaction} \simeq E_o^2\left(\frac{d_p}{2}\right)\left(\frac{2d}{d_p}\right) = E_o^2\,d\ (d << d_p) \qquad (43)$$

For $d = d_p$

$$\text{interaction} = E_o^2 \left(\frac{d_p}{2}\right) (1 - e^{-2})$$

$$= E_o^2 \frac{d_p}{2} (0.864)$$

$$= 0.432 E_o^2 d_p$$

$$\text{interaction} = 0.432 E_o^2 d \text{ since } d_p = d \qquad (44)$$

For $d >> d_p$

$$\text{interaction} = E_o^2 \left(\frac{d_p}{2}\right) [1 - 0]$$

$$\text{interaction} = E_o^2 \frac{d_p}{2} < E_o^2 d \text{ for } d >> d_p \qquad (45)$$

Equations 43, 44, and 45 show that for any sample thickness, d, the maximum interaction possible is $E_o^2 d$. However, as the actual thickness of the sample is increased, the total interaction will be increased, but may not reach the maximum possible for that particular thickness. As d becomes greater than 0.1 d_p, the interaction becomes dependent on wavelength, since d_p is wavelength-dependent. If an interaction efficiency, IE, is defined by

$$IE \equiv \frac{d_p}{2d} [1 - \exp(-2d/d_p)] \qquad (46)$$

the wavelength dependence of the interaction can be calculated and plotted as interaction efficiency versus wavelength for various actual film thicknesses, independent of the various other affecting parameters. Although the effect can be shown as a function of d_p/d, it is more relevant to the purposes of this study to plot IE versus wavelength.

Since d_p is proportional to λ/N_1, the data were first generated in terms of d/d_p ratios (Table 1) and then the wavelengths corresponding to the particular d/d_p ratios were calculated for the various IRE materials using Equation 20 rewritten as

$$\lambda = \frac{N_1}{2\pi} (\sin^2 \theta - n_{21}^2)^{\frac{1}{2}} d \left(\frac{d_p}{d}\right) \tag{47}$$

As will be shown in Section 5, $(\sin^2 \theta - n_{21}^2)^{\frac{1}{2}}$ is approximately equal to 1/3.5 for all IRE materials examined when $\theta \approx \theta_c + 5°$. Consequently, the equations used to generate the curves of Figures 3, 4, and 5 were Equation 46 and

$$\lambda = \frac{N_1}{7\pi} d \left(\frac{d_p}{d}\right) \quad . \tag{48}$$

Figures 3, 4, and 5 show the variation of IE with wavelength for film thicknesses of 0.01 micrometer (100 Å), 0.1 micrometer (1000 Å), and 1 micrometer (10,000 Å), for IRE materials with refractive indicies of 4.00 (Ge), 2.37 (KRS-5), and 1.98 (AgCl), respectively. These curves can be used to select a maximum film thickness for a particular IRE material such that the wavelength distortion of the absorption bands will be negligible, or alternatively to correct for such distortion, assuming the film thickness is known.

For example, for $N_1 = 4.00$ and d = 0.1 micrometer, the maximum absorption of a band at $\lambda = 2.4$ micrometer would be 3.3 percent less than that of a band at $\lambda = 8.0$ micrometer, assuming the absorption coefficients were the same for each band. However, for a film 1.0-micrometer thick, the 2.4-micrometer band absorption would be 25 percent (21.6/86.6) less than the 8.0-micrometer band absorption.

TABLE 1. INTERACTION EFFICIENCY FOR VARIOUS (d/d_p) VALUES

$\frac{d}{d_p}$	$\frac{d_p}{2d}\,[1 - \exp(-2d/d_p)]$
10.00	0.050
8.00	0.0675
6.00	0.0835
4.00	0.125
2.00	0.246
1.00	0.432
0.80	0.500
0.60	0.585
0.40	0.689
0.20	0.825
0.10	0.905
0.08	0.925
0.06	0.941
0.04	0.961
0.02	0.980
0.01	0.990

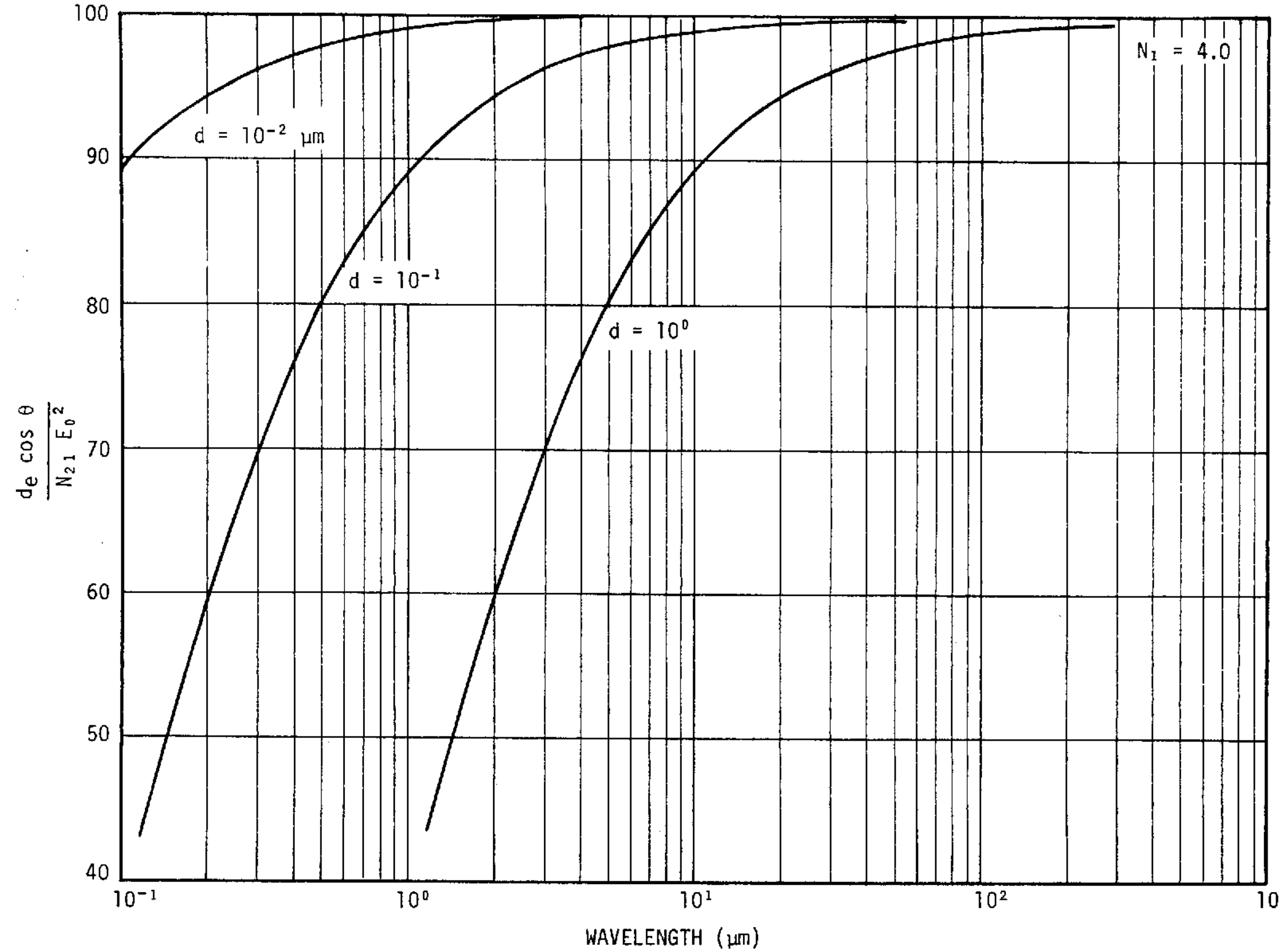


FIGURE 3. VARIATION OF INTERACTION EFFICIENCY WITH WAVELENGTH FOR GERMANIUM IRE

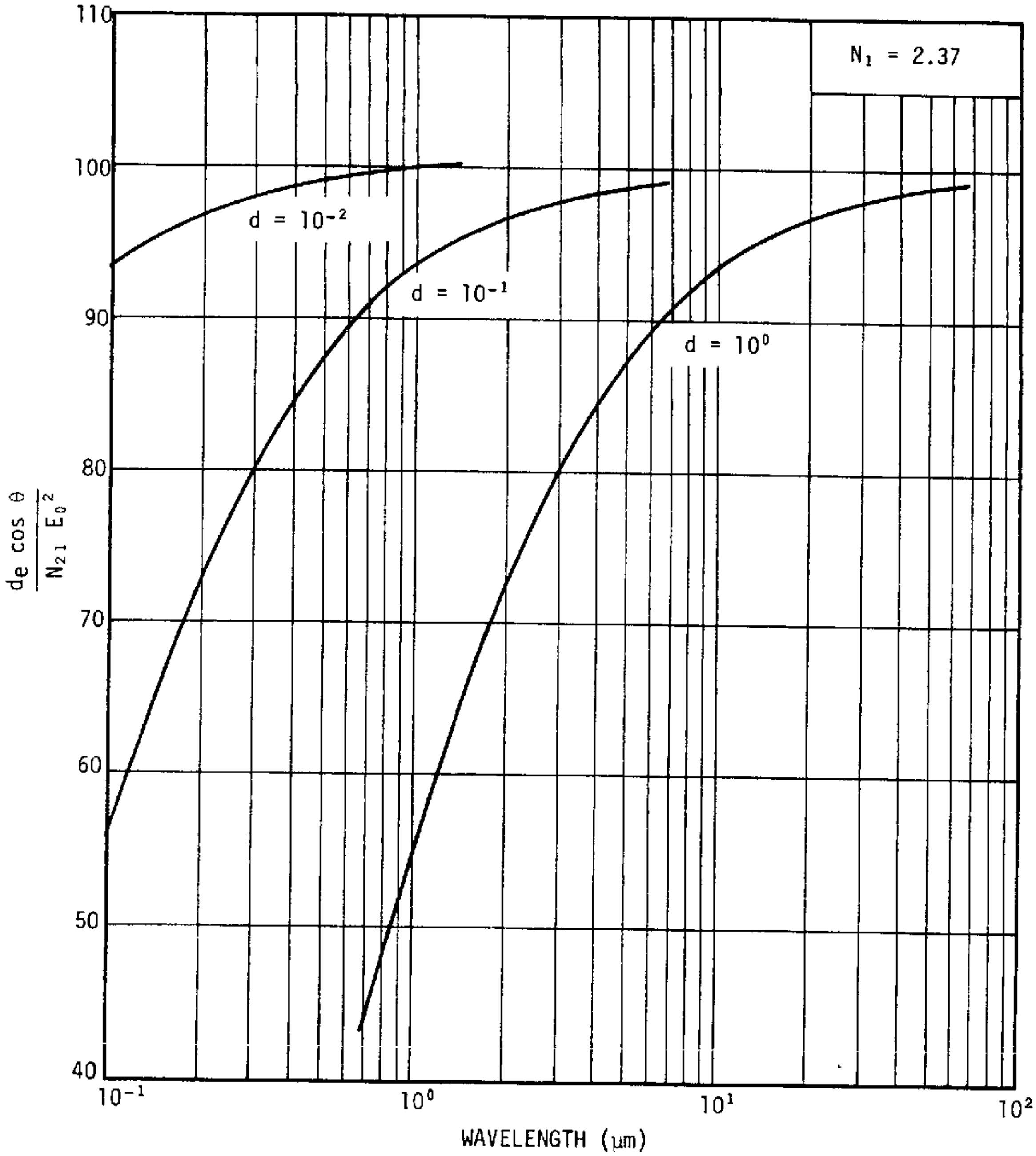


FIGURE 4. INTERACTION EFFICIENCY AS A FUNCTION OF WAVELENGTH FOR KRS-5 IRE

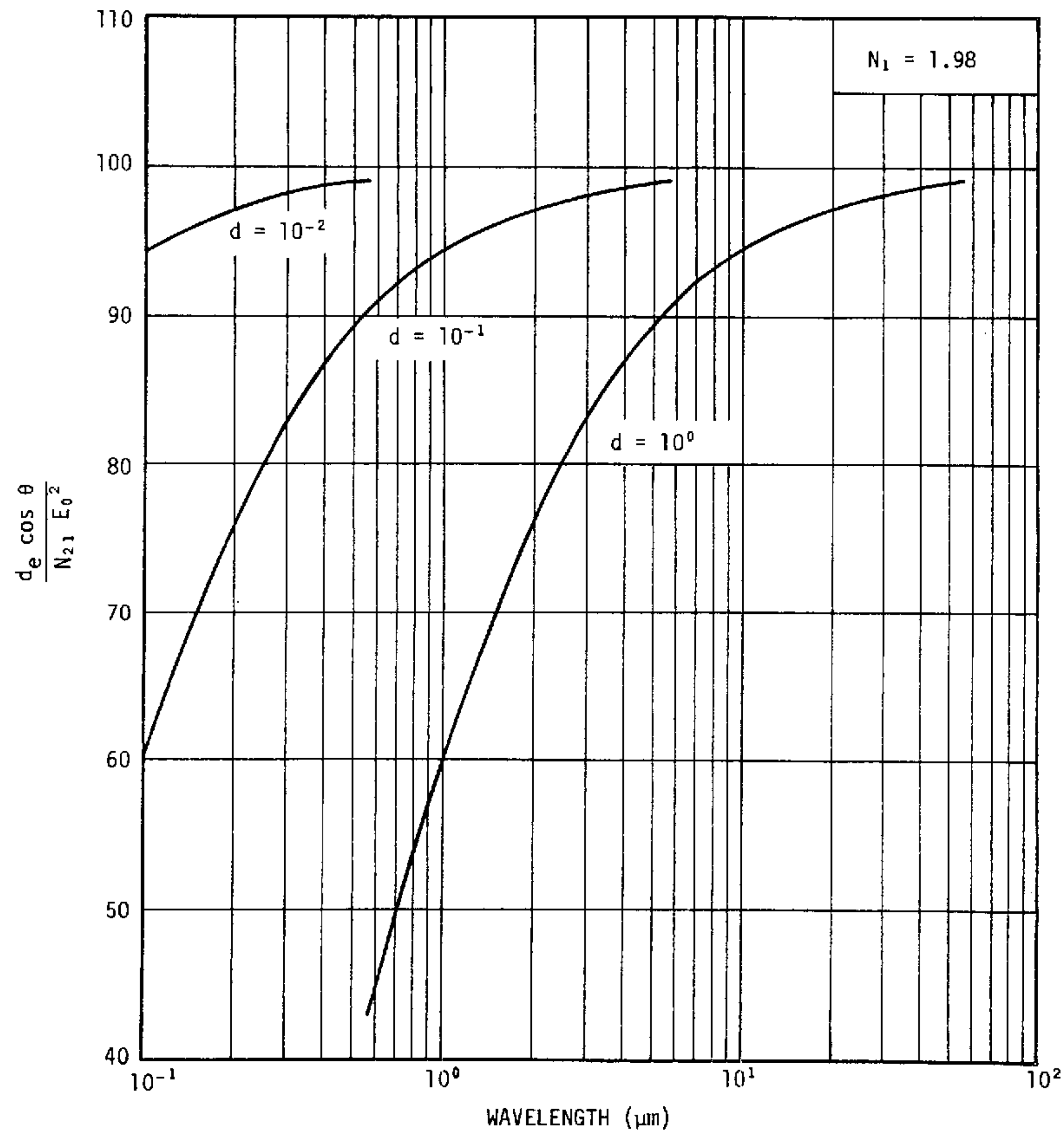
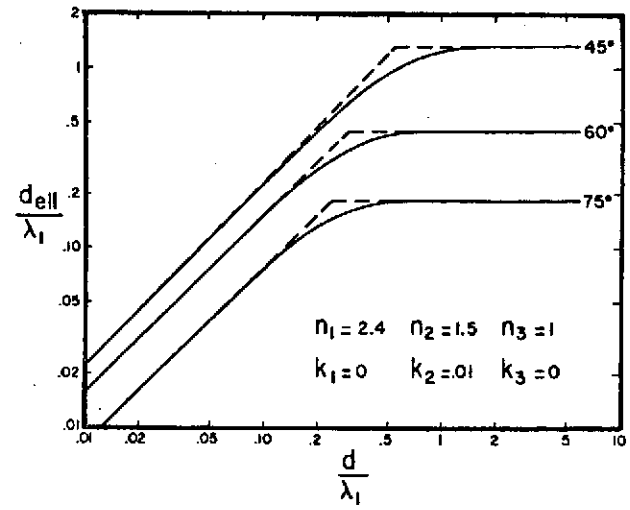


FIGURE 5. VARIATION OF INTERACTION EFFICIENCY WITH WAVELENGTH FOR AgCl IRE

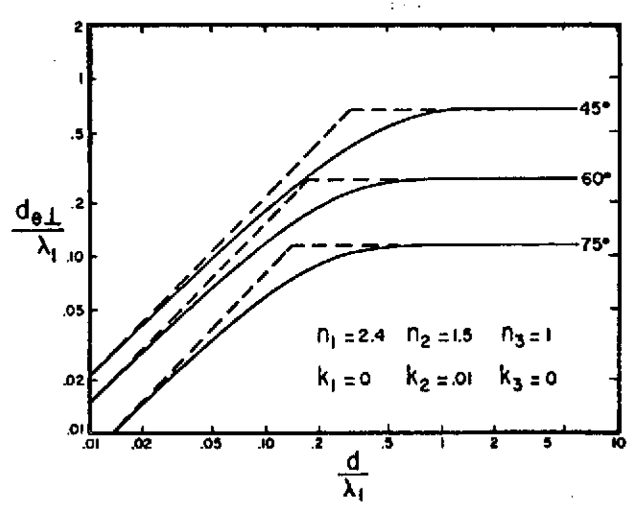
In general, for the distortion to be less than 2 percent, the film thickness should not exceed 1/40 to 1/50 of the minimum wavelength of the spectral scan.

It is also instructive to determine the thicknesses at which the thin film approximations and the bulk approximations for d_e apply. The thin film approximation for d_e is obtained from the exact equation (Equation 22) by substituting $(2d/d_p)$ for $[1 - \exp(-2d/d_p)]$ and is given by Equation 24. The bulk approximation is obtained from Equation 22 by substituting 1 for $[1 - \exp(-2d/d_p)]$. As mentioned in Section 2, these approximations should not be valid in the region where d is comparable to d_p. Harrick (Ref. 4) has recently performed quantitative calculations for several frequently used elements and geometries which serve to illustrate the magnitude of the discrepancies involved. Figures 6 through 9 (Ref. 4) show the dependence of the relative effective thickness (wavelength independent) on the actual film thickness for KRS-5 ($N_1 = 2.4$) and Germanium ($N_1 = 4$). Note that these are log-log plots and that the maximum errors in the region of $d = d_p$ are 25 percent to 40 percent. These errors are quite significant and should not be overlooked, particularly since graphs of the exact variation, such as Figures 3, 4, and 5, are so easily constructed.



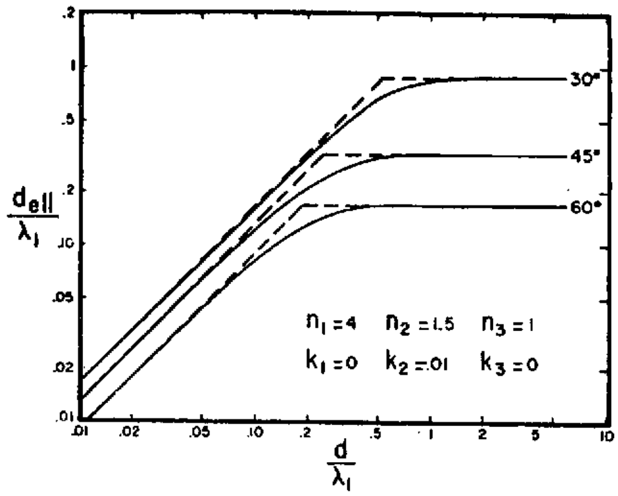
NOTE: ——— EXACT COMPUTER CALCULATIONS
- - - - VALUES OBTAINED FROM LOW ABSORPTION APPROXIMATIONS.

FIGURE 6. RELATIVE EFFECTIVE THICKNESS FOR A WEAK ABSORBER PLACED ON KRS-5 (n_1 = 2.4) AS A FUNCTION OF ACTUAL FILM THICKNESS FOR ||-POLARIZATION AND A NUMBER OF ANGLES OF INCIDENCE (Ref. 4)



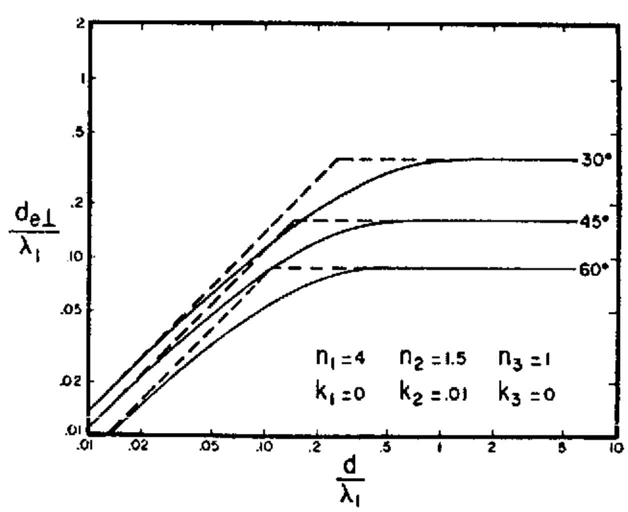
NOTE: ——— EXACT COMPUTER CALCULATIONS
- - - - VALUES OBTAINED FROM LOW ABSORPTION APPROXIMATIONS.

FIGURE 7. RELATIVE EFFECTIVE THICKNESS FOR A WEAK ABSORBER PLACED ON KRS-5 (n_1 = 2.4) AS A FUNCTION OF ACTUAL FILM THICKNESS FOR ⊥-POLARIZATION AND A NUMBER OF ANGLES OF INCIDENCE (Ref. 4)



NOTE: ——— EXACT COMPUTER CALCULATIONS
----- VALUES OBTAINED FROM LOW ABSORPTION APPROXIMATIONS.

FIGURE 8. RELATIVE EFFECTIVE THICKNESS FOR A WEAK ABSORBER PLACED ON GERMANIUM (n_1 = 4) AS A FUNCTION OF ACTUAL FILM THICKNESS FOR ||-POLARIZATION AND A NUMBER OF ANGLES OF INCIDENCE (Ref. 4)



NOTE: ——— EXACT COMPUTER CALCULATIONS
---- VALUES OBTAINED FROM LOW ABSORPTION APPROXIMATIONS.

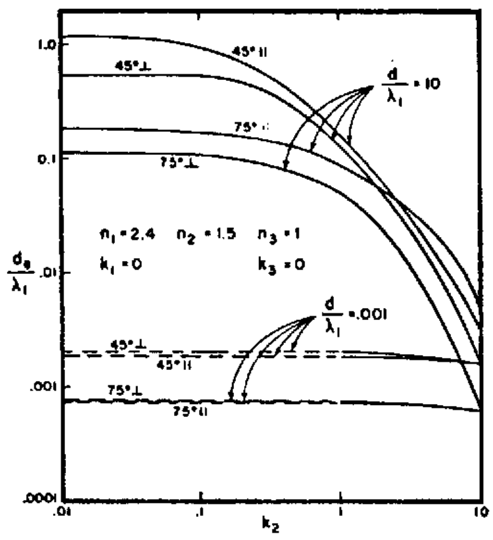
FIGURE 9. RELATIVE EFFECTIVE THICKNESS FOR A WEAK ABSORBER PLACED ON GERMANIUM (n_1 = 4) AS A FUNCTION OF ACTUAL FILM THICKNESS FOR ⊥-POLARIZATION AND A NUMBER OF ANGLES OF INCIDENCE (Ref. 4)

4. OTHER PARAMETERS AFFECTING ATR SPECTRA

4.1 SAMPLE ABSORPTION

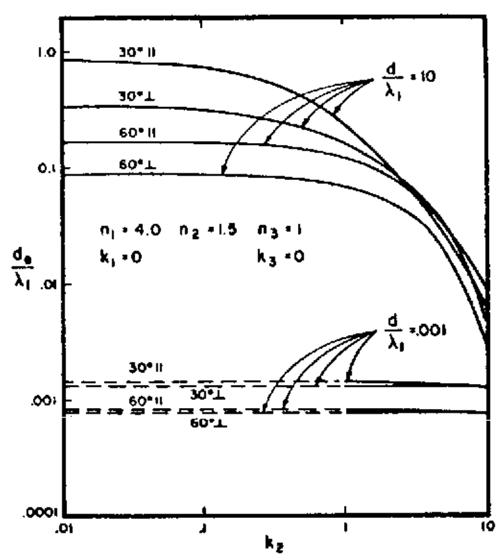
The equations for the electric field amplitudes within the sample were derived assuming zero absorption; i.e., $k_2 = 0$, where k_2 is the extinction coefficient of the sample. For this case, the penetration depth is given by Equation 20. For strongly absorbing materials, dp will depend on k_2 as well as on θ and n_{21} and will not be described accurately by Equation 20. In such a case, the actual dp values will be significantly less than those predicted by Equation 20.

Figures 10 and 11 (Ref. 4) show the variation of d_e/λ_1 with k_2 (for d_e determined from Equation 18 and R calculated from the Fresnel equations). As would be expected from examination of the Fresnel equations, as k_2 approaches a value comparable to $(n_1 - n_2)$, the reflectance of the interface increases and, consequently, the actual value of d_e decreases. Since the effective thickness equation (Equation 21) was calculated from the Fresnel equations with $k_2 = 0$, this equation (21) will not be valid for thick samples with high extinction coefficients. However, since the reflectance for thin films is determined primarily by the optical constants of media 1 and 3, the zero-absorption approximation for d_e should be valid for thin films with high extinction coefficients. Since the effect of k_2 is dependent on its value with respect to $(n_1 - n_2)$, the range of validity of the low absorption approximations should be extended by using internal reflection elements with high n_1 values. This result can be seen by comparing the range of $d/\lambda_1 = 10$ in Figure 10 ($n_1 = 2.4$) with that in Figure 11 ($n_1 = 4$).



NOTE: IN REGIONS WHERE THE CURVES HAVE A HORIZONTAL SLOPE, THE APPROXIMATE EQUATIONS FOR EFFECTIVE THICKNESS ARE VALID.

FIGURE 10. RELATIVE EFFECTIVE THICKNESS AS A FUNCTION OF INCREASING EXTINCTION COEFFICIENT OF MEDIUM 2 FOR THICK AND THIN FILMS WHEN THE INTERNAL REFLECTION ELEMENT IS KRS-5 (n_1 = 2.4)



NOTE: IN REGIONS WHERE THE CURVES HAVE A HORIZONTAL SLOPE, THE APPROXIMATE EQUATIONS FOR EFFECTIVE THICKNESS ARE VALID.

FIGURE 11. RELATIVE EFFECTIVE THICKNESS AS A FUNCTION OF INCREASING EXTINCTION COEFFICIENT OF MEDIUM 2 FOR THICK AND THIN FILMS WHEN THE INTERNAL REFLECTION ELEMENT IS GERMANIUM (n_1 = 4)

For strong absorbers in the infrared spectral region, k vaires from 0.01 to 1. Consequently, some error may be incurred by using the effective thickness equations for thick films. In instances where accurate quantitative data is necessary, the exact Fresnel equations should be utilized for thick films. For thin films, the effective thickness equations should be sufficiently accurate.

4.2 SAMPLE AND IRE REFRACTIVE INDEX VARIATION

The penetration depth and the electric field amplitudes at the interface depend strongly on the refractive indices of the IRE and the sample for thick films, and on the refractive index of medium 3 for thin films.

To determine the sensitivity of the absorption on variations in the refractive indices, several controlling parameters were calculated for various refractive index combinations.

Figure 12 shows the variation of $(n_{21} / 1 - n_{21}^2)$ with n_1 while Figure 13 shows the variation of the same parameter with n_2. For $n_1 \approx n_2$, this parameter is quite sensitive to moderate changes in n_1. However, as $n_1 - n_2$ increases, the variation is minor. This curve shows that when refractive index matching is used to gain sensitivity, care should be taken to ensure that N_1 is slowly varying in the spectral region of interest. This might pose a problem in the ultraviolet and visible spectral regions, for example.

The variation of $(n_{21} / 1 - n_{21}^2)$ with n_2 is significant for large changes in n_2 and should be considered when n_2 is expected to change greatly; e.g., as when passing through a strong absorption band.

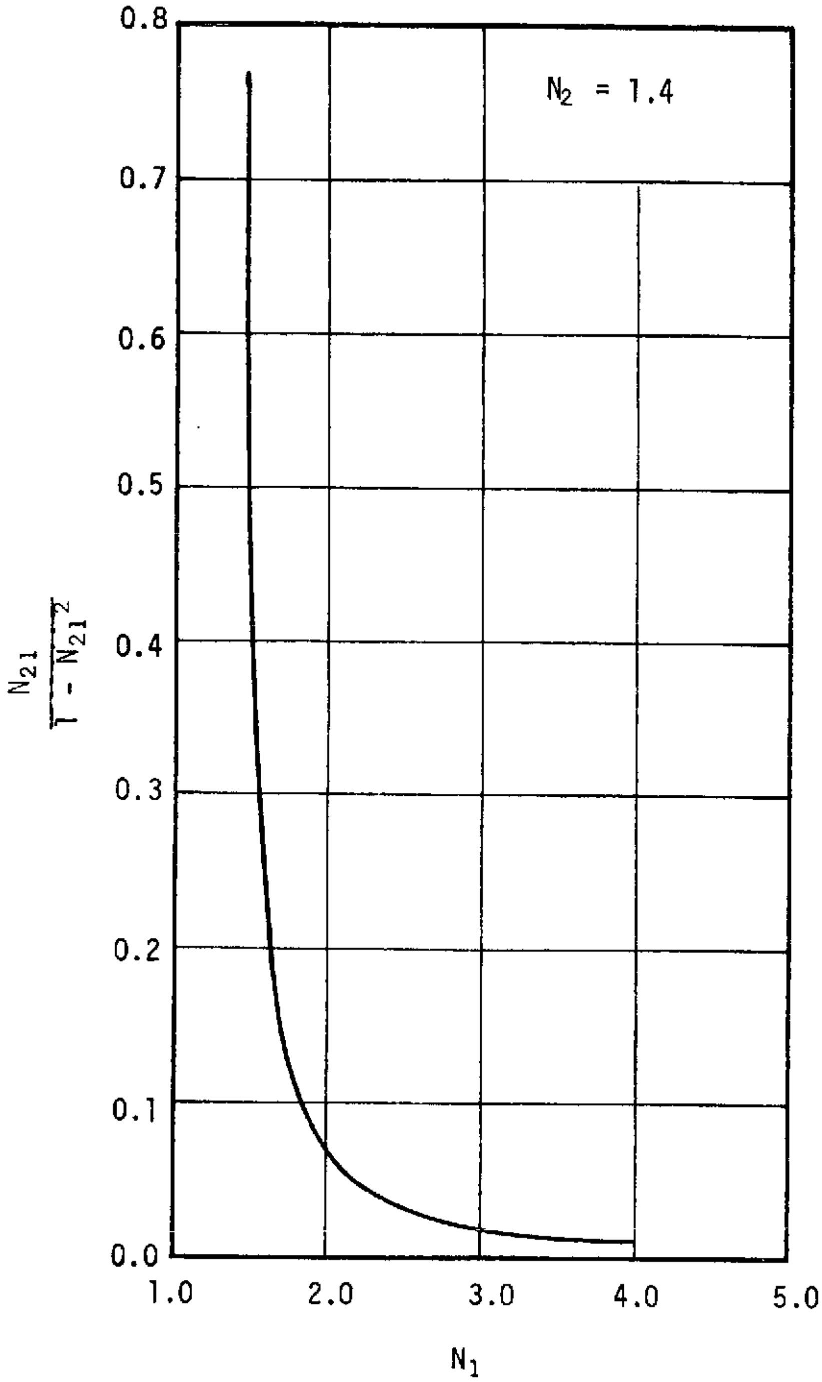


FIGURE 12. CURVE FOR $N_{21}/1 - N_{21}^2$ AS A FUNCTION OF N_1 FOR $N_2 = 1.4$

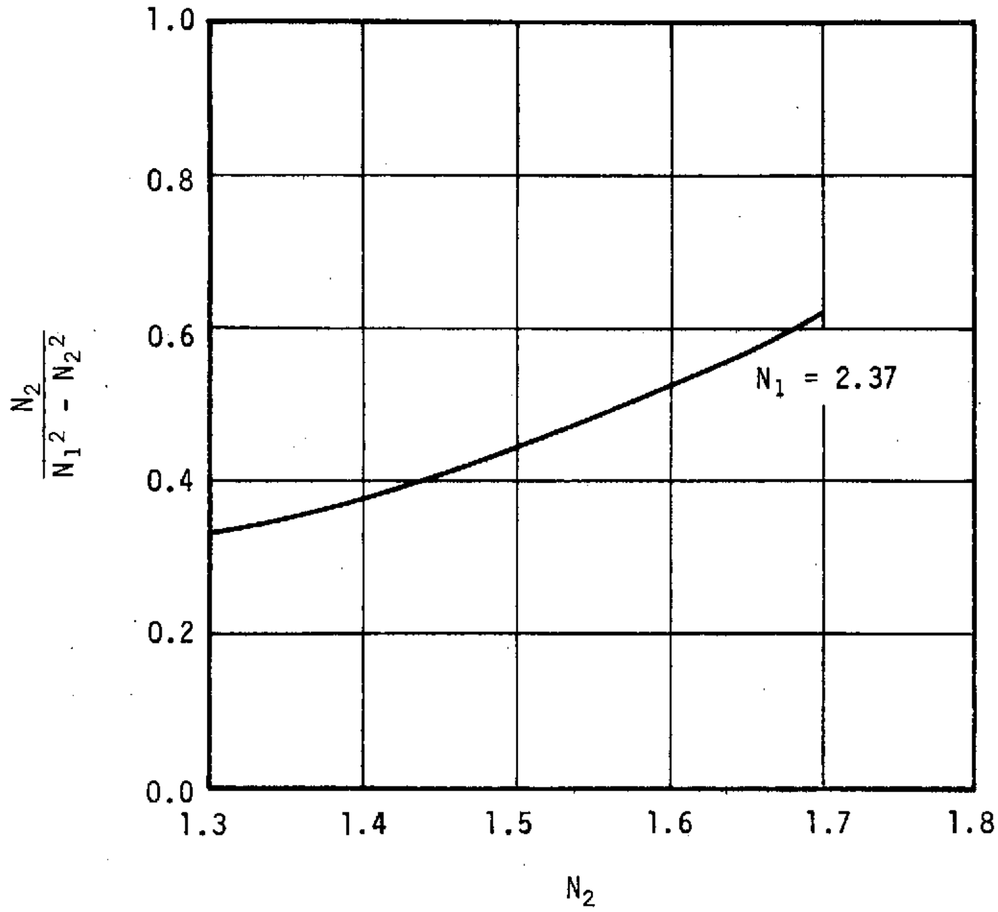


FIGURE 13. CURVE FOR $N_2/N_1^2 - N_2^2$ AS A FUNCTION OF N_2 FOR KRS-5 IRE

Figure 14 shows the variation of DP with N_2 for three IREs for the thick sample approximation. Note that the effect of N_2 variations is more severe for lower index IREs. This curve also shows that small N_2 variations (<0. 1) are not a problem unless operation is very close to the critical angle.

The limiting case for variation of N_2 is when N_2 increases to such a value that total internal reflection is no longer possible at the selected angle of incidence. The reflection losses then are due to both absorption and transmission (frustrated total reflection). Figure 15 shows the maximum N_2 values that can sustain total internal reflection for various angles of incidence, θ, above the critical angle, θ_c, for KRS-5, thick film approximation.

This figure suggests that if large N_2 changes are expected, one should operate 6 to 10 degrees above the critical angle.

In conclusion, it can be observed that small variations in N_1, as occur in the infrared spectral region, are insignificant for a particular measurement, whereas moderate changes that occur in the visible and ultraviolet regions may be quite troublesome, especially since the refractive index matching of the element and the sample is necessarily quite close in these latter two regions.

Small variations in N_2 also are relatively harmless, but large variations at absorption bands should be expected and considered in the IRE design.

IRE materials are subject to refractive index changes with temperature. Consequently, the temperature of the IRE should be maintained relatively constant during a spectral scan.

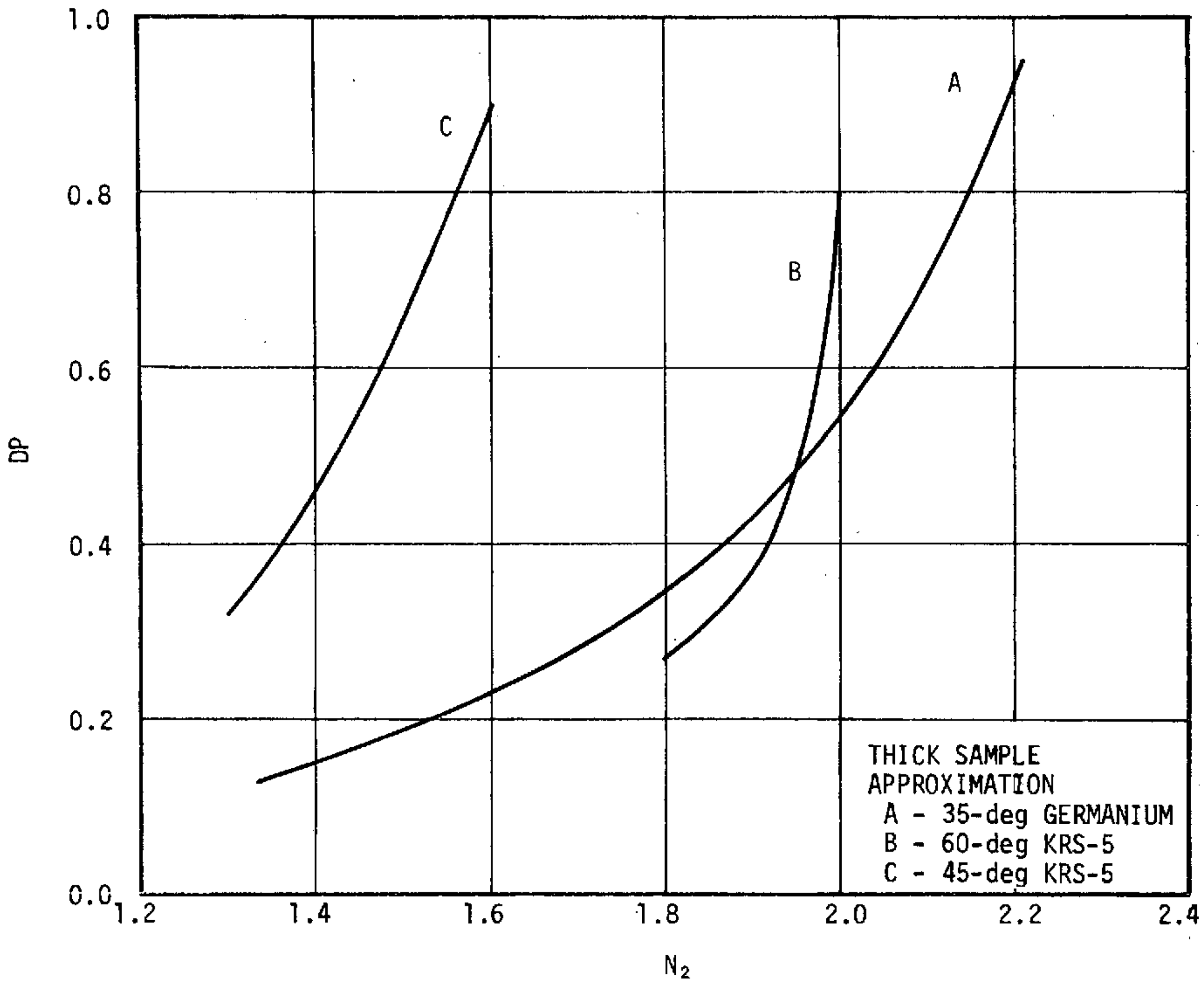


FIGURE 14. VARIATION OF DP WITH N_2 FOR SEVERAL IREs

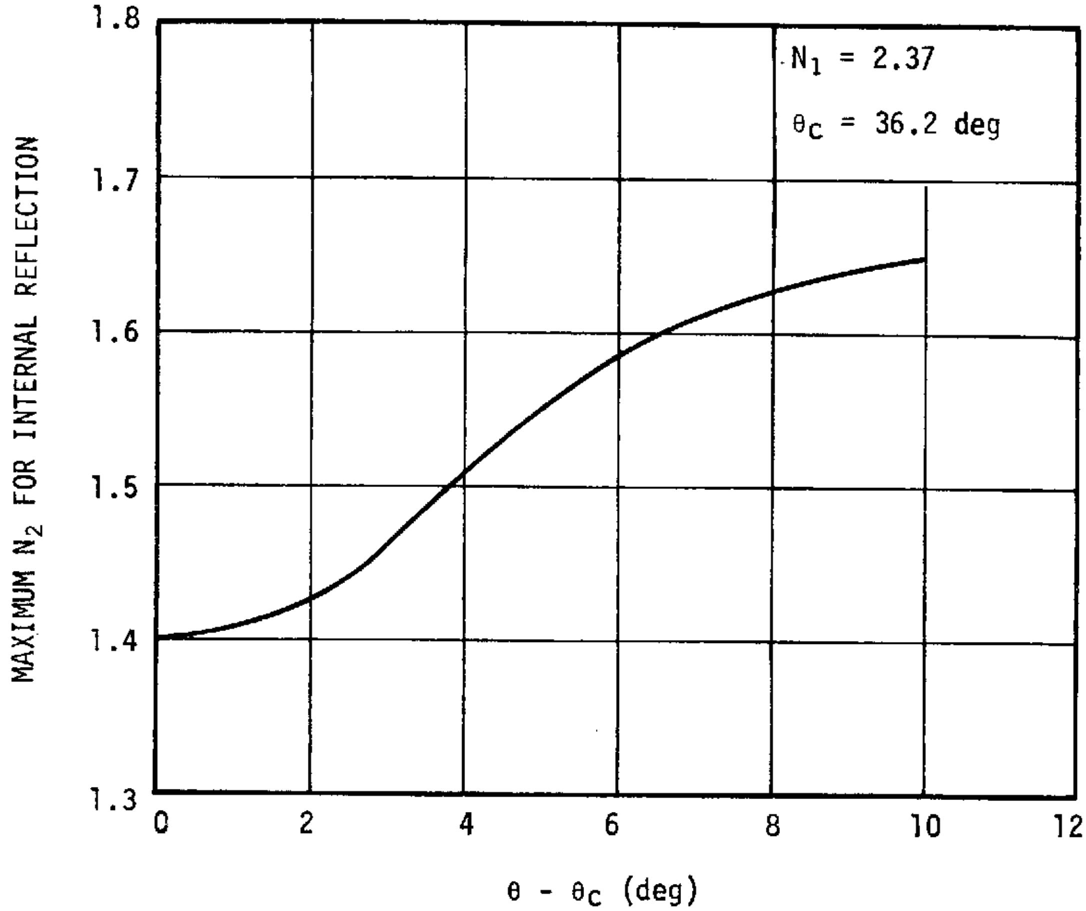


FIGURE 15. MAXIMUM N_2 VALUES THAT WILL SUSTAIN TOTAL INTERNAL REFLECTION AS A FUNCTION OF ANGLE OF OPERATION ABOVE THE ORIGINAL CRITICAL ANGLE

4.3 MISCELLANEOUS OTHER PARAMETERS AFFECTING ATR SPECTRA

Chemical reactions of the IRE with atmospheric constituents or with samples can sometimes be a source of spectral distortion. This problem can be circumvented only through proper IRE material selection.

The degree of film homogeneity will primarily affect the ATR spectra through the variation of the sample refractive index with film homogeneity. If a large area of the IRE is sampled, these effects can be minimized. When several materials comprise the sample, the refractive index of the sample will be some value intermediate between the upper and lower extremes. If the variation between the extremes is large (usually not the case), the effective thickness may be somewhat different than that for one component of the sample. In analyzing the data, the composite refractive index should be used to calculate the effective thickness.

Although the effective thickness of the sample has been shown earlier to be dependent on polarization of the incident light, no specific effects of this parameter have been mentioned. The contrast of the spectra will vary greatly with incident light polarization for most cases. This effect will be discussed in detail in Section 5.

The degree of collimation of the incident light will affect the spectral line width and the contrast of the spectra. The extent of the effect will depend on the proximity of the angle of operation to the critical angle. To obtain high sensitivity, operation must be within 6 to 10 degrees of the critical angle. In this region, one must limit divergence of the incident beam to less than 1 degree for a 5 to 10 percent variation in absorption over the range of incidence angles.

Such a variation would result in approximately a 3 to 5 percent variation in maximum band absorption for the most sensitive thin film arrangement (Figure 23, Section 5). For perpendicular polarization and thin films, the collimation requirements can be relaxed somewhat (see Figure 22, Section 5). For perpendicular polarization and thick samples, divergence or convergence should be limited to approximately 1 degree (Figure 16, Section 5). More detail on this phenomena is included in Section 5.

5. OPTIMIZATION ANALYSIS

As mentioned in Section 2, to maximize the absorption contrast, the product Md_e should be maximized, rather than d_e or M separately. The analysis which follows is based on the validity of the low absorption approximations for $d_{e\parallel}$ and $d_{e\perp}$. The optimization will be performed for the bulk approximation and the thin film approximation. When the actual sample thickness is of the order of the penetration depth, the bulk approximation should be used, but the spectra should be corrected as described in Section 3.

For a given contaminant sample of refractive index N_2 (real part), several parameters can be varied to optimize the spectra. For bulk samples and thin films, these parameters are the refractive index of the IRE, N_1, the angle of incidence, θ, and the polarization of the incident radiation. For thin films a fourth parameter, the refractive index of the third medium, also is important. The geometry of the IRE also is a variable and must be optimized simultaneously with the other parameters.

For quantitative analysis, knowing the state of polarization of the incident radiation is important. For this reason, the IRE design should be such that the initial polarization is unchanged by the IRE. This restriction requires that multiple reflection IREs have a common plane of incidence for all reflections. Then, with minor variations, the total number of internal reflections will be proportional to

$$L/t\ (\cot\ \theta)$$

where

L - the geometrical length of the utilized portion of the IRE

t - the normal distance between the multiple internal reflecting interfaces

θ - the angle of incidence of the radiation with the reflecting interface.

Since the effective thickness is independent of L/t, but dependent on θ, the quantity that will be optimized is $d_e \cot\theta$.

5.1 THICK FILMS OR BULK SAMPLES (d >> dp)

The equations of interest are

$$d_{e\perp} \cot\theta = \frac{\lambda}{\pi} \frac{N_2}{(N_1^2 - N_2^2)} \frac{\cos\theta \cot\theta}{(\sin^2\theta - N_{21}^2)^{\frac{1}{2}}} \quad (49)$$

and

$$d_{e\parallel} \cot\theta = d_{e\perp} \cot\theta \cdot \frac{(2\sin^2\theta - N_{21}^2)}{[(1 + N_{21}^2)\sin^2\theta - N_{21}^2]} \quad (50)$$

Since the wavelength dependence is easily accounted for as outlined in Section 3, it is convenient to define and optimize the following parameters:

$$DS \equiv \frac{1}{\lambda} d_{e\perp} \cot\theta \quad (51)$$

$$DP \equiv \frac{1}{\lambda} d_{e\parallel} \cot\theta \quad (52)$$

For a given wavelength, the observed change in intensity through the IRE will be directly proportional to DS and DP for perpendicular and parallel polarized light, respectively. A thorough analysis requires that the values DS and DP be calculated for the various parameters and that optimum conditions be selected from these exact calculations. A computer program was written to perform these calculations. The program listing as well as the results are presented in Appendix A. Although several tens of combinations of N_1, N_2, θ, and polarization variations can be plotted, only a few were selected to illustrate the general conclusions. For particular problems, the appropriate parameters can be located in the tabulated matrix of Appendix A and the conditions chosen which give the highest tabulated DP or DS value.

Figure 16 shows variations in DP and DS for a sample refractive index of 1.30 for various N_1 and θ combinations. Assuming that N_2 has only small variations and that collimation is very good, the optimum conditions would be $\theta = \theta_C + 2$ degrees, $N_1 \geq 3.0$, and parallel polarization.

Figure 17 shows the variation of DP with N_2 for a number of candidate IRE materials, assuming the operational angle of incidence is always 4 degrees above the critical angle for the particular N_2 value. This figure shows that high index IRE materials have quite an advantage for thick samples with refractive indices above 1.7.

A continuous variation of θ with N_2 is implicit in Figure 17. However, in a practical case, θ is usually constant for a given spectral scan, although N_2 may vary significantly as absorption bands are scanned. Figure 18 shows the variations of DP and DS with N_2 for a fixed geometry (in this case $N_1 = 4.007$ and $\theta = 27$

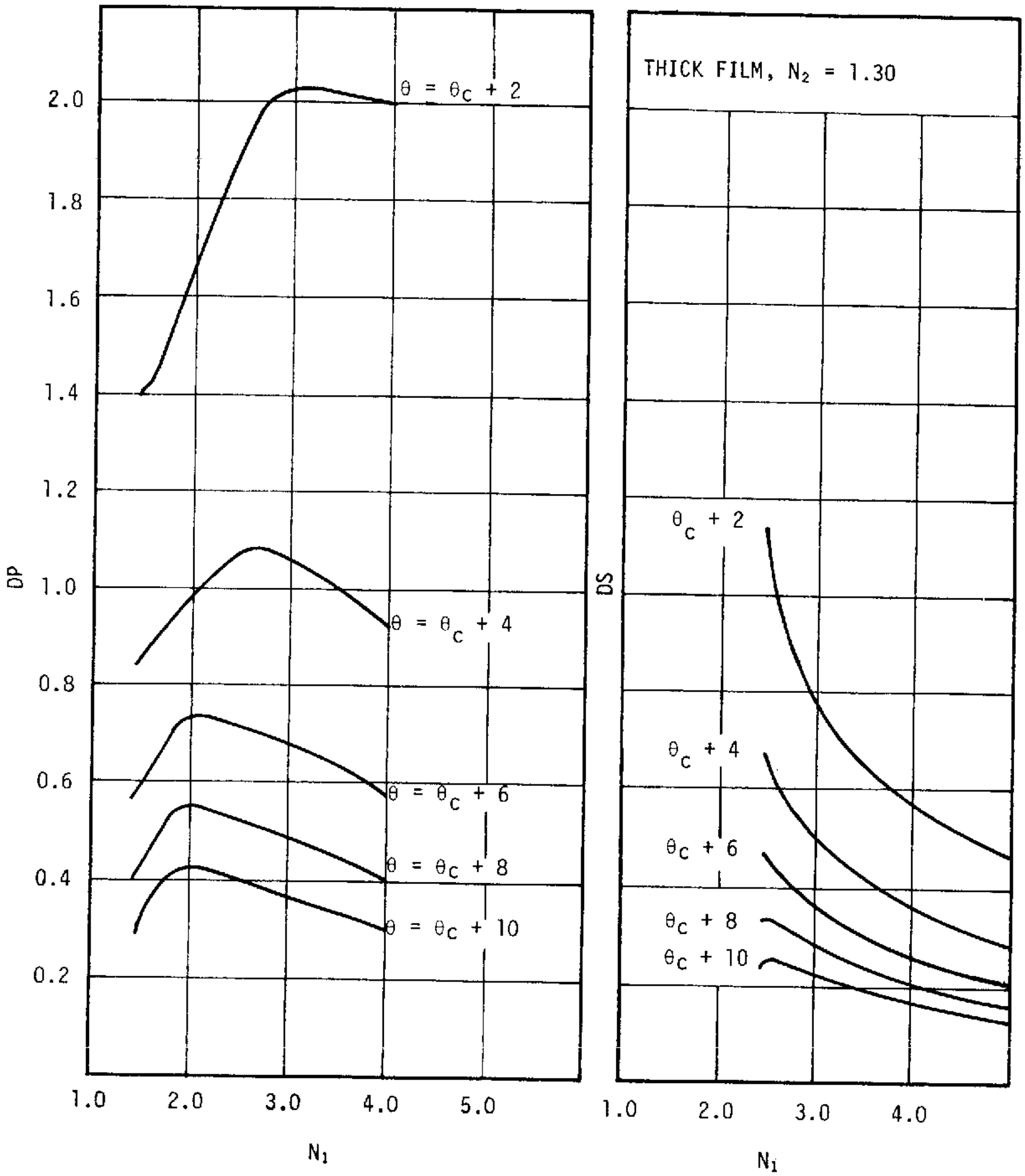


FIGURE 16. DP AND DS AS A FUNCTION OF N_1 FOR VARIOUS ANGLES OF INCIDENCE FOR THICK FILMS

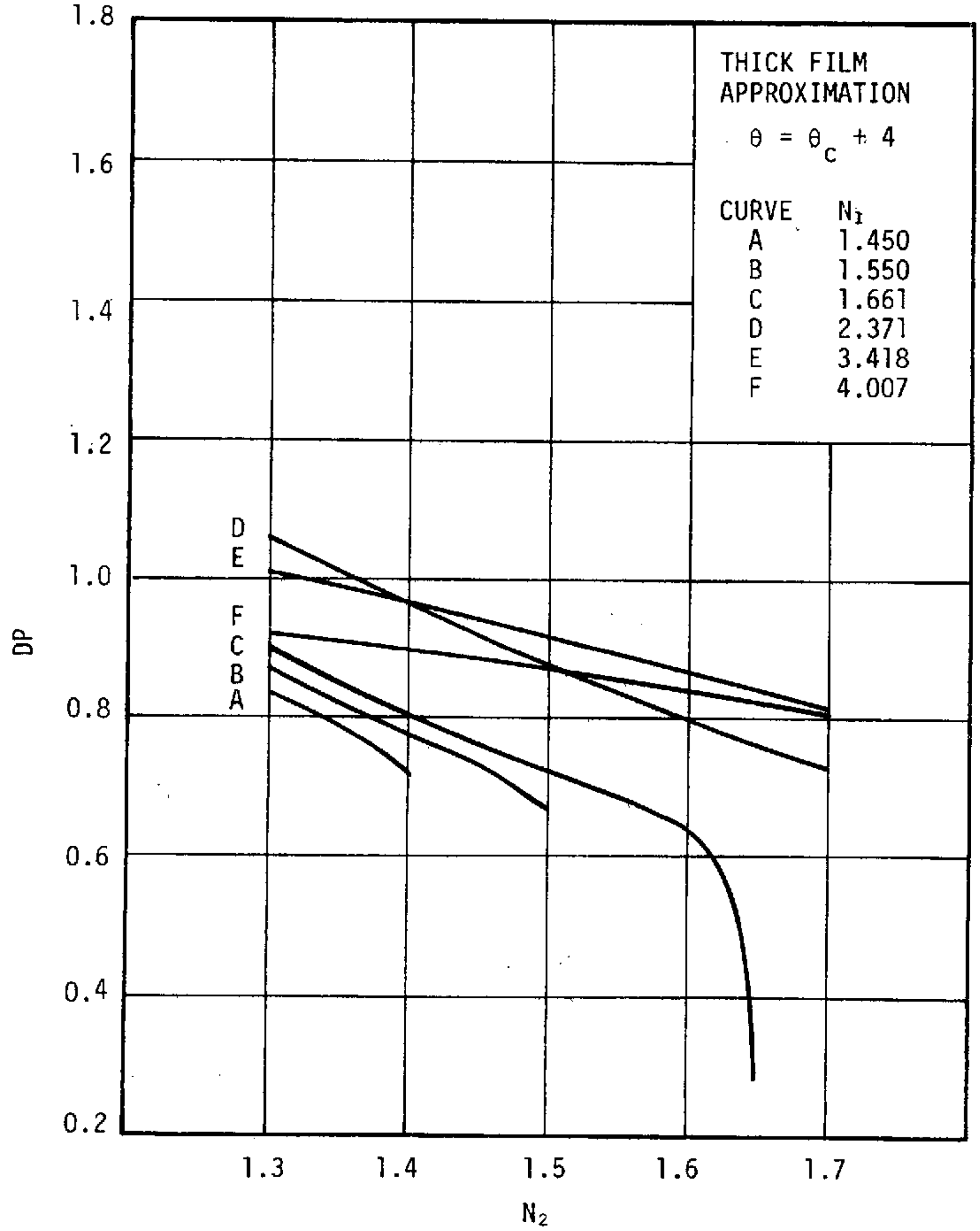


FIGURE 17. VARIATION OF DP WITH N_2 FOR $\theta = \theta_C + 4$ DEGREES FOR SEVERAL N_1 VALUES

degrees). These data were obtained from the computer output data by calculating θ_c for various N_2 values for $N_1 = 4.007$ and then picking the DP and DS values for which θ was equal to 27 degrees simultaneously with N_1 equal to 4.007 and N_2 equal to the selected values.

Figure 18 shows that if N_2 varies significantly through an absorption band, the shape of the absorption band will be distorted. The peak absorption should be calculated based on the DP or DS value calculated for the N_2 value at that particular wavelength.

For example, Figure 19 shows the variation of N_2 and k_2 for the 675-cm^{-1} band of liquid benzene. Since the absorption is proportional to $N_2 k_2$, the maximum absorption position will be shifted to lower frequencies by the refractive index. Note also that in calculating the extinction coefficient, the variation of N_2 must be considered.

It should be emphasized that the angle of incidence should be chosen considering the largest N_2 value that will be encountered. However, N_2 is largest near the absorption band minimum. Consequently, the DS and DP values are greatest in just the region where they are most significant, and very little loss of sensitivity is incurred by operating well above the critical angle to compensate for large N_2 variations.

5.2 THIN FILM SAMPLES (d << dp)

For thin films the equations of interest are

$$DS = \frac{4\, N_2 \cos\theta \cot\theta}{N_1\, (1 - N_{31}^2)} \tag{53}$$

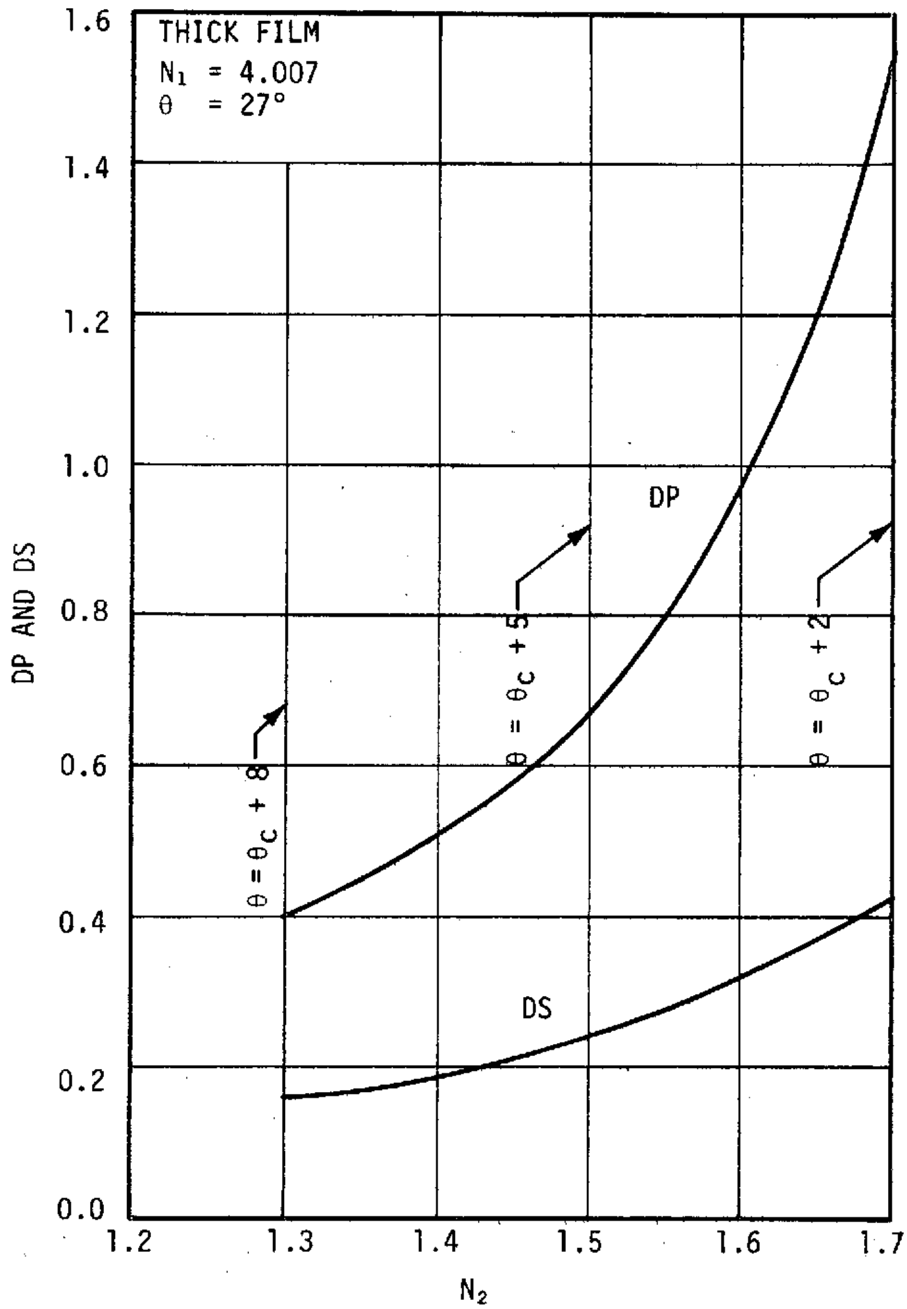


FIGURE 18. VARIATION OF DP AND DS WITH N_2 FOR FIXED θ FOR THICK FILMS

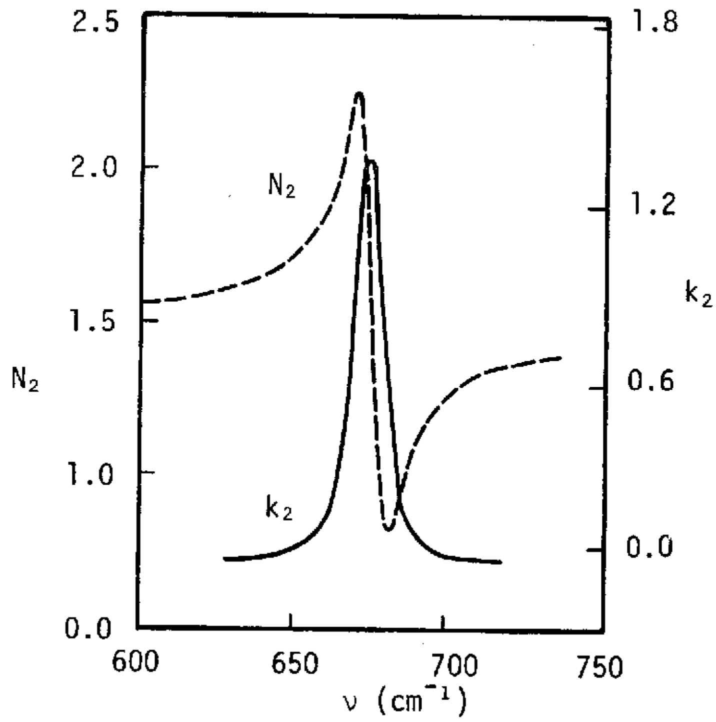


FIGURE 19. REFRACTIVE INDEX, N_2, AND EXTINCTION COEFFICIENT, k_2, for 675-cm^{-1} BAND OF LIQUID BENZENE (Ref. 5)

and

$$DP = DS \cdot \left[\frac{(1 + N_{32}^4) \sin^2 \theta - N_{31}^2}{(1 + N_{31}^2) \sin^2 \theta - N_{31}^2} \right] \tag{54}$$

For thin films there is no wavelength dependence of the effective thickness. For thin films DS and DP are related to the effective thickness by

$$DS = \frac{1}{d} \; d_{e\perp} \cot \theta \tag{55}$$

$$DP = \frac{1}{d} \; d_{e\parallel} \cot \theta \tag{56}$$

Figure 20 shows the variation of the two primary terms of Equation 53 as a function of N_1, for $N_3 = 1.00$. As evident from the composite curve of this figure, which is proportional to DS, the value of DS varies only slightly with N_1, for $N_3 = 1.00$, although the two primary terms have a strong dependence on N_1.

Figure 21 shows the variation of DS and DP with N_1 for various angles of incidence, $N_3 = 1.00$, and $N_2 = 1.4$. In general, for $N_1 > 2.0$, DP > DS, and $\theta > \theta_C + 6$, DP varies slowly with N_1. Note that DS, in general, varies slowly with N_1.

Figures 22 and 23 show the variation of DS and DP with angle of incidence above the critical angle for several possible N_1 and N_3 combinations. Note that as N_1 and N_3 get larger, DP becomes very large but DS decreases. DP also is more dependent on the angle of incidence than is DS. For very weak absorbers, the use of high N_1 and N_3 with parallel polarization can result in an order of magnitude improvement in sensitivity over the use of $N_3 = 1.0$ or perpendicularly polarized radiation.

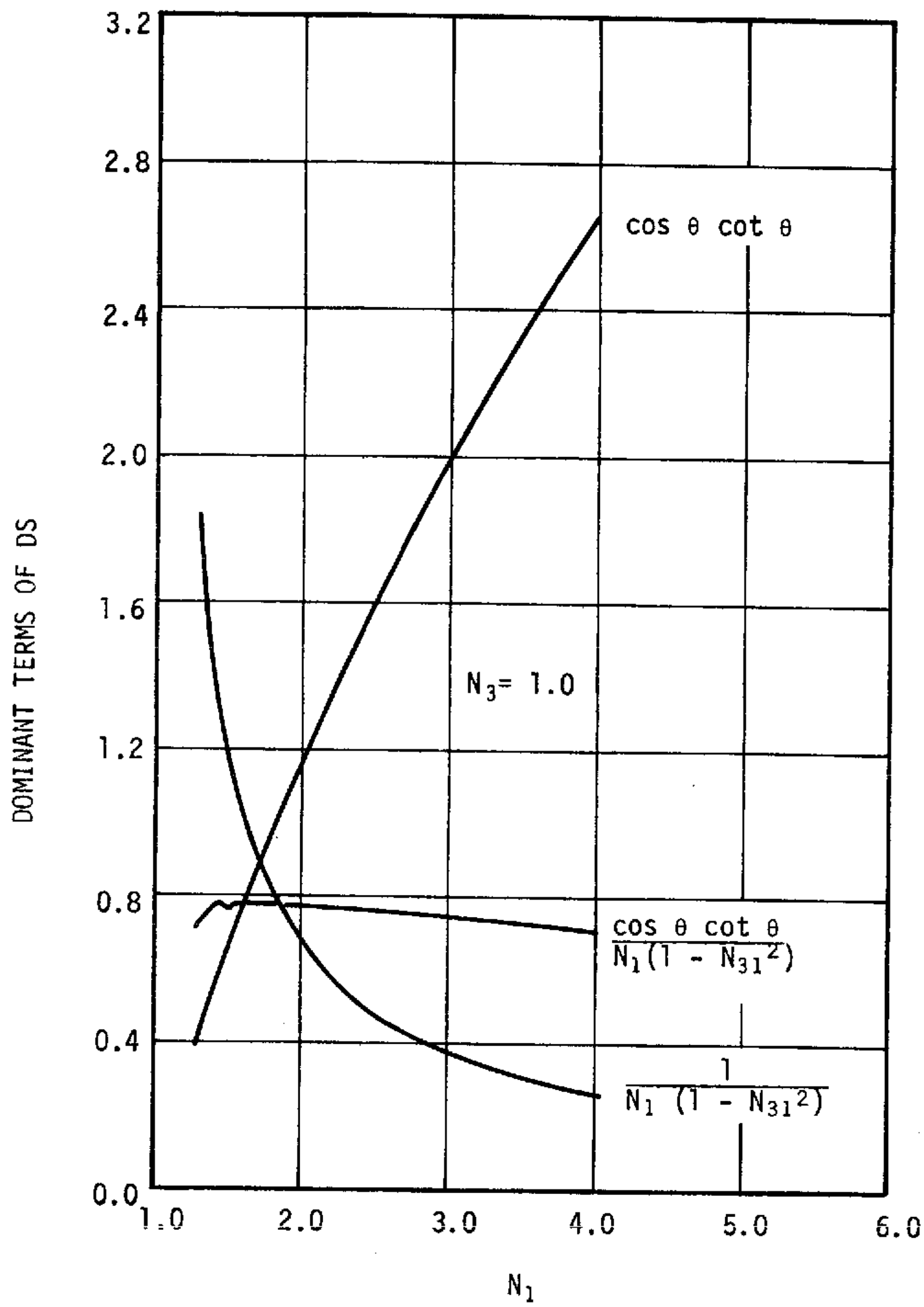
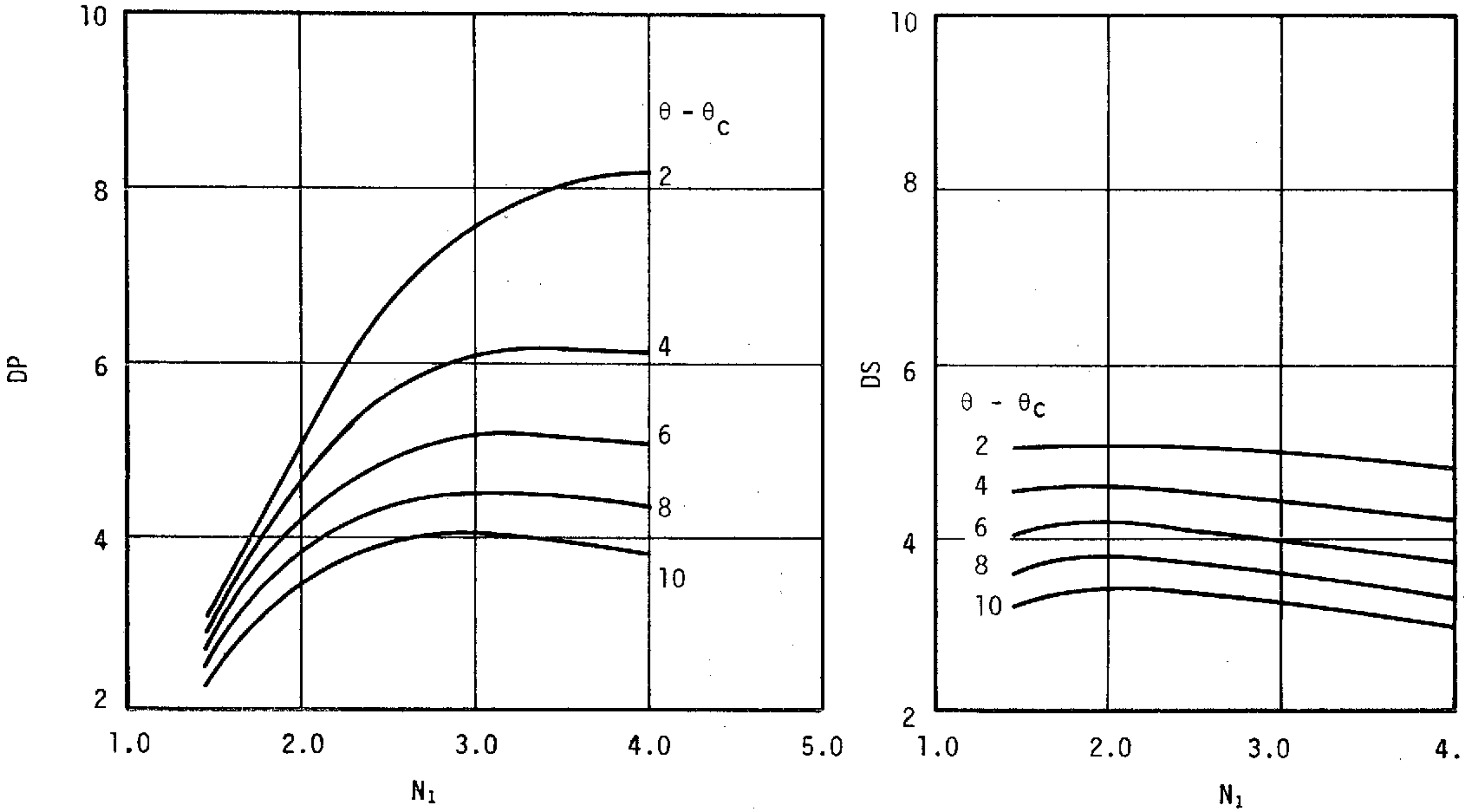


FIGURE 20. VARIATION OF DOMINANT TERMS OF DS WITH N_1



THIN FILM APPROXIMATION

FIGURE 21. DP AND DS AS A FUNCTION OF N_1 FOR VARIOUS θ VALUES FOR N_2 = 1.4 AND N_3 = 1.0

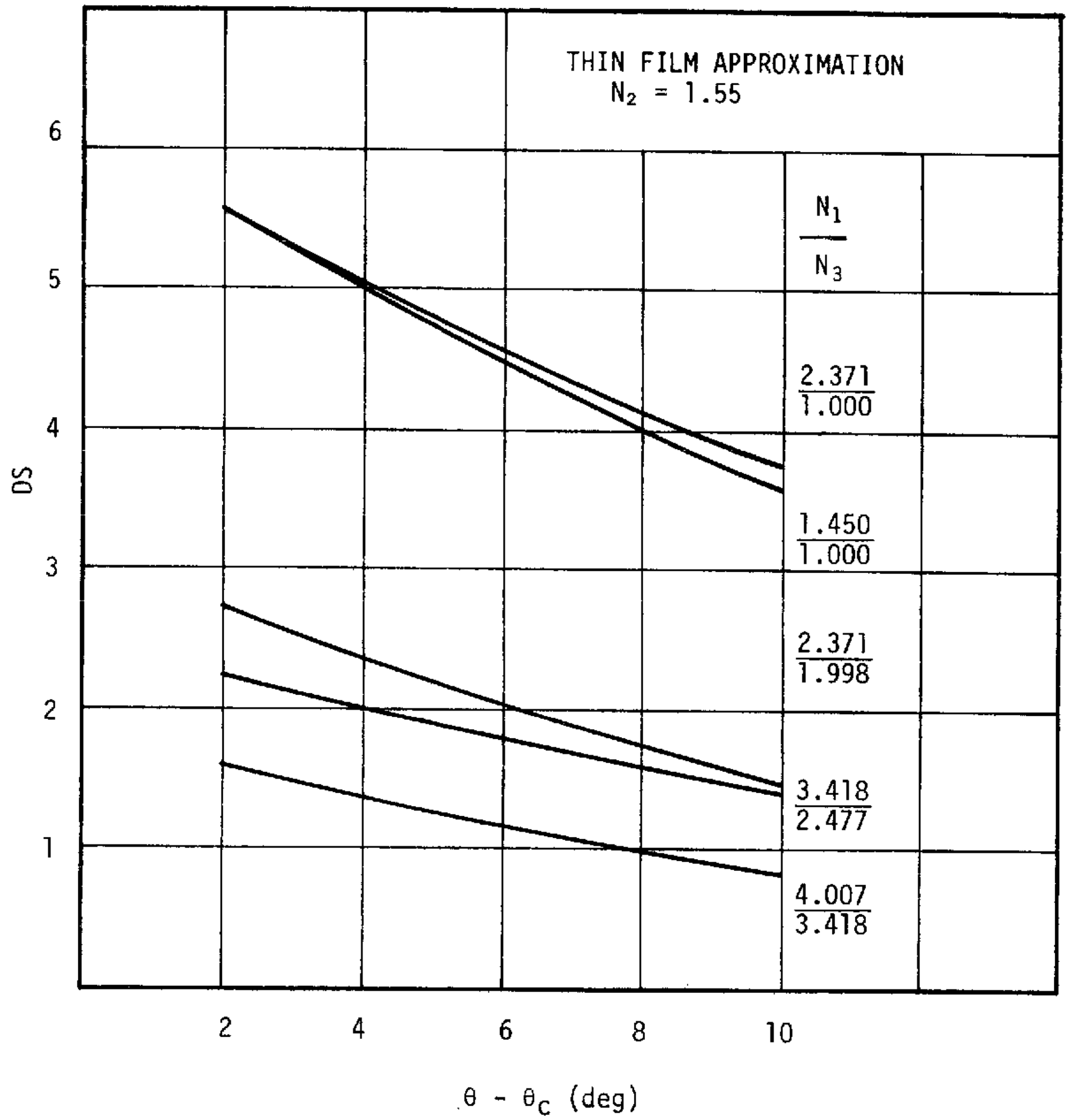


FIGURE 22. DS AS A FUNCTION OF $\theta - \theta_C$ FOR VARIOUS N_1 AND N_3 COMBINATIONS

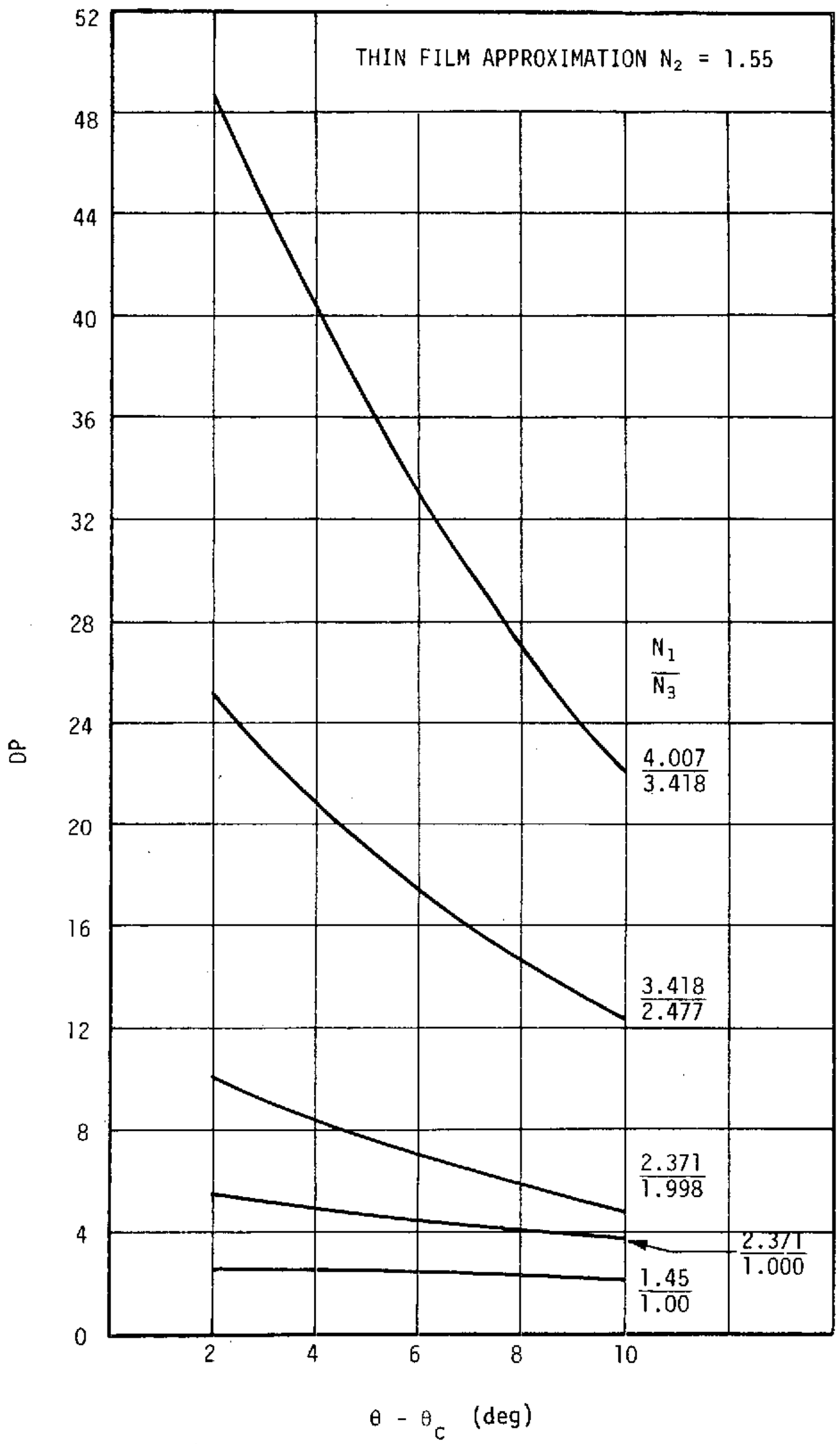


FIGURE 23. DP AS A FUNCTION OF VARIOUS N_1 AND N_3 COMBINATIONS

It should be pointed out that variations in N_2 do affect the values of DP and DS for thin films, although the primary dependence is on N_3 and N_1. Figure 24 shows that N_1 and N_3 combinations which give large DP values, in general, exhibit a DP variation of approximately a factor of 2 as N_2 varies from 1.3 to 1.7. However, for $N_1 = 1.00$ the variation of DP with N_2 is very slight. These results demonstrate the importance of considering the variation of N_2 in the vicinity of an absorption band when measuring thin films as well as when using bulk samples.

5.3 CONCLUSIONS

Several general conclusions can be drawn from the results presented above. First, an obvious conclusion is that for practically all similar N_1, N_2, N_3, and θ combinations, parallel polarization gives more sensitivity than does perpendicular polarization. In many instances over an order of magnitude gain in sensitivity can be realized by using parallel polarization rather than perpendicular polarization.

A second major observation is that, in general, as the sensitivity increases, the effects of N_2 or θ variations also increase. Since θ variations usually can be controlled by careful attention to experimental component design, the prime uncontrollable variation is that of N_2. For accurate quantitative work, variations of N_2 must be known and included in calculations of the effective thickness.

A third observation is that when using parallel polarized radiation, the use of IREs with large N_1 does not reduce the sensitivity more than 25 percent from maximum for thick films. Also, such use increases the sensitivity for thin films, particularly when used with a high N_3 value with thin films.

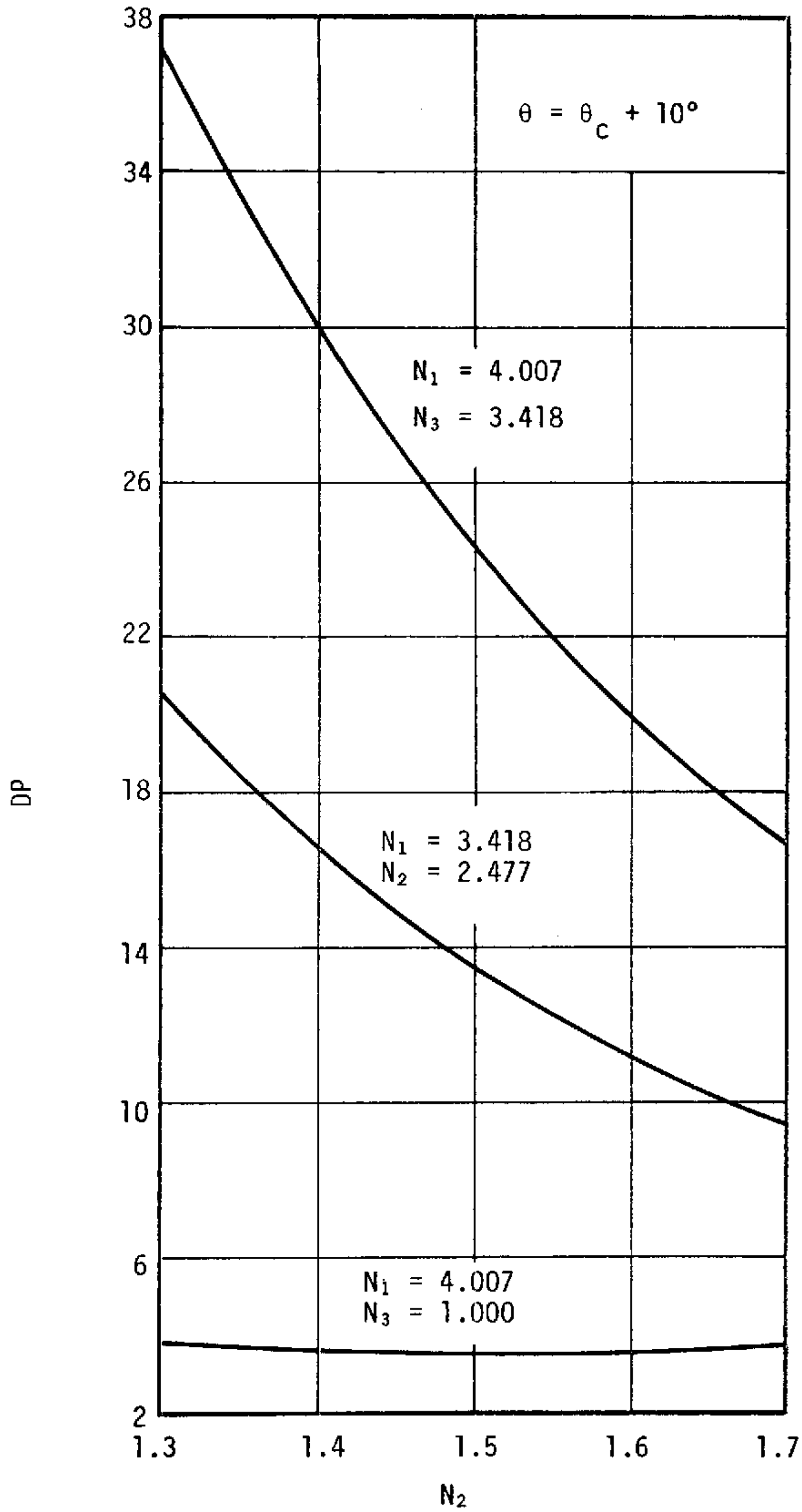


FIGURE 24. VARIATION OF DP WITH N_2 FOR SEVERAL N_3 AND N_1 COMBINATIONS

Finally, in selecting the operational angle of incidence for an IRE, care must be exercised to ensure that variations in N_2 do not result in critical angles that exceed the operational angle of incidence in the vicintiy of strong absorption bands.

6. OPTICAL AND PHYSICAL PROPERTIES OF CANDIDATE IRE MATERIALS

6.1 GENERAL CONSIDERATIONS

The criteria for selecting the IRE material are many. First, the material must be transmitting over the region of interest with negligible scattering. Since the path length in the element is long, typically 3 to 10 centimeters for 25 to 50 reflections, the material must have a very low absorption coefficient (less than $0.1\ cm^{-1}$) in the spectral region of interest. The refractive index of the material must be sufficiently higher than that of the sample to permit internal reflection at a reasonable angle of incidence.

Because the state of polarization must be known for critical work, the IRE material should not be birefringent, unless the element design can take advantage of the birefringence to maintain the desired polarization.

Ideally, the IRE would have a constant refractive index over the spectral range to be studied. As shown in the previous sections, gradual, small variations in N_1 do not present a problem. However, significant rapid variations can complicate ATR spectra.

The IRE material should be chemically inert to the sample or other environments to which it is exposed to avoid the introduction of confusing components at the interface as well as to avoid the deterioration of the element surface.

The physical and mechanical properties of prime concern include the melting point, thermal expansion, the hardness, the brittleness, and the solubility. These factors influence the ease of fabrication and the durability of the elements as well as the optical geometry stability.

In selecting materials for consideration in this study, all these factors were considered. In addition to the materials specifically listed in the RFP, various other materials were included because of their desirable properties and availability.

Materials that were examined and rejected are described in the following paragraphs. Materials that can be fabricated and used as self-supporting IREs are tabulated in the following tables along with several materials that could possibly be used as thin film waveguides for ATR spectroscopy.

6.2 REJECTED MATERIALS

6.2.1 Diamond

Although diamond is transparent in the visible region, it suffers from absorption bands near 3, 4, 5, 8, 10, and 12 micrometers. This renders it useless as an IRE in the infrared region. In the visible spectral region, the refractive index is not much different from other, cheaper, materials. Finally, since IREs require large-size crystals for fabrication, the use of diamond as a multiple IRE would be prohibitively expensive. References 6 and 7 give additional optical properties of diamond.

6.2.2 Zinc Oxide

Undoped zinc oxide is a semiconductor and as such has enough free electrons that free carrier absorption is significant above 2 micrometers. Although theoretically zinc oxide could be used in the visible region down to approximately 0.4 micrometers, large crystals are not presently available. Additional information is given in References 8, 9, and 10.

6.2.3 Cadmium Sulfide

Another semiconductor, cadmium sulfide also suffers from free carrier absorption in the infrared spectral region. The absorption coefficient is approximately 0.1 to 0.2 cm^{-1} from 2 micrometers to 11 micrometers. The maximum size of crystals at present is 1 to 2 inches in length. Cadmium sulfide may be more useful as a thin film waveguide. Its refractive index is not very different than that of KRS-5. Additional information is given in References 11, 12, and 13.

6.2.4 Indium Antimonide and Gallium Antimonide

Both of these materials have high refractive indices in the infrared spectral region. However, as all semiconductors, they suffer from free carrier absorption, which for these materials is especially high (10 to 50 cm^{-1}) in the spectral region of interest (see Refs. 14 and 15).

6.2.5 Gallium Arsenide, Gallium Phosphide, and Indium Phosphide

All of these materials have high refractive indices in the infrared spectral region. However, they are all semiconductors and free carrier absorption is too intense for long path lengths (see Ref. 16).

6.2.6 Arsenic Monoselenide

This material has a high refractive index in the infrared spectral region. Published transmittance curves indicate that the useful range of this material may extend to 20 micrometers (Ref. 17). However, detailed analysis of the data indicates that the absorption coefficient is 0.46 cm^{-1} at 10 micrometers wavelength. Since silicon has about the same refractive index and a greater transmittance range, the limited usefulness of arsenic monoselenide does not appear to make it worth consideration at this time.

6.2.7 Selenium

The refractive index of selenium is approximately 2.5 from 0.7 micrometer to 20 micrometers. However, the absorption coefficient never goes below 0.2 cm^{-1} throughout the infrared region. In addition, strong absorption bands occur near 9, 12, 17, and 20 micrometers. Amorphous selenium might be used as a thin film waveguide (see Refs. 18, 19, and 20 for further details).

6.2.8 Germanium Glasses

Several good germanium, selenium, and tellurium glasses are available. These glasses have refractive indices greater than 3 in the infrared spectral region. However, the glasses are expensive and soft and offer little that cannot be obtained using more commonplace materials (see Refs. 7, 12, and 21).

6.3 CANDIDATE IRE MATERIALS

The materials that can be used in the infrared spectral region include KRS-5, KRS-6, silicon, germanium, silver chloride, arsenic trisulfide, Texas Instrument No. 1173 glass, arsenic modified selenium glass, Texas Instrument No. 20 glass, cesium bromide, sodium fluoride, barium fluoride, calcium fluoride, lithium fluoride, Irtran 2, and silver bromide.

Materials that can be used in the far ultraviolet and visible spectral regions include lithium fluoride, calcium fluoride, sodium fluoride, magnesium fluoride, fused silica, sapphire, ammonium dihydrogen phosphate (ADP), potassium dihydrogen phosphate (KDP), barium fluoride, sodium chloride, potassium chloride, and potassium bromide.

Materials that can be used in the vacuum ultraviolet spectral region include lithium fluoride, calcium fluoride, barium fluoride, magnesium fluoride, sapphire, and fused silica, to a limited extent.

Table 2 summarizes the pertinent physical properties of the materials for the infrared spectral region. For the region 2 to 20 micrometers, the materials with most appeal are cesium bromide ($N \approx 1.65$), silver chloride ($N \approx 2.0$), KRS-5 ($N \approx 2.37$), silicon ($N \approx 3.42$), silver bromide ($N \approx 2.3$), and germanium ($N \approx 4.0$). Cesium bromide has a high solubility in water (124 g/100 g H_2O) and is quite soft. Silver chloride is extremely soft and must be handled and cleaned carefully to avoid surface finish destruction. Silver bromide has low solubility, but is extremely soft. Potassium bromide transmits to about 18 micrometers, but has high solubility. Potassium fluoride and potassium iodide have extended transmission ranges but also are highly soluble. Practically all of the alkali halides have useful optical properties in the infrared spectral region, but almost all are highly soluble and deteriorate in atmospheres with relative humidity greater than 35 percent. The booklet "Harshaw Optical Crystals" available from Harshaw Chemical Company, Cleveland, Ohio (Ref. 37), provides much information on many of the materials considered.

For the vacuum ultraviolet and ultraviolet spectral regions, very few materials are available which have high refractive indices. Sapphire can be used as a long path optical element only down to about 0.22 micrometer, while fused silica can be used to about 0.18 micrometer. The variations of the refractive indices with wavelength (ordinary ray) for these two materials are shown in Figures 25 and 26. The variation of the refractive index of lithium

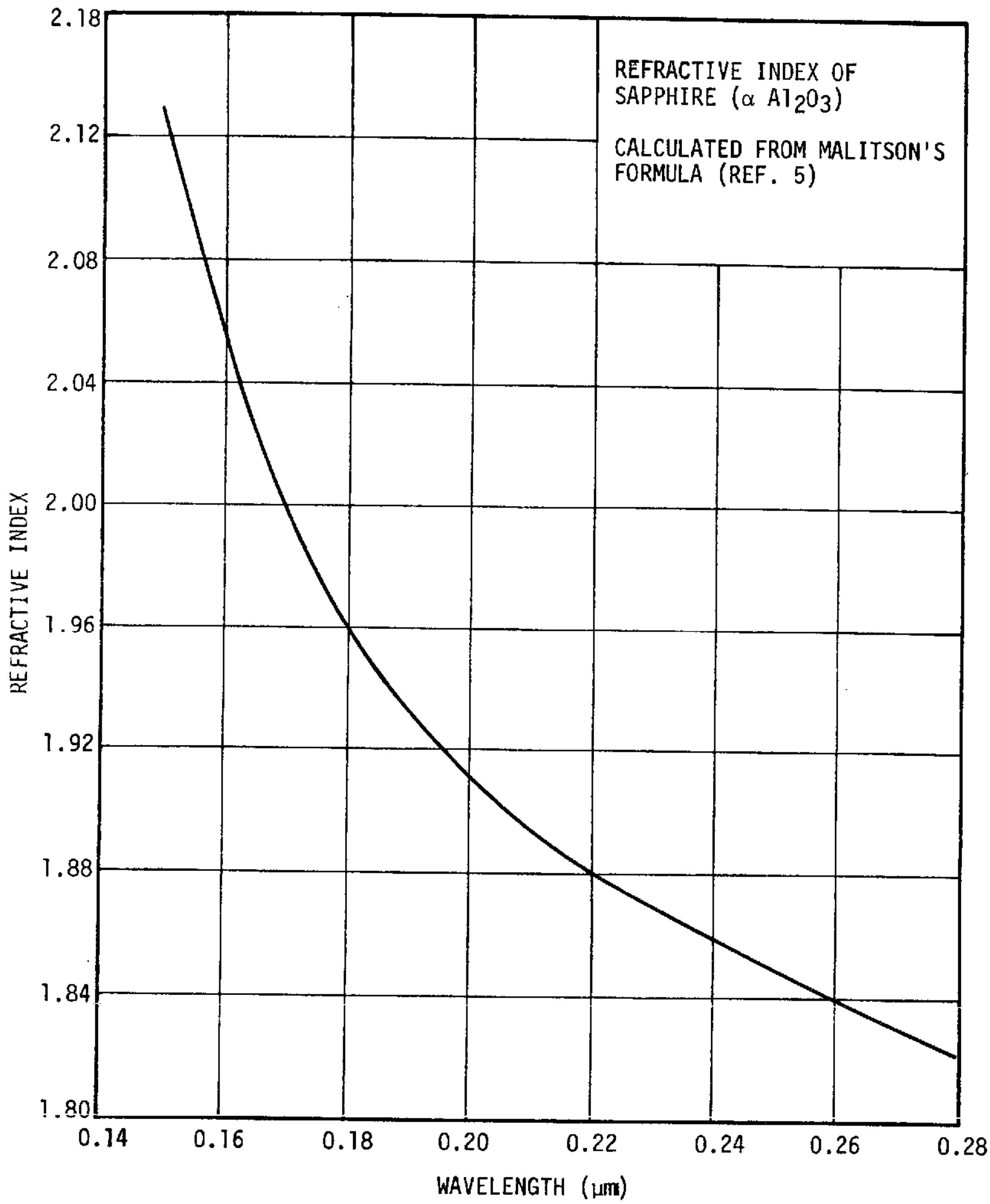


FIGURE 25. REFRACTIVE INDEX OF SAPPHIRE IN THE VACUUM ULTRAVIOLET AND ULTRAVIOLET SPECTRAL REGIONS

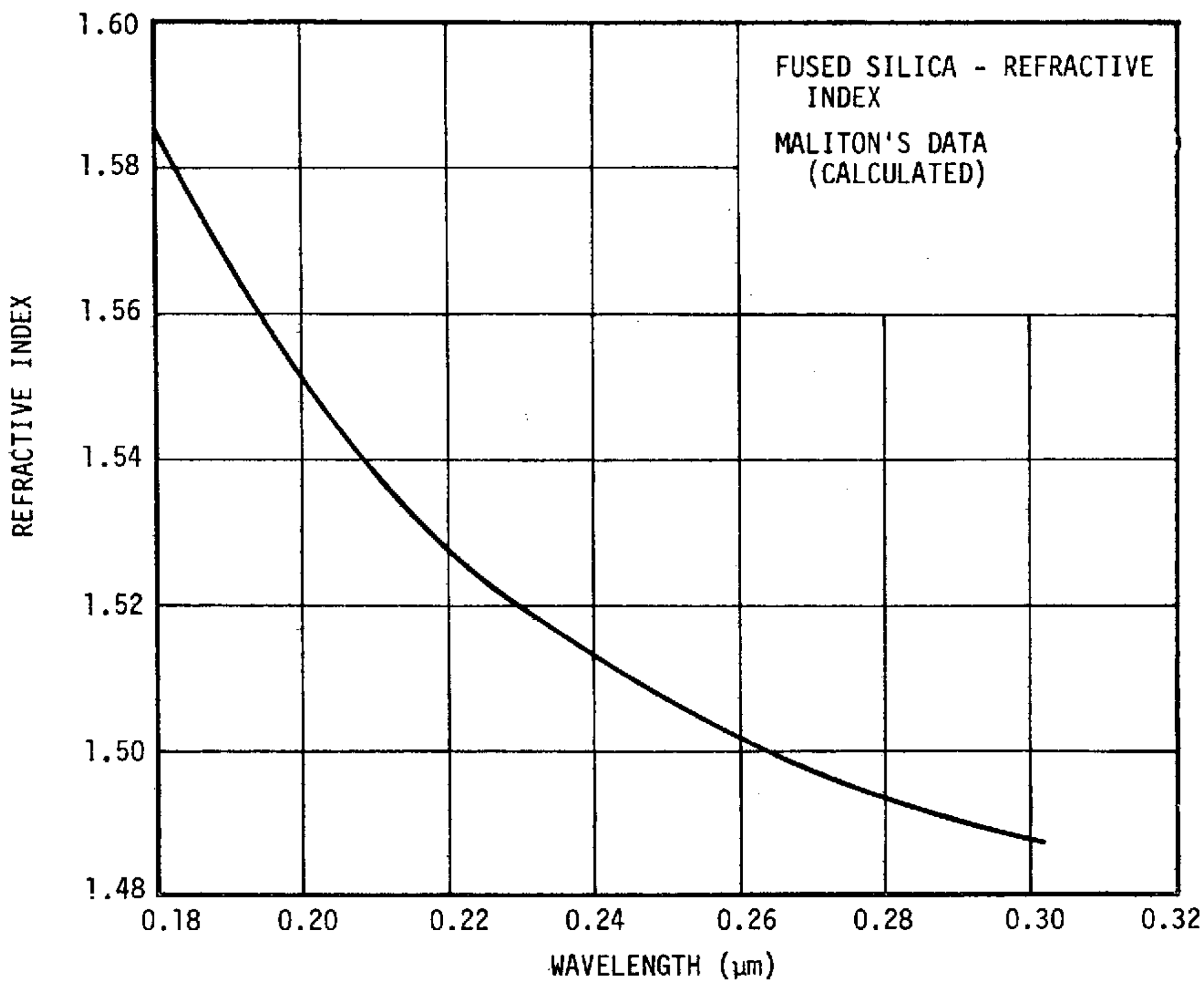


FIGURE 26. REFRACTIVE INDEX OF FUSED SILICA IN THE ULTRAVIOLET SPECTRAL REGION

TABLE 2. OPTICAL AND PHYSICAL PROPERTIES OF INFRARED IRE MATERIALS

WAVELENGTH (μm)	REFRACTIVE INDEX								
	LiF	CaF_2	CsBr	NaF	BaF_2	Si	Ge	ZnO	KBr
0.5	1.3943		1.71	1.327	1.477			2.0511	
1.0	1.3871	1.42888	1.677	1.322	1.468			1.9435	1.54
2.0	1.3788	1.42388	1.672	1.317	1.465	3.4534	4.1066	1.9197	
3.0	1.3666	1.41788	1.669	1.313	1.461	3.4320	4.0452	1.9075	
4.0	1.3494	1.40963	1.668	1.308	1.457	3.4253	4.0246	1.8891	
5.0	1.3266	1.39895	1.667	1.301	1.451	3.4223	4.0152		
6.0	1.2975	1.38559	1.666	1.293	1.445	3.4202	4.0100		
7.0	1.26	1.36932	1.665	1.283	1.438	3.4189	4.0071		
8.0	1.22	1.34983	1.664	1.270	1.432	3.4184	4.0048		
9.0	1.17	1.32677	1.663	1.255	1.426	3.4181	4.0038		
10.0			1.662	1.237	1.420	3.4179	4.0032		1.44
11.0			1.661	1.22	1.414	3.4176	4.0028		
12.0			1.659	1.18		3.4176	4.0024		
13.0			1.658	1.17		3.4176	4.0021		
14.0			1.657	1.12		3.4176	4.0015		
15.0			1.655	1.09		3.4176	4.0014		
16.0			1.653	1.06			4.0012		
17.0			1.651	1.00					
18.0			1.648	0.96					
19.0			1.646	0.89					
20.0			1.644	0.82					
21.0			1.641	0.70					
22.0			1.638	0.55					

TABLE 2 - Continued

WAVELENGTH (μm)	REFRACTIVE INDEX								
	LiF	CaF_2	CsBr	NaF	BaF_2	Si	Ge	ZnO	KBr
23.0			1.635	0.33					
24.0			1.632	0.24					
25.0			1.628						
26.0			1.625						
27.0			1.621						
28.0			1.617						
29.0			1.614						
30.0			1.609						
Knoop Hardness	113	158	19.5	60	65-80	1100-1400	700-880	Not Available	7
Solubility (g/100g H_2O)	0.27	0.0017	124	4.2	0.16	<0.005	<0.005	10^{-4}	65.2
Melting/ Softening Temp. (°K)	1403	1613	909	1270	1553	1693	1209	2100	1003
References	22, 7	23	24	7	25,26	27	27	28	29,37

TABLE 2 - Continued

WAVELENGTH (μm)	REFRACTIVE INDEX TI # 1173	As_2S_3	KRS-5 25°C	Se(As) 27°C	IRTRAN 2	TiO_2	$SrTiO_3$	AgCl 23.9°C	CdS
0.5		2.69*						2.0965	
1.0	2.7235	2.4777	2.4462	2.5815	2.2907		2.316	2.0224	2.34
2.0	2.6402	2.4262	2.3950	2.5005	2.2631	2.399	2.267	2.0062	2.28
3.0	2.6263	2.4161	2.3857	2.4882	2.2558	2.380	2.230	2.0023	2.275
4.0	2.6200	2.4112	2.3820	2.4835	2.2504	2.350	2.185	1.9998	2.27
5.0	2.6165	2.4073	2.3798	2.4811	2.2447	2.290	2.123	1.9975	2.26
6.0	2.6135	2.4033	2.3780	2.4798	2.2381			1.9948	2.255
7.0	2.6102	2.3990	2.3763	2.4787	2.2304			1.9919	2.25
8.0	2.6076	2.3940	2.3745	2.4779	2.2213			1.9885	2.245
9.0	2.6040	2.3883	2.3727	2.4772	2.2107			1.9846	2.24
10.0	2.6002	2.3816	2.3707	2.4767	2.1986			1.9803	2.23
11.0	2.5962	2.3737	2.3685	2.4758	2.1846			1.9756	2.22
12.0	2.5921	2.3645	2.3662	2.4749	2.1688			1.9703	2.21
13.0			2.3637	2.4760	2.1508			1.9644	2.19
14.0			2.3610	2.4743				1.9581	2.18
15.0			2.3581					1.9511	
16.0			2.3550					1.9436	
17.0			2.3517					1.9354	
18.0			2.3482					1.9266	
19.0			2.3445					1.9171	
20.0			2.3406					1.9069	
21.0			2.3364						
22.0			2.3321						

TABLE 2 - Continued

	REFRACTIVE INDEX								
WAVELENGTH (μm)	TI # 1173	As_2S_3	KRS-5 25°C	Se(As) 27°C	IRTRAN 2	TiO_2	$SrTiO_3$	AgCl 23.9°C	CdS
23.0			2.3275						
24.0			2.3226						
25.0			2.3176						
26.0			2.3123						
27.0			2.3068						
28.0			2.3010						
29.0			2.2950						
30.0			2.2887						
Knoop Hardness	150	109	40		354	879	595	9.5	122
Solubility (g/100g H_2O)	Insol.	$5x10^{-5}$	0.05		Insol.	<0.001	<0.01	$1.5x10^{-4}$	10^{-4}
Melting/ Softening Temp. (°K)	370	483	688		2200	2093	2353	731	1253
References	30	31	27	27	32	7	7	7	11, 12, 13

TABLE 2 - Continued

	REFRACTIVE INDEX					
WAVELENGTH (μm)	CdSe (N_o)	$LiTaO_3$ (N_o)[3]	GaP	YAG	TI #20 GLASS	AgBr
0.5		2.2160	3.4595	1.8450		2.31
1.0	2.5502	2.1391	3.1192	1.8197	2.547	
2.0	2.4682	2.1066	3.0379	1.8035	2.524	
3.0	2.4522	2.0755	3.0215	1.7855	2.513	
4.0	2.4491	2.0335	3.0137	1.7602	2.508	
5.0					2.505	
6.0					2.503	
7.0					2.500	
8.0					2.498	
9.0					2.495	
10.0					2.492	
11.0					2.488	
					2.482	
					$\alpha > 0.2$ beyond 11 μm	
20.0						2.0
Knoop Hardness	Not Available					5
Solubility (g/100g H_2O)	Insol.					1×10^{-5}
Melting/ Softening Temp. (°K)	1350					705
References	28	28	28	28	30	37

TABLE 2 - Concluded

WAVELENGTH (μm)	REFRACTIVE INDEX GaAs	SAPPHIRE N_o (24°C)	ULTRAVIOLET SAPPHIRE	QUARTZ (fused)	QUARTZ (UV)	MgF_2
0.2				1.566	1.566	
0.5		1.774		1.462	1.462	1.38
1.0	3.34	1.755		1.450	1.450	
2.0		1.738		1.438	1.438	
3.0		1.712		1.419	1.419	
4.0		1.675				
5.0		1.624				1.33
6.0						
7.0						
8.0	3.34					
9.0						
10.0	3.14					
11.0	3.04					
12.0						
13.0	2.97					
14.0						
15.0	2.73					
16.0						
17.0	2.59					
18.0						
19.0	2.41					
20.0						
21.0						
22.0	2.12					
23.0						
24.0						
25.0						
26.0						
27.0						
28.0						
29.0						
30.0						
Knoop Hardness		1500-2000	1500-2000	461	461	415
Solubility (g/100g H_2O)		9.8×10^{-5}	9.8×10^{-5}	<0.001	<0.001	0.0076
Melting/ Softening Temp. (°K)		2303	2303	1943	1943	1498
References	7	33	33	34	34	25, 35, 36

fluoride with wavelength is shown in Figure 27. Since all of the materials which transmit in the vacuum ultraviolet spectral region have low refractive indices, these materials could be used as IREs only when thin film samples were used. In addition, the rapid variation of the refractive indices of these materials complicates the analysis of the data.

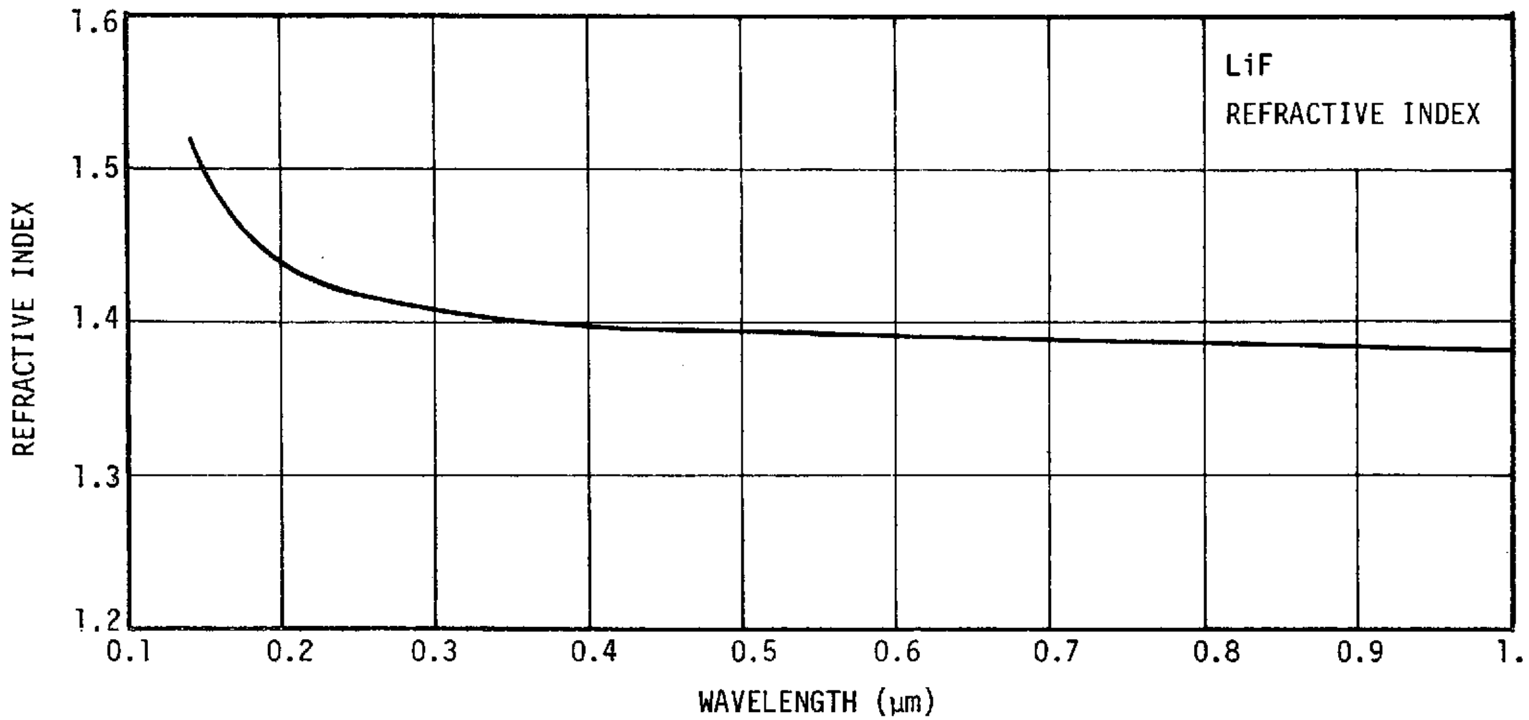


FIGURE 27. REFRACTIVE INDEX OF LITHIUM FLUORIDE FROM 0.1 TO 1.0 MICROMETERS

7. OPTICAL PROPERTIES OF POTENTIAL CONTAMINANTS

7.1 GENERAL DISCUSSION

The optical properties that should be known for the potential contaminants are the identifying absorption bands and the refractive index as a function of wavelength for the spectral region of interest.

The contaminants considered pertinent to this study include Dow Corning 704 and 705 silicone diffusion pump oils, Houghton Safe 1120 and Sun Vis 706 forepump oils, Dow Corning 11 lubricant, and volatile components of 3M Black Velvet paint.

The infrared absorption spectra of these contaminants have been recorded by various workers. Hummel (Ref. 38) and Wolff (Ref. 39) in particular have measured the spectra of several of these compounds in the infrared spectral region. Sowers, et. al. (Ref. 40), have measured the optical properties of DC 704 and DC 705 in the visible, ultraviolet, and vacuum ultraviolet spectral regions. Dow Corning Analytical Laboratories (Ref. 41) have measured the refractive index of the Dow Corning materials in the visible region. However, the infrared refractive indices of these materials have not been published in the open literature that have been reivewed to date. Since the characteristic infrared absorption bands are so strong, the refractive index is expected to vary significantly in the region of the absorption bands. For quantitative analysis of the ATR spectra of these contaminants, the variation of the refractive index with wavelength should be determined for the infrared spectral region. The known optical properties of these contaminants are summarized below.

7.2 DC 704 (TETRAMETHYLTETRAPHENYTRISILOXANE) AND DC 705 (TRIMETHYLPENTAPHENYLTRISILOXANE)

The primary groups used to identify these materials are the methyl C-H stretch at 3.42 micrometers, and the silicon-methyl stretch groups at 7.0, 8.0, and 12.5 micrometers. The 7.0-micrometer band is especially helpful in discriminating DC 704 and DC 705 from polydimethylsiloxane lubricants. Calculations based on Hummel's data for the 7.0-micrometer band of pure DC 704 indicates that the absorption coefficient at the peak is approximately 4×10^3 cm^{-1}. Reduction of Wolff's data for the 7.0-micrometer band indicates an absorption coefficient of approximately 1.6×10^4 cm^{-1}. Since the variation of these two sources is a factor of four, the calculations are included below.

7.2.1 Calculation of Absorption Coefficient from Wolff's Data

For the 7.0-micrometer band, Wolff obtained an absorptance of approximately 1.2 for a contamination of 2×10^{-7} g/cm^2. The total contaminant collected was $(2 \times 10^{-7}\ g/cm^2)(926\ cm^2) = 1.852 \times 10^{-4}$ g. Since DC 705 has a molecular weight of approximately 500, the sample consisted of approximately 3.7×10^{-7} moles.

The absorptance, A, is defined as

$$A = \log_{10} \frac{I_o}{I} = \epsilon C \ell$$

where

ϵ - the molecular absorption coefficient

C - the concentration in moles per liter

ℓ - the path length through the sample

I_o - incident intensity

I - transmitted intensity.

The sample consisted of a 13-millimeter-diameter potassium bromide pellet so that $C\ell$ of the sample was

$$C = \frac{3.7 \times 10^{-7} \text{ moles}}{\text{volume of pellet}} \times \text{Thickness of Pellet}$$

$$= \frac{3.7 \times 10^{-7} \text{ moles}}{\text{area of pellet}}$$

$$= \frac{3.7 \times 10^{-7} \text{ moles}}{1.33 \text{ cm}^2} \times \frac{1000 \text{ cm}^3}{\text{liter}}$$

$$C\ell = 2.78 \times 10^{-4} \frac{\text{mole} \cdot \text{cm}}{\text{liter}}$$

then

$$\epsilon = \frac{1}{C\ell} A = \frac{1.2}{2.78 \times 10^{-4}} \quad \frac{\text{liter}}{\text{mole} \cdot \text{cm}}$$

$$\epsilon = 4.31 \times 10^3 \frac{\text{liter}}{\text{mole} \cdot \text{cm}}$$

This can be related to the linear absorption coefficient, α, of pure material by

$$\ln\left(\frac{I_o}{I}\right) = \alpha\ell = 2.3 \log_{10}\left(\frac{I_o}{I}\right)$$

or

$$\alpha = 2.3\, \epsilon C$$

Since the concentration (C) of pure material is approximately 1.6 moles per liter,

$$\alpha = (2.3)\left(4.31 \times 10^{3} \ \frac{\text{liter}}{\text{mole} \cdot \text{cm}}\right)\left(1.6 \ \frac{\text{mole}}{\text{liter}}\right)$$

$$\alpha = 1.58 \times 10^{4} \ \text{cm}^{-1}$$

7.2.2 Calculation of Absorption Coefficient from Hummel's Data

Hummel's data is for a sample of pure DC 704, 0.005-millimeter thick. Therefore, α can be calculated directly from

$$\alpha = \left(\frac{1}{5 \times 10^{-4} \ \text{cm}}\right) \ln (7.7)$$

$$\alpha = 4.08 \times 10^{3} \ \text{cm}^{-1}$$

The refractive index varies from approximately 2.0 at 0.24 micrometer to about 1.55 at 0.6 micrometer. It is expected that the refractive index remains approximately 1.5 through the infrared spectral region except in the vicinity of strong absorption bands where it probably increases to between 1.7 and 2.0.

7.3 DC-11

The principal absorption bands used for identification of this contaminant are the 3.4-micrometer (C-H stretch), the 7.9-micrometer (CH_3-rocking), and the 11.9- and 12.5-micrometer bands (Ref. 38). The absorption coefficients at the stronger bands are of the order of 10^{3} cm^{-1}. The refractive index in the visible spectral region is approximately 1.45. In the vacuum ultraviolet the refractive index increases to 2.3 and the absorption coefficient exceeds 10^5 cm^{-1}.

7.4 SUN VIS 706 and HOUGHTON SAFE 1120

These forepump oils are typical hydrocarbon based oils with primary identification bands being the 3.4-micrometer (C-H stretch), the 6.8-micrometer (CH_2 symmetrical and CH_3 asymmetrical scissors), and the 7.3-micrometer (CH_3 symmetrical scissors) bands. The absorption coefficient in the vicinity of the 3.42-micrometer band approaches 10^4 cm^{-1}.

The refractive index in the visible is approximately 1.47. It is expected to increase in the vicinity of the strong absorption bands in the infrared spectral region.

In the vacuum ultraviolet, the absorption coefficient exceeds 10^5 cm^{-1} and the refractive index exceeds 2.0 near the electronic absorption bands.

7.5 3M BLACK VELVET PAINT

This paint utilizes a tall oil alkyd based binder which is expected to present the primary outgassing problem. The spectrum to be observed should be that of dioctyl phthalate ester, which has absorption bands at 3.4, 5.8, 6.8, 7.2, and 7.8 micrometers. The band of most practical use is expected to be the 5.8-micrometer band. The absorption coefficient at the peak of this band is of the order of 10^3 cm^{-1}. The refractive index in the visible spectral region is approximately 1.5.

8. IRE DESIGN

8.1 SELECTION OF SPECTRAL REGION

The design of an IRE for real-time contamination detection and identification must consider several trade-offs. The first trade-off is that between maximum detection sensitivity and contaminant identification. The strongest absorption bands are found in the vacuum ultraviolet spectral region between 0.12 micrometer (1,200 Å) and 0.22 micrometer (2,200 Å). Although the gross identifying features characteristic of certain groups of contaminants may be inferred from the recorded spectra in this region, unique identification of single components is difficult and analysis of multicomponent samples is virtually impossible. In addition, materials which are sufficiently transparent in the vacuum ultraviolet have very low refractive indices, which are changing rapidly in this spectral region. For most of the contaminants considered in the previous section, the sample refractive index exceeds that of the candidate IRE materials. Although the use of thin film samples may circumvent this problem, the rapid variation of both the IRE material and the sample refractive indices also complicates the analysis of ATR spectra in this region (see Figures 14, 15, 18, and 24.

In the conventional ultraviolet region, the absorption coefficient is not much different than the peak values in the infrared, but the ultraviolet spectra are not as unambiguous as the infrared spectra.

In the infrared spectral region, unique identification of individual components is relatively easy and multicomponent analysis is often not much more difficult. Problems that might be encountered with multicomponent analysis are discussed in a later section. The infrared spectral region is the logical choice provided the sensitivity can be made high enough.

If thick films or bulk samples are available, infrared sensitivity will be more than adequate using standard, 25-reflection trapezoidal IREs. For example, for a germanium IRE with 25 reflections operated at an angle of incidence of 27 degrees, the DP value for a sample refractive index of 1.7 for parallel polarized radiation is approximately 1.5. For the 8-micron band of DC 704, the parameter $(\ell/t) \cot\theta\, d_{e\parallel}$ would be given by

$$(\ell/t) \cot\theta\, d_{e\parallel} = (\ell/t) \cdot DP \cdot \lambda = (12.75)(1.5)(8\ \mu m)$$

$$= 153\ \mu m = 1.53 \times 10^{-2}\ cm$$

The reflectance to be expected for this example would be

$$R^N = [1 - 2.44]^{25}$$

$$= 0$$

The equations are no longer valid because the low absorption approximation is not satisfied.

Thus, a thick film would be totally absorbing for these conditions at the 8-micrometer band and, consequently, for quantitative analysis the sensitivity would have to be reduced. At this wavelength, a thick film is anything greater than 1 micrometer (10,000 Å) in thickness.

If measurements are made on thin film samples, for example, a film 0.01 micrometer (100 Å) thick, the reflectance change is also adequate, as shown below.

For thin films, for $N_2 = 1.7$ and $\theta = 24.5$ degrees with $N_3 = 1.00$, DP is equal to 3.92. Then

$$(\ell/t) \cot\theta \, d_{e||} = (\ell/t) \cdot DP \cdot d$$

$$= (12.4) \cdot 3.92 \cdot (0.01\ \mu m)$$

$$= 0.486\ \mu m = 4.86 \times 10^{-5}\ cm$$

for a conventional 25-reflection, germanium trapezoidal IRE. The reflectance of the element and film at the peak of the 8-micrometer band of DC 704 would be

$$R^N = [1 - (4.86 \times 10^{-5}\ cm) \cdot \alpha]$$

$$= [1 - (4.86 \times 10^{-5}\ cm)(4000\ cm^{-1})]$$

$$R^N = [1 - 0.195] = 0.805$$

For this second example, a film 0.01-micrometer (100 Å) thick produced a change in reflectance of approximately 20 percent. By using a KRS-5 plate as the third medium ($N_3 = 2.37$) rather than a vacuum, a gain of 3 in sensitivity could have been obtained.

These calculations indicate that for the proper selection of IRE material and operating conditions, the sensitivity of ATR techniques in the infrared should be adequate.

8.2 SELECTION OF IRE GEOMETRY

As discussed in earlier sections, for accurate quantitative analysis of ATR spectra, the polarization of the incident radiation must be the same for each reflection. This requirement eliminates any design that does not maintain a common plane of incidence for all internally reflecting interfaces. For the infrared spectral region, multiple reflections are necessary and hence the hemicylinder must be excluded as the primary element.

Double-pass elements are particularly suited to vacuum chamber applications since these elements require only one window or vacuum seal. These elements also allow all the auxiliary electronic and optical instrumentation to be housed in a single enclosure. One disadvantage of double-pass elements is that the entrance and exit aperture areas are reduced by a factor of two and, consequently, the auxiliary optics must be designed to produce smaller and more highly collimated beams within the IRE. Also, energy transfer through the IRE is generally reduced.

Double-sampling and multiple-sampling techniques are advantageous only when a limited amount of sample is available and all of that limited amount can be deposited on a particular portion of the IRE. For vacuum chamber applications, the ambient atmosphere concentration of contaminant is the controlling quantity. Larger IRE sampling areas result in sampling more deposited contaminants and, therefore, higher contrast spectra. Consequently, multiple sampling elements are not desirable for this purpose.

The next point to consider is whether or not to select a variable-angle IRE. Ideally, a variable-angle IRE would allow optimization of the angle of incidence for each particular experimental situation. Such an IRE also would allow one to determine variations in the sample refractive index and to vary the effective thickness of the sample to determine more precisely the absorption coefficient or the quantity of sample present. However, conventional variable-angle, multiple-reflection IREs are difficult to fabricate, particularly the double-pass variety, and thus are quite expensive, typically of the order of $1,000 each. Breakage and deterioration due to frequent handling and use could result in IRE expenditures of several thousands of dollars each year for each monitor.

On the other hand, realizing many of the advantages of the variable-angle IRE should be possible by using a variety of standard IREs. For example, a collection of germanium elements designed to operate at angles of incidence of 20, 27, 34, and 42 degrees could be used for practically all thin film and bulk sample work with very little sacrifice in sensitivity.

Consider thin film samples first. Here, the critical angle is determined by N_3 and N_1. For strongly absorbing thin films or for ease of operation, it might be desired to operate with $N_3 = 1.00$. A search of the tables of Appendix A shows that for a comparable angle of incidence relative to the critical angle, germanium has as high DP values as any other material. The critical angle for a germanium-air interface is 14.5 degrees. Then, operation at approximately 20 degrees would yield DP values ranging from 5.46 for $N_2 = 1.5$ to 5.69 for $N_2 = 2.0$. These values are nearly optimum for operation 5 degrees above the critical angle with $N_3 = 1.00$.

If more sensitivity were desired for thin film samples, the 42-degree germanium IRE could be used with KRS-5 plates to make $N_3 = 2.37$. Since the critical angle for a germanium-KRS-5 interface is approximately 37 degrees, the angle of incidence is, again, 5 degrees above the critical angle. This arrangement would yield DP values ranging from 25.34 for $N_2 = 1.5$ to 11.25 for $N_2 = 2.0$.

Next, consider bulk samples. For these samples the critical angle is determined by N_2 and N_1 and variations in N_2 result in variations of the critical angle. For samples which have refractive indices in the range from 1.3 to 1.7 (not exceeding 1.8), the 27-degree germanium element could be used. This element would provide DP values ranging from 0.40 for $N_2 = 1.3$ to 1.56 for $N_2 = 1.7$.

For samples which have refractive indices that may exceed 2.2, use of the 34-degree germanium IRE would yield DP values ranging from 0.29 for $N_2 = 1.5$ to 1.18 for $N_2 = 2.1$. Table 3 summarizes these data.

In summary, judicious use of a few IREs could result in the same sensitivity as could be obtained with a variable-angle IRE, since the variation of N_2 determines the practical operational angle of incidence.

TABLE 3. DP VALUES FOR FOUR GERMANIUM ELEMENTS

ANGLE OF INCIDENCE	THIN FILMS $1.5 \leq N_2 \leq 2.0$		BULK SAMPLES	
	$N_3 = 1.00$	$N_3 = 2.37$	$1.3 \leq N_2 \leq 1.7$	$1.5 \leq N_2 \leq 2.1$
20	$5.46 \leq DP \leq 5.69$			
42		$25.3 \geq DP \geq 11.3$		
27			$0.4 \leq DP \leq 1.56$	
34				$0.3 \leq DP \leq 1.18$

Earlier in this subsection the advantages and disadvantages of double-pass IREs were briefly discussed. For vacuum chamber work the primary advantage of the double-pass IRE is that it eliminates the need for two windows. However, possibly the use of two windows does not really produce a problem. Alternatively, if using two windows is not desirable, it may be possible to optically couple the detectors directly to the exit aperture of the IREs, as depicted schematically in Figure 34. Such an arrangement would reduce the number of auxiliary optical components necessary and could result in increased system efficiency by reducing the reflection losses at both the exit aperture of the IRE and the detector window from 46 percent to approximately 6 percent.

8.3 SELECTION OF IRE MATERIAL

The analysis of Section 5 along with further analysis of the results presented in Section 9 and in Appendix A show that maximum sensitivities are obtained by using high refractive index media for both the IRE and the third medium for thin films. However, use of auxiliary plates for the third medium will complicate the experimental procedure.

When air or a vacuum is used as the third medium, IREs with lower refractive indices have some advantages, provided the element size is not greatly restricted. In general, for a fixed IRE size, IREs with higher refractive indices will yield slightly higher sensitivities because they can be used at lower angles of incidence and consequently can provide more reflections. Operation at low angles of incidence results in a smaller aperture at the entrance and exit faces and consequently reduces the total radiant intensity that can be transmitted through the element. The variation in aperture area is approximately a factor of two for angles of incidence of 20 and 45 degrees. In addition, for a fixed IRE size, the total path length traversed by the radiant energy within the IRE is greater for the materials with a higher index (lower angle of incidence). For these reasons, the materials with lower refractive indices should be used for thin film measurements when the third medium is to be air.

Analyses in Section 9 indicate that thick film spectra are likely to show total absorption at even moderate strength absorption bands if high sensitivity elements are used. In addition, due to the dependence of the critical angle on the refractive index of the sample for thick films, the element material should be chosen to minimize this effect. Consequently, a material with a high refractive index should be selected for IREs designed to monitor thick samples.

Two materials which satisfy the above requirements are KRS-5 and germanium. The physical properties of these two materials are adequate for the intended use. The only objectionable property is the hardness of KRS-5, which will require more careful handling and cleaning procedures. Several of the new infrared glasses (e.g., TI #1173 and TI #20) have better mechanical properties than KRS-5, but they do not have quite enough transmittance range.

Table 4 shows the variation of the critical angle with N_2 for thick samples for KRS-5 and germanium elements. Since N_2 is expected to exceed 2.0 in the vicinity of strong absorption bands, either a KRS-5 plate used at an angle of incidence of 60 degrees or a germanium plate used at an angle of incidence of 35 degrees should be selected for thick film studies. A 60-degree KRS-5 element would limit maximum N_2 values to 2.0 and would be operating approximately 21 degrees above the critical angle for samples with $N_2 = 1.5$. A

TABLE 4. CRITICAL ANGLES FOR KRS-5 AND GERMANIUM IREs FOR THICK SAMPLES OF VARIOUS N_2 VALUES

N_2	θ_C FOR N_1 = 2.37 (KRS-5)	θ_C FOR N_1 = 4.0 (GERMANIUM)
1.3	33.4	19.0
1.4	36.2	20.5
1.5	39.4	22.0
1.6	41.5	23.6
1.7	45.9	25.2
1.8	49.4	26.8
1.9	53.1	28.4
2.0	57.5	30.0
2.1	62.4	31.6
2.2	68.1	33.4

35 degree germanium element would allow N_2 values to 2.3 and would be operating only 13 degrees above the critical angle for samples with N_2 = 1.5.

8.4 RECOMMENDATIONS

Based on the above considerations and on the sensitivity analyses the use of three standard-design internal reflection plates is recommended, with two additional polished KRS-5 plates to be used as the third medium when maximum sensitivity is necessary. A 50-reflection KRS-5 plate beveled for operation at an angle of incidence of 30 degrees is recommended for thin film measurements where the third medium has a refractive index of 1.0. For thick film measurements on the RFP-listed contaminants, the use of a 26-reflection, 35-degree germanium plate is recommended.

9. RANGE AND SENSITIVITY

9.1 RANGE

Germanium elements transmit with practically no absorption losses from 2 micrometers to approximately 11 micrometers. Between 11 micrometers and 14 micrometers, weak lattice absorptions will reduce the transmitted intensity by approximately 30 percent. The use of double-beam compensation techniques can minimize the effect of these weak absorptions and result in a practical wavelength range of from 2 to 14 micrometers.

KRS-5 elements transmit with negligible absorption losses between 0.7 and 30 micrometers.

The use of either germanium or KRS-5 elements would allow qualitative and quantitative determinations of the major contaminants expected to be deposited within the space chambers at the Manned Spacecraft Center. Although germanium has the range necessary to study the major contaminants described by Wolff (Ref. 39) and listed in the RFP for this work, KRS-5 has an extended range which may be necessary to identify other contaminants that may be present infrequently. Therefore, it is recommended that both germanium and KRS-5 elements be considered.

9.2 SENSITIVITY

The absorption bands that will be used to detect and identify the contaminants are tabulated in Table 5 along with the calculated maximum absorption coefficients. The phthalate esters have a unique band at 5.8 micrometers which can be used for both detection and identification. The 7.9-micrometer band also should be used for

TABLE 5. IDENTIFYING ABSORPTION BANDS

CONTAMINANTS	BAND MINIMA AND CORRESPONDING ABSORPTION COEFFICIENTS			
3M Black Velvet (Phthalate Esters)	5.8 μm (2400 cm^{-1})	6.8 μm (855 cm^{-1})	7.24 μm (462 cm^{-1})	7.9 μm (2530 cm^{-1})
DC-704, DC-705	7.0 μm (4720 cm^{-1})	7.9 μm (6920 cm^{-1})	12.5 μm (4200 cm^{-1})	
DC-11		7.9 μm (3460 cm^{-1})	12.5 μm (4200 cm^{-1})	
Sun Vis 706 Houghton Safe 1120 (Hydrocarbon)		6.8 μm (1190 cm^{-1})	7.24 μm (470 cm^{-1})	

verification. The polymethylpolyphenyl siloxanes DC-704 and DC-705 have a characteristic band at 7.0 micrometers and auxiliary identifying bands at 7.9 and 12.5-micrometers, which can be used for detection and identification. The polymethyl silicones, e.g., DC-11, have strong bands at 7.9 and 12.5 micrometers which can be used for detection and identification when other methyl silicones are not present. Typical paraffinic hydrocarbons have bands at 6.8 and 7.24 micrometers which can be used for detection and identification.

Table 6 gives the minimum film thickness that can be detected and identified assuming a 10-percent change in beam intensity for the least absorbing identification band, and assuming only the one contaminant is present, for the IREs listed.

Thick film sensitivity for the 35-degree germanium element used alone is such that a 50-percent change in reflectance will be observed at a wavelength of 8 micrometers for a sample having an absorption coefficient of 43 cm^{-1}. This calculation assumes that the film is thicker than 8 micrometers.

9.3 MULTICOMPONENT ANALYSIS

Multicomponent analysis of the contaminants of interest has been performed by Wolff (Ref. 39) from measurements using the potassium bromide pellet technique. Based on detailed examination of published spectra, a slightly different procedure is proposed than that used by Wolff.

Table 7 lists the contaminants of interest and the various spectral regions where these contaminants have strong absorption bands. The Xs denote the individual contaminant band positions. The procedure recommended for determining the quantities of each of these contaminants is as follows:

TABLE 6. SAMPLE THICKNESSES WHICH WILL RESULT IN 10-PERCENT ABSORPTION (ASSUMES N_2 = 1.5)

SAMPLE	30° KRS-5 (50 REFLECTIONS)	42° GERMANIUM WITH KRS-5 AS THIRD MEDIUM (25 REFLECTIONS)
Phthalate Esters 5.8-μm Band (3M Black Velvet)	29 Å	5 Å*
Polymethylpolyphenyl Siloxanes 12.5-μm Band (DC-704, DC-705)	17 Å	3 Å*
Dimethyl Siloxanes 7.9-μm Band (DC-11)	19 Å	3 Å*
Typical Hydrocarbons 7.24-μm Band (Sun Vis 706, Houghton Safe 1120)	147 Å	24 Å

*FOR SAMPLE THICKNESSES OF LESS THAN A MONOLAYER, THE EQUATIONS ARE NOT EXPECTED TO BE CORRECT.

TABLE 7. ABSORPTION BANDS OF CONTAMINANTS

CONTAMINANT	BAND MINIMA POSITIONS (MICROMETERS)											
	3.4, 3.5	5.8	6.3	6.8	7.0	7.24	7.7-8.1	8.9-9.8	10.0	11.8	12.5	13.9
Phthalate Esters (3M Black Velvet)	X	X	X	X		X	X	X			X (Weak)	
Polymethylpolyphenyl Siloxanes (DC-704, DC-705)	X		X		X		X	X	X	X	X	
Dimethyl Siloxanes (DC-11)	X						X	X			X	
Hydrocarbons (Sun Vis 706, Houghton Safe 1120)	X			X		X						X

1. Determine the phthalate content by its unique band at 5.8 micrometers.

2. Determine the DC-704 or DC-705 content by the unique 7.0- and 11.8-micrometer bands.

3. Calculate the absorptances at 6.8 micrometers and at 7.24 micrometers due to the phthalate content, subtract this from the measured absorptance at these bands, and determine the hydrocarbon content from the difference absorptances.

4. Calculate the absorptances at 7.9 micrometers and at 12.5 micrometers due to the phthalate and the DC-704 or DC-705 content, substract these from the measured absorptances at these bands, and determine the DC-11 content from the difference absorptances.

To sufficiently resolve the bands, a spectral resolution of 0.03 micrometer or better is recommended.

Real-time analysis of multicomponent depositions will require the use of digital data along with an on-line computer, although the computer can be a minicomputer.

When contaminants to be determined have overlapping bands, it is important that the concentrations of those contaminants are not too different. Total reflectance changes at the band minima should not be greater than approximately 95 percent and not less than about 15 percent for multicomponent analysis from normal, double-beam operation. However, if single-beam operation is used or if the individual signals are digitized before being ratioed, reflectance changes greater than 95 percent can be utilized provided the signal-to-noise ratio of the received signals is not the limiting error.

10. ADVANTAGES AND LIMITATIONS

10.1 ADVANTAGES

IRS techniques allow real-time analysis of trace quantities of contaminants. Such analysis is possible because the samples do not have to be concentrated before measurement. In addition, the samples are measured in situ and are not disturbed during the measurement so that the time dependence of the accumulation of the contaminants can be monitored.

In theory, precise measurements of the absorption coefficients are possible by varying the effective thickness either by varying the polarization with fixed-angle IREs or by varying the angle of incidence on variable-angle IREs. Alternatively, if the absorption coefficients are known precisely, accurate determinations of the quantities present can be made by the same procedures.

10.2 DISADVANTAGES

Most of the disadvantages are relative to an ideal arrangement and are not very significant when compared to other techniques for obtaining the same data. The considerations that must be included in the experiment and analysis are discussed below.

First, for quantitative analysis the refractive index of the sample should be known at the band minima. Knowledge of the variation of the sample refractive index also may aid in the identification of distorted spectral bands. Very little data are published on the variations of the refractive index of the contaminants of interest and these data should be obtained as soon as possible.

In general, an IRE can be optimized for a particular range of film thicknesses and for a particular range of sample optical constants. Large variations in either the optical constants or the sample thicknesses may require the use of more than one IRE to obtain good results.

For accurate quantitative work, polarized light must be used. Although this problem is not severe, it must be considered.

The auxiliary optics associated with the IRE must be well corrected. Sample beam alignment and collimation must be much better than that of conventional transmission spectroscopy and beam diameter must be kept very small, in general. The use of IREs with high refractive indices results in low throughput efficiencies, unless special procedures are employed.

For double-beam operation, IRE matching may be somewhat a problem, unless tolerances are tightly controlled.

Finally, for real-time multicomponent analysis, an on-line computer is essential.

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APPENDIX. COMPUTER PRINTOUTS FOR DP AND DS

```
PROGRAM      MAIN           DEMO CENTERS        CDC 6400 FTN V3.0-P261 OPT=1  07/11/72  13.21.35.

              PROGRAM MAIN(OUTPUT,TAPE6=OUTPUT)
              DIMENSION RN3(7),RN1(6),TC(6,7),T(6,7,10),RN2(10)
              DIMENSION ENTS(6,7,10),GN31(6,7),GT(6,7,10),GN32(6,7,10)
              DIMENSION ENTP(6,7,10)
              DIMENSION BTC(6,10),BT(6,10,10),BN21(6,10),B(6,10,10)
              DIMENSION BD(6,10,10),ENBS(6,10,10),ENBP(6,10,10),BN21T(6,10,10)
              RN3(1)=1.000
              RN3(2)=1.237
              RN3(3)=1.662
              RN3(4)=1.938
              RN3(5)=2.477
              RN3(6)=3.418
              RN3(7)=4.007
              RN1(1)=1.450
              RN1(2)=1.550
              RN1(3)=1.661
              RN1(4)=2.371
              RN1(5)=3.418
              RN1(6)=4.007
              RN2(1)=1.80
              RN2(2)=1.85
              RN2(3)=1.90
              RN2(4)=1.95
              RN2(5)=2.00
              RN2(6)=2.05
              RN2(7)=2.10
              RN2(8)=2.15
              RN2(9)=2.20
              RN2(10)=2.25
              DO 55 L=1,10
              RRN2=RN2(L)
              DO 95 J=1,7
              RRN3=RN3(J)
              DO 85 I=1,6
              RRN1=RN1(I)
              IF(RRN1-RRN3) 85,85,44
           44 SS=RRN3/RRN1
              CC=SQRT(1.-SS**2)
              TC(I,J)=ATAN(SS/CC)
              P=3.1416/180.
              T(I,J,1)=TC(I,J)+P
              RN21=RRN2/RRN1
              RN31=RRN3/RRN1
              RN32=RRN3/RRN2
```

```
      GN31(I,J)=1./(RRN1*(1.-RN31**2))
      DO 75 K=2,10
      T(I,J,K)=T(I,J,K-1)+P
      GT(I,J,K)=COS(T(I,J,K))*COS(T(I,J,K))/SIN(T(I,J,K))
      ENTS(I,J,K)=4.*RRN2*GT(I,J,K)*GN31(I,J)
      GN32(I,J,K)=((1.+RN32**4)*SIN(T(I,J,K))**2-RN31**2)/
     1((1.+RN31**2)*SIN(T(I,J,K))**2-RN31**2)
      ENTP(I,J,K)=ENTS(I,J,K)*GN32(I,J,K)
   75 CONTINUE
   85 CONTINUE
   95 CONTINUE
      WRITE(6,301)RN2(L)
  301 FORMAT(60X,3HN2=,1X,F5.3//)
      DO 125 K=2,10
      WRITE(6,302)K
  302 FORMAT(60X,14HTHETA=THETAC +,1X,I2/)
      WRITE(6,303)(RN3(J),J=1,7)
  303 FORMAT(1X,3HN3=,5X,7(4X,F5.3,8X))
      WRITE(6,304)
  304 FORMAT(1X,2HN1,6X,7(2X,2HDS,6X,2HDP,5X))
      DO 155 I=1,6
      WRITE(6,305)RN1(I),(ENTS(I,J,K),ENTP(I,J,K),J=1,7)
  305 FORMAT(1X,F5.3,3X,7(F6.3,2X,F6.3,3X))
  155 CONTINUE
  125 CONTINUE
   65 CONTINUE
      DO 710 L=1,10
      RRN2=RN2(L)
      DO 600 I=1,6
      RRN1=RN1(I)
      IF(RRN1-RRN2)600,600,101
  101 CONTINUE
      RN21=RRN2/RRN1
      S=RN21
      C=SQRT(1.-S**2)
      BTC(I,L)=ATAN(S/C)
      P=3.1416/180.
      BT(I,L,1)=BTC(I,L)+P
      DO 510 K=2,10
      BT(I,L,K)=BT(I,L,K-1)+P
      BN21(I,L)=RRN2/(RRN1**2-RRN2**2)
      B(I,L,K)=COS(BT(I,L,K))*COS(BT(I,L,K))/SIN(BT(I,L,K))
      BD(I,L,K)=1./SQRT(SIN(BT(I,L,K))**2-RN21**2)
      ENDS(I,L,K)=(1./3.1416)*BN21(I,L)*B(I,L,K)*BD(I,L,K)
      X=2.*SIN(BT(I,L,K))**2-RN21**2
```

```
      Y=(1.+RN21**2)*SIN(BT(I,L,K))**2-RN21**2
      RN21T(I,L,K)=X/Y
      ENBP(I,L,K)=ENBS(I,L,K)*RN21T(I,L,K)
  500 CONTINUE
  600 CONTINUE
  700 CONTINUE
      DO 225 K=2,10
      WRITE(6,302)K
      WRITE(6,403)(RN1(I),I=1,6)
  403 FORMAT(1X,3HN1=,5X,6(4X,F5.3,8X))
      WRITE(6,404)
  404 FORMAT(1X,2HN2,6X,6(2X,2HDS,6X,2HDP,5X))
      DO 255 L=1,10
      WRITE(6,405)RN2(L),(ENBS(I,L,K),ENBP(I,L,K),I=1,6)
  405 FORMAT(1X,F5.3,3X,6(F6.3,2X,F6.3,3X))
  255 CONTINUE
  225 CONTINUE
      END
```

THIN FILM APPROXIMATION RESULTS

N2= 1.300

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.685	3.604	3.657	4.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.700	4.070	3.723	4.715	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.709	4.579	3.752	5.389	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.678	7.264	3.806	9.346	2.816	13.874	2.289	16.916	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.565	8.894	3.751	12.715	2.829	22.513	2.369	30.763	1.884	42.487	0.000	0.000	0.000	0.000
4.007	4.495	9.022	3.708	13.330	2.813	25.620	2.366	36.989	1.900	54.280	1.324	82.441	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.443	3.473	3.400	3.798	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.466	3.906	3.497	4.399	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.479	4.366	3.554	5.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.442	6.522	3.623	8.329	2.669	12.570	2.135	15.432	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.292	7.494	3.550	10.485	2.691	19.121	2.255	26.982	1.783	38.448	0.000	0.000	0.000	0.000
4.007	4.200	7.468	3.492	10.681	2.670	20.932	2.252	31.300	1.807	47.983	1.231	74.895	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.210	3.335	3.154	3.516	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.242	3.740	3.280	4.101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.260	4.153	3.354	4.692	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.221	5.958	3.448	7.527	2.527	11.478	1.988	14.077	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.044	6.591	3.353	9.021	2.561	16.627	2.145	23.961	1.685	34.926	0.000	0.000	0.000	0.000
4.007	3.934	6.505	3.295	9.047	2.536	17.750	2.143	27.098	1.717	42.830	1.142	68.011	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.987	3.193	2.919	3.247	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.026	3.574	3.071	3.819	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.049	3.959	3.152	4.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.012	5.502	3.282	6.870	2.391	10.514	1.846	12.834	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.816	5.935	3.189	7.966	2.438	14.701	2.040	21.484	1.592	31.822	0.000	0.000	0.000	0.000
4.007	3.695	5.819	3.114	7.913	2.411	15.430	2.039	23.852	1.632	38.523	1.057	61.711	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.772	3.050	2.694	2.991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.819	3.410	2.870	3.553	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.848	3.757	2.977	4.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.816	5.117	3.124	6.315	2.260	9.657	1.711	11.691	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.606	5.421	3.027	7.157	2.320	13.161	1.940	19.407	1.502	29.064	0.000	0.000	0.000	0.000
4.007	3.477	5.290	2.946	7.064	2.292	13.651	1.941	21.258	1.550	34.862	.975	55.929	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.565	2.906	2.479	2.748	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.620	3.248	2.677	3.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.655	3.581	2.799	3.815	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.630	4.783	2.973	5.837	2.134	8.886	1.582	10.637	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.412	4.999	2.875	6.508	2.208	11.894	1.844	17.637	1.415	26.593	0.000	0.000	0.000	0.000
4.007	3.278	4.860	2.791	6.395	2.180	12.233	1.848	19.129	1.471	31.705	.897	50.611	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.366	2.764	2.274	2.516	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.429	3.089	2.493	3.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.469	3.402	2.628	3.557	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.454	4.487	2.828	5.418	2.014	8.189	1.458	9.663	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.232	4.640	2.732	5.959	2.102	10.829	1.752	16.105	1.332	24.367	0.000	0.000	0.000	0.000
4.007	3.095	4.498	2.646	5.848	2.074	11.072	1.758	17.344	1.395	28.948	.823	45.711	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.175	2.623	2.079	2.297	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.245	2.934	2.316	2.833	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.291	3.230	2.454	3.314	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.288	4.220	2.690	5.045	1.897	7.555	1.340	8.762	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.064	4.329	2.597	5.512	2.000	9.916	1.663	14.764	1.252	22.348	0.000	0.000	0.000	0.000
4.007	2.927	4.186	2.511	5.388	1.974	10.097	1.673	15.820	1.323	26.517	.752	41.190	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	2.992	2.485	1.893	2.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.059	2.783	2.146	2.617	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.120	3.054	2.307	3.085	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.129	3.977	2.558	4.709	1.785	6.975	1.227	7.926	0.000	0.000	0.000	0.000	0.000	0.000
3.418	2.908	4.055	2.470	5.115	1.993	9.123	1.578	13.577	1.175	20.510	0.000	0.000	0.000	0.000
4.007	2.771	3.912	2.384	4.992	1.879	9.264	1.592	14.501	1.253	24.353	.685	37.015	0.000	0.000

N2= 1.350

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.865	3.304	3.738	3.685	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.881	3.741	3.957	4.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.890	4.220	3.907	4.865	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.858	6.779	3.953	8.499	2.924	12.393	2.377	15.124	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.741	8.402	3.895	11.652	2.938	20.236	2.461	27.542	1.957	37.968	0.000	0.000	0.000	0.000
4.007	4.668	8.568	3.850	12.258	2.921	23.058	2.457	33.136	1.973	48.519	1.374	73.626	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.614	3.213	3.531	3.428	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.638	3.625	3.632	3.980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.652	4.064	3.631	4.558	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.613	6.158	3.752	7.624	2.771	11.288	2.217	13.805	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.459	7.165	3.696	9.687	2.795	17.234	2.341	24.185	1.851	34.370	0.000	0.000	0.000	0.000
4.007	4.361	7.177	3.627	9.908	2.773	18.897	2.338	28.077	1.876	42.909	1.278	66.891	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.372	3.108	3.276	3.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.405	3.498	3.406	3.723	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.424	3.902	3.483	4.271	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.383	5.673	3.581	6.928	2.624	10.323	2.064	12.600	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.199	6.354	3.492	8.388	2.660	15.021	2.228	21.499	1.750	31.232	0.000	0.000	0.000	0.000
4.007	4.086	6.300	3.422	8.448	2.634	16.067	2.225	24.338	1.784	38.317	1.186	60.746	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.140	2.994	3.031	2.947	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.181	3.363	3.199	3.478	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.205	3.739	3.284	4.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.167	5.273	3.408	6.352	2.483	9.470	1.917	11.493	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.952	5.755	3.312	7.446	2.531	13.309	2.119	19.294	1.653	28.465	0.000	0.000	0.000	0.000
4.007	3.837	5.667	3.234	7.427	2.503	13.999	2.118	21.446	1.695	34.477	1.097	55.122	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.917	2.874	2.798	2.721	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.966	3.225	2.980	3.244	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.996	3.576	3.092	3.746	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.963	4.929	3.244	5.853	2.347	8.719	1.777	10.474	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.744	5.280	3.143	6.717	2.409	11.937	2.015	17.445	1.559	26.005	0.000	0.000	0.000	0.000
4.007	3.611	5.172	3.050	6.658	2.380	12.409	2.016	19.132	1.609	31.211	1.013	49.960	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.652		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.702	2.751	2.574	2.505	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.759	3.086	2.780	3.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.795	3.414	2.907	3.505	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.770	4.626	3.087	5.438	2.217	8.024	1.643	9.534	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.543	4.885	2.985	6.129	2.293	10.805	1.915	15.866	1.469	23.801	0.000	0.000	0.000	0.000
4.007	3.494	4.767	2.938	6.047	2.264	11.140	1.919	17.231	1.528	28.393	.932	45.212	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.496	2.626	2.351	2.299	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.561	2.946	2.589	2.808	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.603	3.256	2.730	3.276	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.587	4.354	2.937	5.062	2.091	7.403	1.514	8.665	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.356	4.548	2.837	5.638	2.183	9.852	1.819	14.499	1.383	21.813	0.000	0.000	0.000	0.000
4.007	3.214	4.422	2.748	5.545	2.154	10.098	1.826	15.636	1.449	25.933	.855	40.837	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.297	2.500	2.159	2.102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.370	2.807	2.405	2.605	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.418	3.101	2.559	3.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.414	4.106	2.733	4.726	1.970	6.837	1.391	7.859	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.182	4.252	2.697	5.219	2.077	9.034	1.727	13.300	1.300	20.011	0.000	0.000	0.000	0.000
4.007	3.030	4.124	2.607	5.121	2.050	9.222	1.738	14.273	1.374	23.761	.781	36.800	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.107	2.375	1.956	1.915	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.187	2.670	2.229	2.411	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.561	3.240	2.950	2.335	2.853	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.250	3.879	2.656	4.422	1.854	6.318	1.274	7.112	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.019	3.990	2.555	4.854	1.976	8.322	1.639	12.238	1.220	18.368	0.000	0.000	0.000	0.000
4.007	2.877	3.860	2.476	4.755	1.951	8.472	1.653	13.092	1.301	21.828	.712	33.071	0.000	0.000

N2= 1.400

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.045	3.048	3.938	3.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.062	3.461	4.010	3.850	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.071	3.914	4.052	4.414	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.038	6.371	4.099	7.774	3.032	11.151	2.465	13.580	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.916	7.995	4.039	10.746	3.047	18.278	2.552	24.768	2.029	34.072	0.000	0.000	0.000	0.000
4.007	4.840	8.195	3.993	11.347	3.029	20.856	2.548	29.818	2.046	43.553	1.425	66.026	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.785	2.992	3.552	3.111	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.810	3.387	3.756	3.620	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.824	3.909	3.928	4.156	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.794	5.856	3.901	7.023	2.874	10.185	2.299	12.404	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.623	6.900	3.823	9.011	2.898	15.613	2.428	21.776	1.920	30.856	0.000	0.000	0.000	0.000
4.007	4.523	6.944	3.761	9.255	2.875	17.150	2.425	25.304	1.946	38.536	1.325	59.990	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.574	2.915	3.397	2.897	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.569	3.294	3.532	3.399	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.537	3.698	3.612	3.911	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.546	5.441	3.713	6.419	2.721	9.330	2.141	11.327	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.255	6.157	3.622	7.455	2.758	13.642	2.310	19.380	1.815	28.048	0.000	0.000	0.000	0.000
4.007	4.237	6.142	3.549	7.945	2.731	14.623	2.308	21.963	1.850	34.428	1.230	54.483	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.233	2.827	3.144	2.690	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.276	3.188	3.307	3.186	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.251	3.556	3.405	3.677	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.321	5.099	3.535	5.914	2.575	8.573	1.988	10.338	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.109	5.515	3.435	7.009	2.625	12.115	2.197	17.410	1.714	25.572	0.000	0.000	0.000	0.000
4.007	3.979	5.553	3.353	7.021	2.596	12.772	2.196	19.377	1.757	30.991	1.138	49.442	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.062	2.728	2.901	2.490	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.113	3.073	3.091	2.991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.144	3.413	3.206	3.454	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.110	4.780	3.354	5.481	2.434	7.895	1.843	9.426	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.883	5.174	3.250	6.350	2.499	10.888	2.089	15.756	1.617	23.369	0.000	0.000	0.000	0.000
4.007	3.745	5.088	3.173	6.320	2.468	11.347	2.091	17.305	1.669	28.066	1.050	44.814	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.839	2.522	2.670	2.298	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.899	2.952	2.883	2.783	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.936	3.279	3.015	3.241	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.910	4.503	3.201	5.101	2.299	7.284	1.703	8.585	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.674	4.803	3.096	5.814	2.378	9.873	1.986	14.343	1.524	21.394	0.000	0.000	0.000	0.000
4.007	3.530	4.702	3.005	5.760	2.348	10.206	1.990	15.601	1.584	25.541	.966	40.558	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.625	2.512	2.449	2.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.693	2.829	2.635	2.593	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.736	3.138	2.831	3.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.720	4.252	3.046	4.764	2.168	6.729	1.570	7.805	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.490	4.482	2.942	5.364	2.263	9.017	1.886	13.117	1.434	19.613	0.000	0.000	0.000	0.000
4.007	3.333	4.372	2.849	5.297	2.234	9.267	1.894	14.169	1.503	23.336	.886	36.635	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.420	2.400	2.238	1.936	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.495	2.704	2.494	2.410	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.544	2.998	2.654	2.843	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.541	4.021	2.897	4.459	2.043	6.221	1.443	7.083	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.300	4.200	2.737	4.978	2.154	8.280	1.791	12.042	1.348	17.997	0.000	0.000	0.000	0.000
4.007	3.152	4.085	2.704	4.903	2.126	8.475	1.802	12.944	1.424	21.388	.810	33.015	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.222	2.396	2.038	1.767	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.305	2.580	2.311	2.235	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.360	2.853	2.494	2.657	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.370	3.807	2.754	4.182	1.923	5.755	1.322	6.412	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.131	3.947	2.550	4.639	2.050	7.637	1.700	11.088	1.265	16.524	0.000	0.000	0.000	0.000
4.007	2.994	3.829	2.558	4.561	2.024	7.796	1.714	11.882	1.349	19.654	.738	29.670	0.000	0.000

N2= 1.450

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.226	2.830	4.079	3.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.243	3.222	4.153	3.504	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.252	3.554	4.136	4.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.219	6.027	4.245	7.151	3.141	10.094	2.553	12.242	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.092	7.553	4.183	9.971	3.155	16.586	2.643	22.366	2.102	30.697	0.000	0.000	0.000	0.000
4.007	5.013	7.899	4.135	10.570	3.137	18.953	2.639	26.946	2.119	39.250	1.476	59.438	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.956	2.805	3.733	2.837	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.982	3.185	3.901	3.311	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.996	3.595	3.954	3.810	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.955	5.605	4.041	6.509	2.977	9.231	2.381	11.190	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.788	6.586	3.959	8.436	3.092	14.213	2.515	19.691	1.989	27.811	0.000	0.000	0.000	0.000
4.007	4.684	6.761	3.895	8.703	2.978	15.643	2.511	22.904	2.015	34.748	1.373	54.009	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.695	2.755	3.518	2.651	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.731	3.123	3.658	3.121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.751	3.509	3.741	3.601	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.798	5.252	3.946	5.985	2.819	8.473	2.217	10.225	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.510	6.021	3.751	7.404	2.857	12.454	2.393	17.547	1.880	25.290	0.000	0.000	0.000	0.000
4.007	4.389	5.021	3.676	7.522	2.829	13.379	2.390	19.910	1.916	31.059	1.273	49.055	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.447	2.687	3.256	2.469	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.491	3.042	3.425	2.935	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.517	3.405	3.527	3.399	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.475	4.942	3.661	5.542	2.667	7.798	2.059	9.338	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.256	5.512	3.557	6.641	2.719	11.087	2.276	15.782	1.775	23.066	0.000	0.000	0.000	0.000
4.007	4.121	5.471	3.473	6.682	2.689	11.717	2.275	17.588	1.820	27.971	1.178	44.519	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.207	2.606	3.005	2.292	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.260	2.947	3.201	2.755	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.292	3.290	3.321	3.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.256	4.664	3.484	5.158	2.521	7.193	1.909	8.519	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.022	5.098	3.376	6.043	2.588	9.985	2.164	14.297	1.675	21.086	0.000	0.000	0.000	0.000
4.007	3.878	5.030	3.286	6.040	2.557	10.433	2.165	15.726	1.729	25.343	1.088	40.355	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.976	2.515	2.755	2.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.038	2.844	2.986	2.579	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.076	3.169	3.122	3.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.049	4.413	3.315	4.818	2.381	6.646	1.764	7.753	0.000	0.000	0.000	0.000	0.000	0.000
3.419	3.895	4.745	3.207	5.552	2.463	9.072	2.056	13.027	1.578	19.311	0.000	0.000	0.000	0.000
4.007	3.656	4.661	3.113	5.523	2.432	9.404	2.061	14.193	1.641	23.072	1.001	36.524	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.755	2.419	2.536	1.954	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.825	2.735	2.780	2.409	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.870	3.043	2.932	2.834	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.853	4.176	3.154	4.513	2.246	6.147	1.626	7.061	0.000	0.000	0.000	0.000	0.000	0.000
3.419	3.605	4.440	3.047	5.137	2.344	8.299	1.954	11.924	1.485	17.708	0.000	0.000	0.000	0.000
4.007	3.452	4.343	2.951	5.092	2.314	8.553	1.961	12.903	1.556	21.088	.913	32.993	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.542	2.318	2.318	1.794	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.620	2.622	2.583	2.245	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.671	2.916	2.749	2.659	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.567	3.959	3.010	4.235	2.116	5.690	1.494	6.411	0.000	0.000	0.000	0.000	0.000	0.000
3.419	3.418	4.168	2.997	4.779	2.231	7.632	1.855	10.955	1.396	16.254	0.000	0.000	0.000	0.000
4.007	3.264	4.064	2.801	4.724	2.202	7.835	1.866	11.798	1.475	19.335	.839	29.734	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.337	2.214	2.111	1.540	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.427	2.509	2.394	2.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.480	2.788	2.573	2.491	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.490	3.755	2.853	3.981	1.991	5.270	1.369	5.806	0.000	0.000	0.000	0.000	0.000	0.000
3.419	3.243	3.923	2.755	4.463	2.123	7.049	1.760	10.095	1.310	14.927	0.000	0.000	0.000	0.000
4.007	3.090	3.815	2.659	4.403	2.096	7.217	1.775	10.838	1.397	17.773	.764	26.724	0.000	0.000

N2= 1.455

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.244	2.810	4.093	2.999	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.261	3.209	4.157	3.472	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.270	3.631	4.211	3.990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.235	5.996	4.250	7.094	3.152	9.996	2.562	12.118	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.110	7.628	4.138	9.900	3.166	16.430	2.652	22.144	2.109	30.385	0.000	0.000	0.000	0.000
4.007	5.031	7.862	4.150	10.499	3.148	18.778	2.648	26.680	2.127	38.852	1.481	58.829	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.973	2.788	3.806	2.812	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.999	3.169	3.914	3.282	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.013	3.575	3.978	3.778	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.972	5.583	4.055	6.462	2.987	9.143	2.390	11.077	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.804	6.657	3.973	8.384	3.012	14.083	2.524	19.498	1.995	27.529	0.000	0.000	0.000	0.000
4.007	4.700	6.745	3.909	8.652	2.988	15.503	2.520	22.683	2.022	34.398	1.377	53.456	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.712	2.741	3.531	2.628	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.747	3.108	3.671	3.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.768	3.492	3.754	3.572	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.724	5.235	3.859	5.945	2.828	8.397	2.225	10.123	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.526	6.008	3.754	7.363	2.866	12.344	2.401	17.377	1.886	25.035	0.000	0.000	0.000	0.000
4.007	4.404	6.011	3.688	7.483	2.839	13.265	2.398	19.720	1.922	30.747	1.278	48.553	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.452	2.675	3.257	2.449	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.505	3.028	3.437	2.912	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.532	3.391	3.539	3.373	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.491	4.929	3.673	5.508	2.676	7.727	2.067	9.245	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.270	5.504	3.570	6.608	2.728	10.992	2.284	15.631	1.782	22.834	0.000	0.000	0.000	0.000
4.007	4.135	5.464	3.485	6.652	2.698	11.620	2.283	17.423	1.826	27.692	1.183	44.063	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.221	2.595	3.015	2.274	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.274	2.935	3.212	2.734	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.307	3.279	3.332	3.181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.271	4.653	3.496	5.128	2.533	7.128	1.915	8.436	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.035	5.032	3.388	6.015	2.597	9.902	2.171	14.162	1.681	20.875	0.000	0.000	0.000	0.000
4.007	3.892	5.125	3.298	6.014	2.565	10.349	2.173	15.581	1.735	25.091	1.091	39.942	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.930	2.507	2.775	2.104	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.052	2.834	2.997	2.561	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.090	3.159	3.133	2.995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.063	4.402	3.327	4.792	2.389	6.587	1.770	7.687	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.818	4.742	3.218	5.528	2.472	8.998	2.064	12.905	1.584	19.118	0.000	0.000	0.000	0.000
4.007	3.669	4.659	3.123	5.502	2.440	9.330	2.068	14.053	1.646	22.844	1.004	36.151	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.769	2.411	2.545	1.940	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.838	2.726	2.790	2.392	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.883	3.035	2.942	2.816	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.856	4.170	3.155	4.490	2.254	6.093	1.632	6.993	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.617	4.437	3.058	5.117	2.352	8.233	1.960	11.814	1.491	17.532	0.000	0.000	0.000	0.000
4.007	3.464	4.341	2.951	5.074	2.322	8.488	1.968	12.786	1.562	20.880	.921	32.656	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.554	2.311	2.326	1.781	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.632	2.615	2.592	2.230	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.694	2.903	2.758	2.542	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.680	3.954	3.011	4.215	2.123	5.641	1.500	6.349	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.429	4.166	2.907	4.751	2.239	7.573	1.861	10.855	1.401	16.093	0.000	0.000	0.000	0.000
4.007	3.276	4.053	2.810	4.708	2.210	7.776	1.873	11.692	1.480	19.145	.842	29.431	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.348	2.208	2.118	1.628	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.435	2.501	2.402	2.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.492	2.782	2.592	2.476	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.502	3.752	2.853	3.953	1.938	5.225	1.374	5.750	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.254	3.922	2.765	4.447	2.130	6.995	1.766	10.003	1.315	14.780	0.000	0.000	0.000	0.000
4.007	3.101	3.815	2.659	4.389	2.103	7.164	1.782	10.742	1.402	17.599	.767	26.451	0.000	0.000

N2= 1.500

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.406	2.642	4.220	2.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.424	3.017	4.296	3.205	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.433	3.433	4.341	3.689	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.398	5.739	4.392	6.613	3.249	9.167	2.641	11.077	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.259	7.381	4.328	9.306	3.254	15.116	2.734	20.276	2.174	27.757	0.000	0.000	0.000	0.000
4.007	5.185	7.641	4.278	9.905	3.245	17.302	2.730	24.448	2.192	35.503	1.527	53.701	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.125	2.646	3.923	2.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.157	3.016	4.035	3.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.168	3.414	4.101	3.511	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.126	5.399	4.180	6.057	3.079	8.402	2.464	10.133	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.953	6.515	4.096	7.947	3.105	12.999	2.602	17.878	2.057	25.160	0.000	0.000	0.000	0.000
4.007	4.846	6.619	4.030	8.234	3.081	14.337	2.598	20.819	2.085	31.451	1.420	48.800	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.858	2.619	3.540	2.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.894	2.980	3.734	2.880	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.915	3.359	3.870	3.334	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.870	5.099	3.979	5.614	2.916	7.728	2.294	9.266	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.666	5.910	3.881	7.023	2.955	11.424	2.475	15.953	1.945	22.889	0.000	0.000	0.000	0.000
4.007	4.540	5.934	3.802	7.166	2.926	12.303	2.472	18.126	1.982	28.127	1.317	44.327	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.600	2.571	3.358	2.278	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.645	2.920	3.543	2.719	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.672	3.280	3.648	3.160	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.630	4.825	3.787	5.226	2.759	7.126	2.131	8.468	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.403	5.437	3.680	6.333	2.813	10.197	2.354	14.356	1.837	20.885	0.000	0.000	0.000	0.000
4.007	4.263	5.415	3.593	6.399	2.781	10.806	2.353	16.035	1.883	25.344	1.219	40.231	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.352	2.506	3.108	2.121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.406	2.844	3.312	2.551	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.440	3.185	3.435	2.989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.403	4.574	3.504	4.884	2.608	6.534	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.150	5.047	3.433	5.786	2.677	9.205	1.974	7.731	0.000	0.000	0.000	0.000	0.000	0.000
4.007	4.012	4.995	3.339	5.807	2.645	9.645	2.238	13.030	1.733	19.099	0.000	0.000	0.000	0.000
							2.240	14.356	1.788	22.973	1.125	36.471	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.114	2.429	2.850	1.957	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.177	2.755	3.089	2.405	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.217	3.080	3.230	2.823	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.189	4.340	3.430	4.579	2.453	6.093	1.825	7.048	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.936	4.711	3.317	5.335	2.548	8.380	2.127	11.885	1.633	17.497	0.000	0.000	0.000	0.000
4.007	3.782	4.640	3.220	5.328	2.516	8.712	2.132	12.972	1.697	20.924	1.035	33.011	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.884	2.344	2.624	1.817	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.957	2.659	2.876	2.252	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.003	2.968	3.033	2.660	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.985	4.122	3.253	4.302	2.323	5.644	1.682	6.415	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.729	4.417	3.152	4.950	2.425	7.680	2.021	10.889	1.537	16.051	0.000	0.000	0.000	0.000
4.007	3.571	4.332	3.053	4.925	2.394	7.939	2.029	11.805	1.610	19.132	.950	29.821	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.664	2.253	2.398	1.672	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.745	2.557	2.672	2.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	3.798	2.852	2.843	2.503	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.793	3.916	3.104	4.048	2.189	5.231	1.546	5.827	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.535	4.153	2.937	4.616	2.308	7.074	1.919	10.013	1.444	14.737	0.000	0.000	0.000	0.000
4.007	3.377	4.060	2.837	4.579	2.278	7.284	1.931	10.804	1.526	17.548	.868	26.877	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.452	2.157	2.184	1.531	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.541	2.451	2.476	1.959	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	3.600	2.734	2.651	2.349	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.611	3.722	2.951	3.814	2.060	4.850	1.416	5.280	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.355	3.915	2.850	4.319	2.196	6.543	1.821	9.234	1.356	13.538	0.000	0.000	0.000	0.000
4.007	3.197	3.815	2.751	4.276	2.163	6.720	1.837	9.934	1.446	16.136	.791	24.157	0.000	0.000

N2= 1.550

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.596	2.481	4.350	2.531	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.604	2.842	4.439	2.944	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.614	3.243	4.486	3.396	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.579	5.495	4.538	6.148	3.357	8.358	2.729	10.059	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.443	7.153	4.472	8.734	3.373	13.835	2.825	18.449	2.247	25.186	0.000	0.000	0.000	0.000
4.007	5.359	7.440	4.421	9.335	3.354	15.864	2.821	22.265	2.265	32.227	1.578	48.680	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.297	2.510	4.054	2.393	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.325	2.871	4.170	2.810	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.341	3.261	4.238	3.251	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.297	5.230	4.319	5.687	3.182	7.679	2.546	9.209	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.118	6.383	4.232	7.530	3.209	11.941	2.688	16.295	2.126	22.841	0.000	0.000	0.000	0.000
4.007	5.007	6.510	4.154	7.836	3.183	13.201	2.684	18.998	2.154	28.567	1.467	44.242	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.020	2.505	3.751	2.253	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.057	2.850	3.910	2.672	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.070	3.234	3.939	3.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.033	4.977	4.111	5.297	3.013	7.079	2.370	8.428	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.821	5.828	4.010	6.700	3.054	10.529	2.558	14.562	2.010	20.790	0.000	0.000	0.000	0.000
4.007	4.691	5.873	3.929	6.867	3.024	11.369	2.555	16.569	2.048	25.564	1.361	40.190	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.733	2.473	3.490	2.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.910	2.920	3.651	2.533	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.828	3.178	3.770	2.954	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.794	4.735	3.913	4.956	2.851	6.541	2.202	7.708	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.549	5.387	3.833	6.074	2.906	9.424	2.433	13.132	1.898	18.977	0.000	0.000	0.000	0.000
4.007	4.405	5.382	3.713	6.164	2.874	10.015	2.432	14.681	1.946	23.047	1.260	36.479	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.497	2.423	3.212	1.973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.553	2.759	3.422	2.393	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.588	3.101	3.550	2.905	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.550	4.509	3.724	4.652	2.695	6.054	2.040	7.041	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.299	5.015	3.609	5.573	2.766	8.528	2.313	11.925	1.790	17.362	0.000	0.000	0.000	0.000
4.007	4.145	4.979	3.513	5.616	2.733	8.963	2.315	13.163	1.848	20.902	1.163	33.072	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.251	2.358	2.956	1.835	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.316	2.684	3.192	2.254	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.357	3.010	3.338	2.657	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.328	4.291	3.544	4.377	2.545	5.612	1.886	6.424	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.068	4.695	3.428	5.155	2.633	7.781	2.198	10.839	1.687	15.912	0.000	0.000	0.000	0.000
4.007	3.908	4.635	3.327	5.168	2.600	8.114	2.203	11.908	1.754	19.047	1.070	29.937	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.014	2.283	2.711	1.699	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.088	2.598	2.972	2.117	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.135	2.913	3.134	2.512	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.119	4.085	3.372	4.125	2.401	5.206	1.738	5.850	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.853	4.410	3.257	4.797	2.506	7.144	2.088	9.987	1.588	14.602	0.000	0.000	0.000	0.000
4.007	3.690	4.335	3.155	4.790	2.473	7.409	2.097	10.849	1.664	17.424	.981	27.046	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.786	2.200	2.478	1.567	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.859	2.506	2.751	1.982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.924	2.803	2.938	2.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.920	3.890	3.207	3.892	2.262	4.832	1.598	5.317	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.653	4.153	3.097	4.483	2.385	6.592	1.983	9.192	1.492	13.412	0.000	0.000	0.000	0.000
4.007	3.489	4.068	2.934	4.463	2.354	6.809	1.995	9.940	1.577	15.988	.897	24.378	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.567	2.112	2.257	1.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.659	2.408	2.559	1.849	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.720	2.693	2.750	2.229	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.731	3.704	3.050	3.675	2.129	4.486	1.463	4.820	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.467	3.920	2.946	4.203	2.269	6.107	1.882	8.484	1.401	12.324	0.000	0.000	0.000	0.000
4.007	3.303	3.828	2.843	4.175	2.240	6.291	1.898	9.148	1.494	14.707	.817	21.912	0.000	0.000

N2= 1.600

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.766	2.342	4.501	2.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.785	2.691	4.583	2.716	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.795	3.080	4.631	3.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.758	5.290	4.685	5.744	3.466	7.647	2.817	9.164	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.619	6.968	4.616	8.241	3.482	12.712	2.916	16.846	2.319	22.927	0.000	0.000	0.000	0.000
4.007	5.532	7.280	4.553	8.845	3.462	14.605	2.912	20.350	2.338	29.348	1.629	44.267	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.468	2.395	4.185	2.213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.497	2.748	4.304	2.607	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.513	3.131	4.375	3.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.467	5.092	4.459	5.359	3.284	7.046	2.628	8.398	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.283	6.281	4.359	7.173	3.313	11.017	2.775	14.906	2.194	20.804	0.000	0.000	0.000	0.000
4.007	5.169	6.431	4.298	7.497	3.286	12.209	2.771	17.401	2.224	26.034	1.515	40.236	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.182	2.408	3.882	2.092	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.220	2.759	4.036	2.491	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.243	3.139	4.128	2.903	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.195	4.881	4.244	5.024	3.110	6.510	2.446	7.692	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.977	5.771	4.139	6.427	3.152	9.748	2.640	13.343	2.074	18.946	0.000	0.000	0.000	0.000
4.007	4.842	5.835	4.056	6.615	3.122	10.555	2.637	15.206	2.114	23.313	1.405	36.554	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.917	2.392	3.593	1.969	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.955	2.737	3.779	2.371	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.984	3.094	3.892	2.776	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.938	4.659	4.039	4.725	2.943	6.029	2.273	7.041	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.696	5.357	3.925	5.857	3.000	8.751	2.511	12.050	1.959	17.303	0.000	0.000	0.000	0.000
4.007	4.548	5.368	3.832	5.968	2.967	9.328	2.510	13.496	2.008	21.031	1.300	33.183	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.642	2.355	3.316	1.845	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.700	2.691	3.532	2.248	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.736	3.033	3.654	2.646	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.597	4.461	3.845	4.455	2.782	5.591	2.106	6.437	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.439	5.003	3.726	5.395	2.855	7.939	2.388	10.957	1.843	15.338	0.000	0.000	0.000	0.000
4.007	4.279	4.979	3.626	5.459	2.821	8.371	2.389	12.118	1.907	19.085	1.200	30.036	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.388	2.301	3.051	1.720	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.455	2.627	3.235	2.124	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.499	2.955	3.445	2.515	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.468	4.260	3.658	4.206	2.627	5.192	1.947	5.876	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.199	4.694	3.538	5.007	2.718	7.260	2.269	10.017	1.742	14.521	0.000	0.000	0.000	0.000
4.007	4.034	4.645	3.435	5.039	2.683	7.595	2.274	10.978	1.810	17.400	1.104	27.236	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.143	2.235	2.739	1.597	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.228	2.551	3.058	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.270	2.865	3.235	2.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.252	4.065	3.481	3.976	2.478	4.824	1.794	5.355	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.977	4.417	3.352	4.671	2.587	6.679	2.156	9.198	1.639	13.331	0.000	0.000	0.000	0.000
4.007	3.809	4.351	3.257	4.681	2.553	6.949	2.164	10.014	1.717	15.925	1.013	24.608	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.908	2.160	2.558	1.476	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.994	2.467	2.850	1.877	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.051	2.757	3.033	2.254	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.045	3.978	3.311	3.751	2.335	4.484	1.649	4.870	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.771	4.155	3.137	4.375	2.462	6.174	2.047	8.474	1.541	12.248	0.000	0.000	0.000	0.000
4.007	3.602	4.088	3.090	4.370	2.439	6.398	2.059	9.184	1.628	14.619	.926	22.182	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.682	2.079	2.329	1.357	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.777	2.376	2.642	1.756	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.840	2.654	2.839	2.126	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.851	3.593	3.148	3.559	2.197	4.169	1.510	4.417	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.579	3.935	3.041	4.110	2.342	5.728	1.942	7.829	1.446	11.259	0.000	0.000	0.000	0.000
4.007	3.410	3.851	2.934	4.095	2.313	5.921	1.959	8.461	1.542	13.454	.843	19.940	0.000	0.000

N2= 1.650

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.945	2.222	4.642	2.152	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.965	2.551	4.726	2.516	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.976	2.940	4.775	2.916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.938	5.119	4.831	5.392	3.574	7.022	2.905	8.375	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.794	6.919	4.750	7.815	3.591	11.726	3.007	15.434	2.391	20.935	0.000	0.000	0.000	0.000
4.007	5.705	7.155	4.706	8.424	3.578	13.500	3.003	18.663	2.412	26.809	1.680	40.374	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.639	2.295	4.316	2.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.669	2.644	4.439	2.429	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.685	3.027	4.511	2.828	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.638	4.980	4.598	5.075	3.387	6.489	2.710	7.683	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.448	6.206	4.505	6.868	3.416	10.207	2.862	13.683	2.263	19.008	0.000	0.000	0.000	0.000
4.007	5.330	6.377	4.433	7.211	3.389	11.340	2.858	15.996	2.293	23.802	1.562	36.701	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.744	2.327	4.004	1.952	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.784	2.675	4.153	2.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.407	3.045	4.257	2.728	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.357	4.307	4.377	4.790	3.207	6.011	2.523	7.044	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.132	5.735	4.259	6.196	3.251	9.064	2.723	12.270	2.139	17.320	0.000	0.000	0.000	0.000
4.007	4.994	5.817	4.183	6.405	3.219	9.843	2.720	14.007	2.180	21.329	1.449	33.347	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.069	2.325	3.705	1.844	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.110	2.569	3.837	2.230	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.140	3.027	4.013	2.621	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.093	4.621	4.156	4.529	3.035	5.579	2.344	6.453	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.843	5.344	4.048	5.676	3.094	8.163	2.590	11.099	2.020	15.827	0.000	0.000	0.000	0.000
4.007	4.690	5.370	3.952	5.807	3.060	8.728	2.589	12.454	2.071	19.255	1.341	30.274	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.787	2.299	3.419	1.733	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.847	2.535	3.643	2.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.884	2.993	3.779	2.508	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.843	4.431	3.965	4.288	2.869	5.186	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.576	5.006	3.942	5.249	2.945	7.426	2.172	5.904	0.000	0.000	0.000	0.000	0.000	0.000
4.007	4.413	4.394	3.739	5.331	2.909	7.854	2.462	10.107	1.906	14.494	0.000	0.000	0.000	0.000
							2.464	11.201	1.967	17.483	1.238	27.451	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.525	2.255	3.146	1.621	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.595	2.583	3.398	2.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.639	2.913	3.553	2.392	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.608	4.743	3.773	4.063	2.709	4.824	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.330	4.706	3.649	4.887	2.803	6.806	2.008	5.394	0.000	0.000	0.000	0.000	0.000	0.000
4.007	4.161	4.667	3.542	4.935	2.767	7.144	2.340	9.252	1.796	13.295	0.000	0.000	0.000	0.000
							2.345	10.162	1.867	15.949	1.139	24.853	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.273	2.197	2.886	1.509	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.352	2.516	3.154	1.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.403	2.833	3.336	2.275	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.394	4.358	3.589	3.852	2.556	4.490	1.851	4.919	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.192	4.435	3.457	4.571	2.668	6.275	2.223	8.595	1.690	12.210	0.000	0.000	0.000	0.000
4.007	3.929	4.378	3.358	4.596	2.633	6.550	2.232	9.281	1.771	14.605	1.045	22.457	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.030	2.129	2.638	1.397	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.119	2.438	2.939	1.787	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.177	2.742	3.128	2.156	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.173	3.878	3.414	3.653	2.408	4.190	1.701	4.476	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.889	4.188	3.297	4.290	2.539	5.811	2.111	7.844	1.589	11.224	0.000	0.000	0.000	0.000
4.007	3.715	4.118	3.187	4.299	2.506	6.042	2.124	8.522	1.679	13.414	.955	20.245	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.797	2.052	2.402	1.288	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	3.895	2.353	2.724	1.675	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	3.960	2.645	2.927	2.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	3.972	3.703	3.246	3.464	2.265	3.892	1.558	4.063	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.690	3.962	3.136	4.037	2.416	5.400	2.003	7.254	1.491	10.321	0.000	0.000	0.000	0.000
4.007	3.516	3.892	3.026	4.034	2.385	5.600	2.020	7.859	1.590	12.350	.870	18.200	0.000	0.000

N2= 1.700

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.127	2.118	4.792	1.996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.147	2.450	4.859	2.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.158	2.821	4.920	2.719	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.118	4.976	4.977	5.085	3.682	6.470	2.993	7.677	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.970	6.700	4.905	7.447	3.699	10.857	3.099	14.185	2.464	19.171	0.000	0.000	0.000	0.000
4.007	5.878	7.059	4.848	8.052	3.678	12.526	3.094	17.173	2.485	24.562	1.731	36.926	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.810	2.212	4.447	1.916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.840	2.556	4.573	2.273	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.857	2.931	4.648	2.655	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.809	4.891	4.737	4.829	3.490	5.997	2.792	7.050	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.613	6.153	4.642	5.608	3.520	9.494	2.949	12.603	2.331	17.418	0.000	0.000	0.000	0.000
4.007	5.492	6.345	4.557	5.958	3.492	10.576	2.944	14.756	2.363	21.826	1.609	33.571	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.506	2.253	4.175	1.828	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.547	2.606	4.289	2.195	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.570	2.975	4.386	2.577	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.520	4.753	4.509	4.589	3.305	5.571	2.599	6.471	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.288	5.718	4.398	6.002	3.349	8.464	2.805	11.323	2.204	15.881	0.000	0.000	0.000	0.000
4.007	5.146	5.816	4.309	6.230	3.317	9.219	2.802	12.949	2.246	19.574	1.493	30.506	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.213	2.270	3.917	1.734	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.255	2.614	4.015	2.107	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.295	2.973	4.135	2.487	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.247	4.589	4.232	4.362	3.127	5.134	2.415	5.933	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.992	5.347	4.171	5.525	3.188	7.647	2.668	10.260	2.082	14.520	0.000	0.000	0.000	0.000
4.007	4.832	5.395	4.072	5.675	3.152	8.203	2.667	11.536	2.134	17.683	1.382	27.698	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.932	2.255	3.523	1.636	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.994	2.593	3.753	2.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.032	2.933	3.893	2.389	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.990	4.416	4.085	4.147	2.956	4.829	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.715	5.021	3.958	5.129	3.034	6.976	2.238	5.434	0.000	0.000	0.000	0.000	0.000	0.000
4.007	4.547	5.020	3.853	5.228	2.997	7.404	2.537	9.357	1.954	13.305	0.000	0.000	0.000	0.000
							2.539	10.393	2.027	16.067	1.275	25.118	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.662	2.219	3.242	1.534	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.734	2.549	3.501	1.914	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.779	2.883	3.651	2.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.747	4.238	3.887	3.943	2.791	4.501	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.461	4.729	3.759	4.790	2.888	6.410	2.068	4.968	0.000	0.000	0.000	0.000	0.000	0.000
4.007	4.287	4.699	3.649	4.853	2.851	6.751	2.411	8.577	1.850	12.211	0.000	0.000	0.000	0.000
							2.416	9.443	1.924	14.667	1.173	22.743	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.402	2.169	2.974	1.432	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.484	2.490	3.250	1.813	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.537	2.811	3.437	2.181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.517	4.052	3.638	3.749	2.633	4.197	1.907	4.534	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.225	4.464	3.573	4.491	2.749	5.922	2.290	7.895	1.742	11.220	0.000	0.000	0.000	0.000
4.007	4.049	4.414	3.450	4.529	2.713	6.203	2.299	8.637	1.825	13.438	1.076	20.552	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.152	2.105	2.718	1.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.244	2.419	3.028	1.710	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.304	2.727	3.222	2.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.299	3.888	3.518	3.563	2.481	3.914	1.752	4.129	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.007	4.220	3.397	4.223	2.615	5.494	2.175	7.290	1.637	10.318	0.000	0.000	0.000	0.000
4.007	3.827	4.156	3.283	4.244	2.582	5.733	2.188	7.941	1.730	12.349	.984	18.529	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	3.912	2.034	2.475	1.227	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.013	2.339	2.807	1.507	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.080	2.535	3.016	1.953	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.032	3.718	3.345	3.387	2.335	3.640	1.605	3.750	0.000	0.000	0.000	0.000	0.000	0.000
3.418	3.602	3.995	3.231	3.981	2.489	5.114	2.064	6.749	1.536	9.492	0.000	0.000	0.000	0.000
4.007	3.623	3.321	3.118	3.389	2.457	5.322	2.082	7.331	1.638	11.375	.896	16.659	0.000	0.000

N2= 1.800

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.487	1.951	5.054	1.736	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.508	2.271	5.155	2.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.520	2.630	5.209	2.393	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.477	4.760	5.270	4.582	3.890	5.545	3.159	5.534	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.321	6.540	5.193	6.852	3.917	9.406	3.281	12.090	2.609	16.206	0.000	0.000	0.000	0.000
4.007	6.223	6.942	5.134	7.483	3.894	10.904	3.276	14.674	2.631	20.787	1.833	31.127	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.152	2.081	4.708	1.686	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.184	2.419	4.842	2.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.292	2.791	4.921	2.371	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.151	4.770	5.016	4.431	3.695	5.176	2.956	5.988	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.943	6.105	4.915	6.198	3.727	8.308	3.122	10.794	2.459	14.747	0.000	0.000	0.000	0.000
4.007	5.815	5.333	4.836	6.591	3.697	9.310	3.117	12.680	2.502	18.507	1.704	28.306	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.830	2.155	4.358	1.624	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.873	2.502	4.541	1.957	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.898	2.873	4.544	2.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.844	4.690	4.774	4.258	3.499	4.838	2.752	5.509	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.590	5.729	4.657	5.704	3.545	7.468	2.970	9.739	2.334	13.465	0.000	0.000	0.000	0.000
4.007	5.448	5.856	4.553	5.967	3.512	8.188	2.967	11.182	2.378	16.629	1.581	25.729	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.520	2.133	4.042	1.554	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.574	2.535	4.232	1.905	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.607	2.900	4.378	2.259	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.556	4.566	4.544	4.099	3.311	4.526	2.557	5.052	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.283	5.730	4.416	5.300	3.375	6.795	2.825	8.857	2.204	12.328	0.000	0.000	0.000	0.000
4.007	5.116	5.453	4.312	5.483	3.338	7.339	2.824	10.005	2.260	15.047	1.453	23.367	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.222	2.132	3.730	1.476	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.288	2.535	3.974	1.835	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.328	2.889	4.122	2.197	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.284	4.413	4.325	3.928	3.130	4.236	2.369	4.645	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.992	5.084	4.131	4.956	3.212	6.235	2.686	8.135	2.079	11.309	0.000	0.000	0.000	0.000
4.007	4.814	5.122	4.079	5.085	3.174	6.665	2.688	9.047	2.146	13.693	1.350	21.196	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.936	2.172	3.433	1.393	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.012	2.508	3.707	1.757	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.060	2.859	3.876	2.117	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.027	4.261	4.116	3.750	2.955	3.965	2.190	4.255	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.774	4.904	3.931	4.653	3.058	5.759	2.553	7.453	1.959	10.391	0.000	0.000	0.000	0.000
4.007	4.539	4.790	3.854	4.744	3.019	6.139	2.558	8.247	2.037	12.516	1.242	19.196	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.551	2.133	3.149	1.307	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.749	2.462	3.452	1.674	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.904	2.792	3.639	2.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.793	4.097	3.916	3.594	2.788	3.712	2.019	3.890	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.475	4.545	3.783	4.382	2.910	5.344	2.425	6.879	1.844	9.558	0.000	0.000	0.000	0.000
4.007	4.236	4.598	3.654	4.445	2.872	5.638	2.435	7.566	1.932	11.482	1.140	17.350	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.397	2.087	2.878	1.219	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.494	2.401	3.237	1.585	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.557	2.718	3.412	1.940	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.552	3.933	3.725	3.432	2.627	3.473	1.855	3.548	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.243	4.307	3.596	4.135	2.770	4.977	2.303	6.367	1.733	8.798	0.000	0.000	0.000	0.000
4.007	4.052	4.252	3.477	4.179	2.733	5.230	2.317	6.974	1.831	10.564	1.042	15.645	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.142	2.017	2.521	1.131	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.249	2.330	2.972	1.497	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.220	2.635	3.134	1.846	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.333	3.773	3.541	3.274	2.472	3.248	1.699	3.227	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.025	4.084	3.421	3.910	2.635	4.648	2.185	5.908	1.627	8.102	0.000	0.000	0.000	0.000
4.007	3.836	4.017	3.301	3.938	2.602	4.871	2.204	6.454	1.735	9.742	.949	14.069	0.000	0.000

N2= 1.850

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.667	1.884	5.204	1.627	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.690	2.200	5.239	1.925	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.701	2.555	5.354	2.257	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.657	4.681	5.417	4.376	4.067	5.157	3.257	6.011	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.497	6.492	5.337	6.614	4.026	8.790	3.372	11.210	2.681	14.957	0.000	0.000	0.000	0.000
4.097	6.396	6.913	5.276	7.253	4.073	10.227	3.367	13.625	2.704	19.196	1.884	28.681	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.727	2.030	4.839	1.590	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.755	2.757	4.977	1.909	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.374	2.739	5.058	2.254	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.392	4.732	5.155	4.271	3.798	4.832	3.038	5.542	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.109	6.105	5.051	6.039	3.837	7.814	3.203	10.034	2.537	13.622	0.000	0.000	0.000	0.000
4.097	5.976	6.349	4.970	6.447	3.809	8.784	3.204	11.810	2.571	17.110	1.751	26.085	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.992	2.117	4.499	1.540	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.035	2.463	4.657	1.874	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.062	2.877	4.774	2.226	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.027	4.679	4.917	4.141	3.596	4.531	2.829	5.104	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.754	5.751	4.786	5.592	3.645	7.056	3.053	9.075	2.399	12.448	0.000	0.000	0.000	0.000
4.097	5.599	5.893	4.689	5.871	3.609	7.761	3.049	10.443	2.444	15.389	1.625	23.715	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.673	2.161	4.154	1.479	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.729	2.510	4.370	1.824	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.757	2.877	4.500	2.180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.712	4.572	4.671	3.997	3.473	4.251	2.628	4.696	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.430	5.427	4.539	5.219	3.459	6.443	2.903	8.271	2.265	11.495	0.000	0.000	0.000	0.000
4.097	5.258	5.501	4.431	5.417	3.430	6.984	2.902	9.365	2.322	13.938	1.504	21.541	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.757	2.173	3.334	1.411	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.435	2.513	4.084	1.753	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.476	2.875	4.237	2.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.430	4.436	4.445	3.846	3.245	3.939	2.435	4.314	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.131	5.123	4.308	4.896	3.362	5.931	2.761	7.582	2.137	10.470	0.000	0.000	0.000	0.000
4.007	4.943	5.155	4.193	5.039	3.262	6.362	2.763	8.485	2.205	12.694	1.338	19.542	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.073	2.158	3.528	1.336	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.152	2.439	3.810	1.694	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.201	2.845	3.934	2.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.155	4.285	4.230	3.692	3.038	3.743	2.251	3.955	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.855	4.953	4.031	4.608	3.147	5.491	2.624	6.983	2.014	9.626	0.000	0.000	0.000	0.000
4.007	4.665	4.845	3.971	4.712	3.103	5.846	2.629	7.749	2.093	11.613	1.277	17.700	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.791	2.125	3.236	1.257	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.830	2.459	3.547	1.618	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.937	2.733	3.740	1.972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.916	4.127	4.025	3.538	2.865	3.511	2.075	3.619	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.599	4.597	3.988	4.349	2.991	5.107	2.493	6.455	1.895	8.859	0.000	0.000	0.000	0.000
4.007	4.495	4.555	3.755	4.423	2.952	5.438	2.502	7.120	1.986	10.661	1.171	16.000	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.519	2.075	2.958	1.175	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.618	2.402	3.296	1.537	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.594	2.724	3.507	1.888	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.579	3.955	3.328	3.385	2.7[illegible]	3.231	1.907	3.334	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.750	4.359	3.696	4.111	2.846	4.766	2.367	5.933	1.781	8.159	0.000	0.000	0.000	0.000
4.007	4.155	4.309	3.573	4.154	2.809	5.026	2.381	6.572	1.882	9.815	1.071	14.429	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.257	2.017	2.693	1.092	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.357	2.374	3.054	1.454	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.440	2.645	3.282	1.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.453	3.805	3.540	3.236	2.541	3.093	1.746	3.007	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.139	4.136	3.515	3.892	2.728	4.459	2.246	5.558	1.672	7.517	0.000	0.000	0.000	0.000
4.007	3.947	4.073	3.393	3.929	2.674	4.689	2.265	6.090	1.783	9.056	.975	12.977	0.000	0.000

N2= 1.900

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.847	1.825	5.345	1.530	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.870	2.133	5.442	1.817	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.892	2.492	5.439	2.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.837	4.518	5.553	4.195	4.115	4.810	3.345	5.568	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.672	6.459	5.432	6.408	4.135	8.258	3.463	10.421	2.754	13.836	0.000	0.000	0.000	0.000
4.007	6.563	6.901	5.419	7.056	4.111	9.625	3.458	12.686	2.777	17.770	1.934	26.486	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.494	1.987	4.970	1.506	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.529	2.325	5.111	1.815	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.547	2.596	5.135	2.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.403	4.708	5.295	4.132	3.900	4.525	3.121	5.141	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.274	5.117	5.188	5.904	3.934	7.376	3.295	9.355	2.606	12.613	0.000	0.000	0.000	0.000
4.007	6.138	6.379	5.104	6.328	3.902	8.317	3.291	11.033	2.641	15.858	1.799	24.094	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.157	2.085	4.510	1.466	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.199	2.435	4.793	1.792	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.225	2.811	4.903	2.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.150	4.678	5.040	4.032	3.693	4.258	2.905	4.742	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.910	5.785	4.915	5.500	3.743	6.690	3.135	8.481	2.463	11.536	0.000	0.000	0.000	0.000
4.007	5.750	5.939	4.916	5.795	3.707	7.385	3.132	9.733	2.510	14.278	1.663	21.908	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.927	2.149	4.256	1.414	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.884	2.492	4.438	1.753	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.913	2.867	4.621	2.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.864	4.535	4.797	3.911	3.495	4.007	2.699	4.368	0.000	0.000	0.000	0.000	0.000	0.000
3.413	5.577	5.473	4.651	5.155	3.563	6.132	2.982	7.747	2.326	10.578	0.000	0.000	0.000	0.000
4.007	5.600	5.555	4.551	5.368	3.523	6.571	2.981	8.794	2.385	12.945	1.544	19.902	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.513	2.158	3.937	1.353	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.592	2.509	4.135	1.701	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.624	2.871	4.351	2.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.577	4.463	4.555	3.777	3.303	3.770	2.501	4.017	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.270	5.181	4.424	4.851	3.391	5.662	2.835	7.116	2.195	9.718	0.000	0.000	0.000	0.000
4.007	5.092	5.215	4.305	5.007	3.390	6.096	2.837	7.935	2.255	11.800	1.425	18.058	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.211	2.159	3.623	1.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.291	2.495	3.913	1.639	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.341	2.847	4.031	1.932	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.305	4.317	4.344	3.537	3.100	3.546	2.312	3.688	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.996	4.908	4.202	4.577	3.278	5.257	2.695	5.565	2.058	8.941	0.000	0.000	0.000	0.000
4.007	4.791	4.907	4.079	4.692	3.187	5.617	2.700	7.306	2.150	10.804	1.312	16.358	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.920	2.122	3.323	1.213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.012	2.460	3.643	1.570	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.070	2.799	3.842	1.922	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.049	4.163	4.133	3.494	2.943	3.333	2.131	3.378	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.723	4.654	3.993	4.327	3.072	4.900	2.560	6.078	1.946	8.234	0.000	0.000	0.000	0.000
4.007	4.524	4.627	3.857	4.412	3.032	5.207	2.570	6.724	2.039	9.926	1.203	14.789	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.641	2.077	3.038	1.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.743	2.407	3.385	1.495	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.810	2.735	3.602	1.844	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.805	4.105	3.931	3.350	2.773	3.130	1.958	3.096	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.479	4.416	3.736	4.097	2.923	4.582	2.431	5.641	1.829	7.588	0.000	0.000	0.000	0.000
4.007	4.277	4.773	3.670	4.159	2.885	4.849	2.445	6.215	1.933	9.145	1.100	13.339	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.372	2.020	2.756	1.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.495	2.342	3.137	1.417	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.550	2.653	3.371	1.762	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.573	3.846	3.738	3.207	2.610	2.937	1.794	2.812	0.000	0.000	0.000	0.000	0.000	0.000
3.419	4.250	4.193	3.611	3.894	2.782	4.234	2.307	5.247	1.717	6.994	0.000	0.000	0.000	0.000
4.007	4.049	4.173	3.485	3.920	2.746	4.532	2.327	5.767	1.831	8.443	1.001	11.997	0.000	0.000

N2= 1.950

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.029	1.777	5.485	1.444	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.051	2.097	5.385	1.721	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.063	2.438	5.544	2.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.017	4.559	5.709	4.036	4.224	4.490	3.433	5.170	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.848	6.445	5.626	5.230	4.243	7.775	3.554	9.714	2.826	12.828	0.000	0.000	0.000	0.000
4.007	6.742	6.904	5.551	6.889	4.219	9.087	3.549	11.844	2.850	16.488	1.985	24.510	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.664	1.951	5.100	1.430	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.633	2.289	5.246	1.732	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.719	2.662	5.332	2.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.603	4.694	5.434	4.013	4.003	4.250	3.203	4.781	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.430	6.140	5.325	5.792	4.037	6.985	3.382	8.746	2.674	11.707	0.000	0.000	0.000	0.000
4.007	6.299	6.417	5.239	6.230	4.005	7.903	3.377	10.336	2.710	14.733	1.846	22.302	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.715	2.062	4.732	1.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.352	2.413	4.919	1.720	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.330	2.792	5.032	2.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.771	4.596	5.172	3.940	3.791	4.014	2.982	4.417	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.065	5.828	5.045	5.426	3.842	6.365	3.218	7.950	2.528	10.717	0.000	0.000	0.000	0.000
4.007	5.902	5.894	4.943	5.736	3.904	7.052	3.214	9.192	2.576	13.280	1.713	20.281	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.930	2.124	4.379	1.357	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.039	2.480	4.606	1.690	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.074	2.955	4.743	2.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.019	4.603	4.923	3.840	3.587	3.730	2.770	4.074	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.723	5.526	4.784	5.106	3.656	5.857	3.060	7.278	2.388	9.835	0.000	0.000	0.000	0.000
4.007	5.542	5.619	4.571	5.333	3.616	6.395	3.059	8.235	2.448	12.053	1.585	18.428	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.659	2.150	4.041	1.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.728	2.504	4.305	1.646	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.772	2.871	4.456	1.996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.724	4.402	4.585	3.722	3.393	3.575	2.567	3.752	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.408	5.239	4.540	4.819	3.491	5.425	2.910	6.699	2.253	9.042	0.000	0.000	0.000	0.000
4.007	5.216	5.281	4.419	4.987	3.479	5.663	2.912	7.539	2.325	10.998	1.463	16.723	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.348	2.147	3.719	1.242	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.430	2.497	4.016	1.592	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.492	2.854	4.199	1.943	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.445	4.354	4.459	3.594	3.202	3.371	2.373	3.448	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.117	4.970	4.312	4.557	3.312	5.050	2.766	6.192	2.123	8.325	0.000	0.000	0.000	0.000
4.007	4.917	4.974	4.186	4.683	3.275	5.416	2.771	6.911	2.207	10.078	1.346	15.151	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.050	2.123	3.411	1.175	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.144	2.466	3.739	1.529	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.224	2.811	3.943	1.979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.182	4.224	4.242	3.460	3.020	3.175	2.187	3.151	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.947	4.716	4.098	4.315	3.193	4.718	2.627	5.741	1.998	7.572	0.000	0.000	0.000	0.000
4.007	4.643	4.693	3.959	4.411	3.112	5.032	2.638	6.371	2.093	9.267	1.235	13.700	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.757	2.092	3.118	1.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.868	2.417	3.474	1.459	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.937	2.751	3.595	1.808	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.931	4.049	4.035	3.324	2.846	2.937	2.010	2.891	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.596	4.473	3.895	4.093	3.030	4.421	2.495	5.337	1.878	7.075	0.000	0.000	0.000	0.000
4.007	4.390	4.435	3.756	4.153	2.961	4.695	2.510	5.899	1.984	8.544	1.129	12.358	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.487	2.029	2.379	1.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.607	2.355	3.219	1.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	4.630	2.577	3.450	1.731	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.634	3.891	3.937	3.187	2.678	2.808	1.841	2.636	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.351	4.255	3.706	3.884	2.855	4.150	2.367	4.970	1.762	6.525	0.000	0.000	0.000	0.000
4.007	4.156	4.197	3.676	3.936	2.818	4.395	2.388	5.480	1.879	7.894	1.028	11.116	0.000	0.000

N2= 2.000

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.208	1.734	5.626	1.367	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.232	2.042	5.728	1.535	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.344	2.393	5.788	1.935	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.497	4.532	5.856	3.897	4.332	4.220	3.521	4.811	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.324	6.442	5.770	6.078	4.352	7.342	3.645	9.077	2.899	11.920	0.000	0.000	0.000	0.000
4.007	6.915	6.320	5.704	5.747	4.327	8.607	3.640	11.096	2.923	15.331	2.036	22.728	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.835	1.922	5.231	1.363	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.871	2.261	5.380	1.658	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.891	2.635	5.458	1.979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.934	4.691	5.573	3.909	4.105	4.094	3.285	4.457	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.874	6.174	5.451	5.699	4.141	6.537	3.469	8.199	2.743	10.889	0.000	0.000	0.000	0.000
4.007	6.461	6.455	5.373	6.152	4.108	7.534	3.464	9.711	2.780	13.718	1.893	20.684	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.477	2.043	4.953	1.342	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.526	2.397	5.045	1.656	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.557	2.789	5.151	1.991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.494	4.703	5.305	3.863	3.898	3.796	3.958	4.124	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.291	5.873	5.174	5.368	3.940	6.077	3.300	7.473	2.593	9.978	0.000	0.000	0.000	0.000
4.007	6.153	6.056	5.070	5.693	3.902	6.757	3.297	8.653	2.642	12.381	1.756	18.814	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.137	2.114	4.491	1.306	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.194	2.477	4.724	1.635	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.230	2.953	4.855	1.978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.177	4.538	5.049	3.781	3.679	3.595	2.841	3.810	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.870	5.595	4.907	5.071	3.759	5.613	3.139	6.858	2.449	9.165	0.000	0.000	0.000	0.000
4.007	5.694	5.687	4.721	5.311	3.703	6.151	3.138	7.829	2.511	11.250	1.625	17.097	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	5.907	2.146	4.145	1.259	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	5.875	2.595	4.415	1.590	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.920	2.973	4.580	1.947	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.871	4.537	4.806	3.677	3.477	3.412	2.633	3.513	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.547	5.393	4.657	4.799	3.569	5.216	2.984	6.326	0.000	0.000	0.000	0.000	0.000	0.000
4.007	5.749	5.351	4.533	4.979	3.526	5.658	2.986	7.141	2.310	6.434	0.000	0.000	0.000	0.000
									2.384	10.276	1.500	15.518	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	5.485	2.148	3.814	1.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	5.569	2.593	4.119	1.551	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.623	2.965	4.307	1.901	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.585	4.397	4.573	3.560	3.284	3.215	2.433	3.232	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.249	5.035	4.423	4.547	3.397	4.869	2.837	5.858	2.177	7.771	0.000	0.000	0.000	0.000
4.007	5.043	5.045	4.293	4.694	3.354	5.241	2.843	6.559	2.263	9.425	1.381	14.062	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	5.172	2.123	3.498	1.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	5.275	2.477	3.835	1.493	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.337	2.829	4.044	1.843	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.714	4.251	4.351	3.435	3.398	3.035	2.243	2.957	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.972	4.782	4.203	4.314	3.234	4.559	2.695	5.440	2.049	7.167	0.000	0.000	0.000	0.000
4.007	4.762	4.754	4.071	4.418	3.191	4.850	2.705	5.057	2.147	8.674	1.266	12.717	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	4.885	2.091	3.198	1.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	4.923	2.431	3.553	1.429	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.063	2.773	3.731	1.777	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.059	4.097	4.139	3.306	2.919	2.861	2.061	2.716	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.714	4.544	3.935	4.096	3.077	4.290	2.559	5.065	1.926	6.613	0.000	0.000	0.000	0.000
4.007	4.593	4.504	3.853	4.175	3.037	4.561	2.574	5.617	2.035	8.003	1.158	11.473	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	4.692	2.039	2.912	1.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	4.721	2.371	3.302	1.359	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.890	2.599	3.548	1.795	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.614	3.940	3.935	3.174	2.747	2.634	1.888	2.479	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.477	4.319	3.831	3.891	2.928	4.025	2.428	4.723	1.807	6.103	0.000	0.000	0.000	0.000
4.007	4.262	4.264	3.658	3.951	2.891	4.276	2.449	5.225	1.928	7.400	1.054	10.321	0.000	0.000

N2= 2.050

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.789	1.697	5.757	1.297	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.412	2.005	5.871	1.558	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.425	2.355	5.337	1.850	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.377	4.505	6.012	3.775	4.440	3.968	3.609	4.437	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.190	5.452	5.914	5.947	4.461	6.954	3.735	8.502	2.971	11.098	0.000	0.000	0.000	0.000
4.007	7.083	6.947	5.847	5.627	4.435	8.176	3.731	10.404	2.996	14.287	2.087	21.115	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.606	1.899	5.752	1.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.347	2.239	5.515	1.592	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.063	2.617	5.505	1.908	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.005	4.695	5.713	3.830	4.293	3.787	3.767	4.155	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.759	5.215	5.598	5.623	4.244	6.325	3.556	7.735	2.811	10.150	0.000	0.000	0.000	0.000
4.007	6.622	5.571	5.507	6.090	4.210	7.206	3.550	9.148	2.849	12.802	1.941	19.221	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.639	2.030	4.974	1.290	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.689	2.387	5.172	1.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.717	2.777	5.290	1.931	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.656	4.727	5.438	3.798	3.995	3.601	3.134	3.859	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.776	5.936	5.303	5.374	4.039	5.820	3.383	7.045	2.658	9.311	0.000	0.000	0.000	0.000
4.007	6.234	6.125	5.196	5.663	3.999	6.495	3.379	8.189	2.708	11.570	1.806	17.486	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.287	2.193	4.603	1.251	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.349	2.472	4.842	1.587	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.396	2.857	4.936	1.928	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.327	4.674	5.176	3.733	3.770	3.422	2.912	3.571	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.017	5.551	5.029	5.047	3.844	5.397	3.217	6.481	2.510	8.561	0.000	0.000	0.000	0.000
4.007	5.827	5.751	4.910	5.300	3.891	5.937	3.216	7.420	2.573	10.525	1.656	15.894	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.948	2.146	4.249	1.221	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.022	2.519	4.526	1.558	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.069	2.888	4.535	1.905	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.017	4.577	4.726	3.643	3.554	3.247	2.698	3.237	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.685	5.372	4.773	4.788	3.659	5.032	3.059	5.991	2.368	7.885	0.000	0.000	0.000	0.000
4.007	5.493	5.427	4.346	4.980	3.614	5.478	3.061	5.784	2.444	9.624	1.538	14.429	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.629	2.153	3.919	1.170	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.739	2.514	4.222	1.516	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.763	2.882	4.414	1.865	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.725	4.445	4.687	3.536	3.366	3.076	2.494	3.038	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.790	5.135	4.533	4.547	3.482	4.719	2.907	5.558	2.231	7.271	0.000	0.000	0.000	0.000
4.007	5.159	5.121	4.401	4.693	3.479	5.087	2.914	6.244	2.320	8.836	1.415	13.077	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.399	2.137	3.586	1.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.407	2.491	3.931	1.463	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.471	2.848	4.145	1.913	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.447	4.391	4.450	3.418	3.175	2.910	2.299	2.792	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.235	4.353	4.398	4.320	3.314	4.420	2.762	5.171	2.100	6.711	0.000	0.000	0.000	0.000
4.007	4.991	4.837	4.172	4.432	3.271	4.747	2.773	5.776	2.200	8.139	1.298	11.329	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.007	2.101	3.279	1.056	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.118	2.448	3.652	1.407	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.130	2.794	3.886	1.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.184	4.149	4.242	3.235	2.992	2.749	2.113	2.558	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.832	4.613	4.096	4.107	3.154	4.157	2.623	4.822	1.974	6.197	0.000	0.000	0.000	0.000
4.007	4.615	4.576	3.959	4.193	3.113	4.446	2.639	5.365	2.086	7.516	1.187	10.672	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.719	2.052	2.985	.983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.839	2.390	3.385	1.338	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	4.929	2.724	3.637	1.697	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	4.935	3.993	4.033	3.158	2.815	2.593	1.935	2.337	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.585	4.387	3.896	3.905	3.091	3.916	2.489	4.503	1.853	5.723	0.000	0.000	0.000	0.000
4.007	4.369	4.334	3.759	3.971	2.963	4.174	2.510	4.998	1.976	5.955	1.080	9.603	0.000	0.000

N2= 2.100

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.558	1.565	5.907	1.235	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.593	1.974	6.315	1.489	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.606	2.324	6.078	1.774	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.567	4.490	6.149	3.658	4.549	3.741	3.697	4.194	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.375	6.471	6.059	5.936	4.570	6.605	3.828	7.983	3.044	10.354	0.000	0.000	0.000	0.000
4.007	7.261	5.985	5.989	6.527	4.543	7.791	3.822	9.787	3.969	13.340	2.138	19.653	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.177	1.980	5.493	1.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.215	2.223	5.549	1.534	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.036	2.603	5.742	1.845	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.176	4.709	5.352	3.745	4.311	3.594	3.449	3.900	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.974	6.255	5.734	5.562	4.349	6.047	3.642	7.261	2.889	9.481	0.000	0.000	0.000	0.000
4.007	6.794	6.595	5.642	5.044	4.313	6.913	3.637	8.641	2.919	11.973	1.988	17.894	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.991	2.021	5.096	1.244	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.852	2.392	5.298	1.551	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.891	2.772	5.419	1.879	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.818	4.758	5.570	3.744	4.092	3.425	3.211	3.621	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.572	6.000	5.433	5.232	4.177	5.592	3.465	6.658	2.723	8.707	0.000	0.000	0.000	0.000
4.007	6.756	6.193	5.323	5.645	4.097	6.263	3.461	7.761	2.774	10.836	1.844	16.283	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.440	2.105	4.715	1.222	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.507	2.475	4.959	1.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.541	2.865	5.108	1.885	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.432	4.715	5.302	3.695	3.862	3.266	2.983	3.356	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.154	5.721	5.152	5.033	3.938	5.205	3.296	6.142	2.571	8.014	0.000	0.000	0.000	0.000
4.007	5.959	6.339	5.030	5.299	3.894	5.748	3.295	7.052	2.636	9.870	1.707	14.803	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.093	2.150	4.352	1.187	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.169	2.519	4.636	1.527	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.219	2.993	4.809	1.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.164	4.621	5.046	3.517	3.651	3.108	2.764	3.133	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.826	5.445	4.390	4.787	3.749	4.859	3.174	5.690	2.426	7.388	0.000	0.000	0.000	0.000
4.007	5.617	5.505	4.759	4.990	3.703	5.320	3.136	6.464	2.504	9.036	1.575	13.441	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.759	2.152	4.005	1.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.849	2.528	4.325	1.486	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.904	2.932	4.522	1.835	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.864	4.497	4.802	3.519	3.448	2.953	2.555	2.862	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.541	5.199	4.644	4.554	3.567	4.559	2.973	5.230	2.286	6.819	0.000	0.000	0.000	0.000
4.007	5.295	5.199	4.508	4.719	3.522	4.953	2.935	5.962	2.376	8.305	1.450	12.184	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.438	2.149	3.673	1.088	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.573	2.598	4.027	1.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.694	2.972	4.246	1.798	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.593	4.756	4.558	3.409	3.253	2.799	2.355	2.634	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.220	4.925	4.413	4.333	3.335	4.298	2.829	4.930	2.151	6.299	0.000	0.000	0.000	0.000
4.007	5.009	4.314	4.274	4.453	3.351	4.632	2.841	5.526	2.254	7.657	1.330	11.022	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.129	2.116	3.358	1.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.242	2.458	3.741	1.382	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.717	2.820	3.981	1.731	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.311	4.205	4.345	3.231	3.065	2.650	2.164	2.416	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.950	4.586	4.196	4.123	3.231	4.050	2.687	4.674	2.022	5.820	0.000	0.000	0.000	0.000
4.007	4.728	4.651	4.056	4.217	3.189	4.346	2.703	5.140	2.137	7.077	1.215	9.947	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.833	2.068	3.057	.965	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	4.957	2.412	3.457	1.320	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.040	2.752	3.726	1.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.055	4.049	4.132	3.158	2.884	2.503	1.982	2.210	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.637	4.458	3.931	3.925	3.074	3.821	2.549	4.306	1.898	5.379	0.000	0.000	0.000	0.000
4.007	4.476	4.405	3.851	3.997	3.035	4.087	2.571	4.735	2.024	6.553	1.107	8.951	0.000	0.000

N2= 2.150

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.743	1.640	5.048	1.180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.774	1.948	5.158	1.429	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.787	2.299	5.222	1.707	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.737	4.492	5.295	3.574	4.657	3.536	3.785	3.927	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.550	6.500	6.203	5.742	4.679	6.292	3.919	7.513	3.116	9.578	0.000	0.000	0.000	0.000
4.007	7.434	7.031	6.132	6.445	4.652	7.444	3.913	9.229	3.142	12.481	2.189	18.324	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.748	1.866	5.624	1.203	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.386	2.211	5.734	1.482	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.408	2.595	5.878	1.789	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.747	4.729	5.991	3.680	4.413	3.405	3.531	3.660	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.099	6.323	5.871	5.514	4.451	5.737	3.729	6.859	2.949	8.874	0.000	0.000	0.000	0.000
4.007	6.945	6.655	5.776	6.010	4.416	6.652	3.724	8.184	2.988	11.221	2.035	15.688	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.963	2.015	5.217	1.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.015	2.390	5.424	1.507	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	7.045	2.775	5.548	1.834	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.981	4.794	5.703	3.700	4.179	3.268	3.287	3.405	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.637	6.063	5.552	5.271	4.236	5.398	3.548	6.309	2.787	8.159	0.000	0.000	0.000	0.000
4.007	6.507	6.278	5.450	5.637	4.195	6.057	3.544	7.375	2.840	10.170	1.888	15.189	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.593	2.108	4.828	1.188	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.658	2.481	5.078	1.509	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.697	2.877	5.230	1.947	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.536	4.761	5.428	3.656	3.954	3.127	3.054	3.150	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.310	5.795	5.275	5.029	4.031	5.036	3.374	5.835	2.633	7.518	0.000	0.000	0.000	0.000
4.007	6.111	5.922	5.150	5.306	3.987	5.581	3.373	5.722	2.699	9.276	1.747	13.812	0.000	0.000

THETA=THETAC + 6

N3 =	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.239	2.158	4.456	1.158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.316	2.537	4.747	1.492	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.364	2.922	4.924	1.838	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.311	4.673	5.156	3.599	3.738	2.985	2.830	2.927	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.953	5.323	5.016	4.794	3.837	4.725	3.208	5.419	2.484	6.938	0.000	0.000	0.000	0.000
4.007	5.751	5.589	4.873	5.007	3.791	5.192	3.210	6.176	2.563	8.502	1.613	12.544	0.000	0.000

THETA=THETAC + 7

N3 =	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.996	2.173	4.100	1.117	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.997	2.545	4.428	1.459	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.044	2.925	4.630	1.810	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.004	4.553	4.916	3.509	3.530	2.842	2.615	2.704	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.642	5.257	4.755	4.568	3.652	4.446	3.049	5.049	2.340	6.409	0.000	0.000	0.000	0.000
4.007	5.421	5.291	4.515	4.733	3.606	4.837	3.056	5.709	2.433	7.823	1.434	11.373	0.000	0.000

THETA=THETAC + 8

N3 =	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.567	2.153	3.751	1.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.671	2.529	4.123	1.417	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.738	2.899	4.347	1.758	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.713	4.414	4.677	3.405	3.330	2.701	2.411	2.431	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.345	5.003	4.518	4.352	3.476	4.131	2.897	4.714	2.203	5.925	0.000	0.000	0.000	0.000
4.007	5.119	4.994	4.376	4.480	3.431	4.532	2.908	5.301	2.308	7.220	1.361	10.290	0.000	0.000

THETA=THETAC + 9

N3 =	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.251	2.133	3.438	1.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.367	2.491	3.830	1.364	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.443	2.849	4.075	1.715	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.437	4.264	4.449	3.292	3.139	2.561	2.216	2.288	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.068	4.761	4.296	4.146	3.308	3.957	2.750	4.409	2.070	5.479	0.000	0.000	0.000	0.000
4.007	4.840	4.723	4.152	4.246	3.265	4.250	2.767	4.939	2.188	6.679	1.244	9.288	0.000	0.000

THETA=THETAC + 10

N3 =	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	4.948	2.086	3.130	.950	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.075	2.437	3.550	1.305	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	5.160	2.783	3.915	1.654	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.175	4.108	4.230	3.173	2.953	2.424	2.030	2.095	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.809	4.531	4.086	3.950	3.148	3.739	2.610	4.129	1.943	5.067	0.000	0.000	0.000	0.000
4.007	4.582	4.481	3.943	4.028	3.109	4.012	2.633	4.615	2.072	6.190	1.133	8.360	0.000	0.000

N2= 2.200

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.929	1.618	6.139	1.129	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.955	1.927	6.391	1.372	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.969	2.290	6.357	1.646	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.917	4.483	6.441	3.492	4.765	3.350	3.873	3.685	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.726	6.538	6.347	5.664	4.798	6.009	4.010	7.086	3.189	9.062	0.000	0.000	0.000	0.000
4.007	7.606	7.085	6.274	6.379	4.760	7.133	4.004	8.723	3.215	11.699	2.240	17.113	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.519	1.855	5.754	1.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.558	2.203	5.918	1.436	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.580	2.591	6.015	1.741	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.513	4.755	6.131	3.625	4.516	3.243	3.613	3.442	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.254	6.395	6.007	5.479	4.555	5.574	3.816	6.495	3.017	8.721	0.000	0.000	0.000	0.000
4.007	7.107	6.730	5.910	5.988	4.518	6.419	3.810	7.769	3.058	10.536	2.083	15.589	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.552		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	7.125	2.014	5.338	1.158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.178	2.383	5.550	1.469	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.299	2.783	5.677	1.794	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.145	4.835	5.835	3.664	4.277	3.126	3.364	3.288	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.847	6.144	5.591	5.260	4.334	5.207	3.630	5.994	2.852	7.661	0.000	0.000	0.000	0.000
4.007	6.659	6.362	5.577	5.639	4.292	5.875	3.626	7.027	2.907	9.565	1.932	14.193	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.747	2.113	4.940	1.157	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.813	2.492	5.136	1.477	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	6.853	2.893	5.351	1.816	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.790	4.812	5.554	3.645	4.046	3.002	3.125	2.983	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.457	5.875	5.397	5.033	4.125	4.886	3.453	5.559	2.694	7.067	0.000	0.000	0.000	0.000
4.007	6.253	6.008	5.270	5.322	4.079	5.434	3.451	6.424	2.762	8.737	1.788	12.909	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.383	2.168	4.559	1.132	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.467	2.543	4.857	1.466	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.512	2.944	5.038	1.812	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.458	4.733	5.286	3.587	3.825	2.874	2.896	2.757	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.192	5.604	5.173	4.898	3.926	4.599	3.293	5.176	2.541	6.529	0.000	0.000	0.000	0.000
4.007	5.884	5.675	4.386	5.031	3.879	5.061	3.285	5.918	2.623	8.018	1.650	11.726	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.033	2.187	4.135	1.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.126	2.555	4.531	1.439	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.195	2.952	4.737	1.790	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.144	4.613	5.030	3.505	3.612	2.744	2.677	2.560	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.773	5.333	4.855	4.588	3.737	4.338	3.120	4.831	2.395	6.037	0.000	0.000	0.000	0.000
4.007	5.547	5.365	4.723	4.752	3.690	4.736	3.127	5.482	2.439	7.386	1.519	10.634	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.597	2.193	3.848	1.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.803	2.552	4.219	1.339	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.871	2.928	4.448	1.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.946	4.475	4.796	3.407	3.439	2.613	2.467	2.352	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.469	5.092	4.623	4.377	3.557	4.098	2.964	4.519	2.254	5.586	0.000	0.000	0.000	0.000
4.007	5.238	5.075	4.478	4.513	3.511	4.447	2.976	5.100	2.361	6.824	1.393	9.623	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.374	2.152	3.518	.996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.492	2.516	3.919	1.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.570	2.891	4.170	1.703	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.564	4.325	4.552	3.299	3.211	2.433	2.267	2.172	0.000	0.000	0.000	0.000	0.000	0.000
3.418	5.185	4.839	4.336	4.173	3.395	3.876	2.814	4.234	2.118	5.170	0.000	0.000	0.000	0.000
4.007	4.953	4.898	4.249	4.280	3.341	4.186	2.832	4.760	2.238	6.319	1.273	8.688	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.063	2.107	3.203	.938	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.193	2.463	3.532	1.293	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.280	2.916	3.903	1.645	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.296	4.163	4.328	3.183	3.022	2.354	2.077	1.991	0.000	0.000	0.000	0.000	0.000	0.000
3.418	4.921	4.605	4.181	3.979	3.221	3.669	2.671	3.971	1.988	4.785	0.000	0.000	0.000	0.000
4.007	4.599	4.557	4.035	4.053	3.180	3.948	2.694	4.453	2.120	5.862	1.160	7.821	0.000	0.000

N2= 2.250

THETA=THETAC + 2

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	[illegible]	1.601	6.329	1.084	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	8.135	1.919	6.444	1.323	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	8.150	2.265	6.512	1.593	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	8.097	4.480	6.538	3.421	4.874	3.191	3.961	3.454	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.901	6.582	6.492	5.599	4.895	5.754	4.101	6.698	3.261	8.501	0.000	0.000	0.000	0.000
4.007	7.779	7.145	6.417	6.326	4.858	6.853	4.095	8.264	3.288	10.986	2.291	16.008	0.000	0.000

THETA=THETAC + 3

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	7.690	1.848	5.385	1.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	7.730	2.200	5.753	1.396	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.757	2.591	6.152	1.698	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.640	4.797	6.270	3.580	4.619	3.096	3.695	3.244	0.000	0.000	0.000	0.000	0.000	0.000
3.418	7.429	6.454	5.144	5.453	4.650	5.374	3.902	6.154	3.086	7.818	0.000	0.000	0.000	0.000
4.007	7.258	6.811	6.045	5.977	4.621	6.210	3.897	7.394	3.127	9.913	2.130	14.587	0.000	0.000

THETA=THETAC + 4

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	7.297	2.015	5.460	1.136	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.559	7.341	2.389	5.676	1.436	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.373	2.795	5.836	1.760	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	7.395	4.381	5.958	3.637	4.374	2.998	3.440	3.029	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.999	6.227	5.821	5.258	4.433	5.045	3.713	5.708	2.917	7.207	0.000	0.000	0.000	0.000
4.007	6.812	6.450	5.703	5.649	4.390	5.714	3.709	6.713	2.973	9.014	1.976	13.284	0.000	0.000

THETA=THETAC + 5

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.459	6.910	2.121	5.052	1.131	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.968	2.595	5.315	1.450	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.661	7.009	2.913	5.473	1.789	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.945	4.865	5.690	3.630	4.138	2.839	3.196	2.822	0.000	0.000	0.000	0.000	0.000	0.000
3.418	6.684	5.958	5.520	5.044	4.219	4.753	3.531	5.310	2.755	6.656	0.000	0.000	0.000	0.000
4.007	6.395	6.098	5.389	5.344	4.172	5.305	3.530	6.156	2.824	8.246	1.829	12.085	0.000	0.000

THETA=THETAC + 6

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.528	2.180	4.555	1.110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.610	2.566	4.957	1.444	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.650	2.969	5.153	1.791	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.655	4.789	5.405	3.592	3.912	2.775	2.962	2.622	0.000	0.000	0.000	0.000	0.000	0.000
3.419	6.241	5.587	5.239	4.828	4.015	4.488	3.358	4.955	2.599	6.156	0.000	0.000	0.000	0.000
4.007	6.018	5.764	5.099	5.050	3.967	4.956	3.360	5.685	2.632	7.576	1.688	10.980	0.000	0.000

THETA=THETAC + 7

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	6.170	2.204	4.231	1.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	6.256	2.587	4.534	1.421	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.325	2.981	4.845	1.774	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	6.283	4.675	5.145	3.507	3.694	2.656	2.738	2.430	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.955	5.421	4.976	4.614	3.822	4.244	3.191	4.636	2.449	5.699	0.000	0.000	0.000	0.000
4.007	5.673	5.452	4.930	4.736	3.774	4.648	3.193	5.278	2.546	6.989	1.553	9.950	0.000	0.000

THETA=THETAC + 8

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.926	2.139	3.936	1.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.935	2.577	4.314	1.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	6.004	2.960	4.549	1.740	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.979	4.539	4.995	3.414	3.485	2.536	2.523	2.245	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.593	5.164	4.728	4.406	3.638	4.018	3.032	4.345	2.305	5.278	0.000	0.000	0.000	0.000
4.007	5.357	5.161	4.580	4.549	3.590	4.373	3.043	4.920	2.415	6.464	1.425	9.015	0.000	0.000

THETA=THETAC + 9

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.495	2.173	3.598	.983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.617	2.544	4.008	1.339	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.696	2.915	4.255	1.594	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.690	4.383	4.656	3.310	3.294	2.414	2.319	2.067	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.303	4.918	4.435	4.205	3.452	3.807	2.878	4.077	2.166	4.889	0.000	0.000	0.000	0.000
4.007	5.065	4.899	4.346	4.319	3.417	4.124	2.896	4.599	2.289	5.992	1.302	8.140	0.000	0.000

THETA=THETAC + 10

N3=	1.000		1.237		1.662		1.988		2.477		3.418		4.007	
N1	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.450	5.178	2.123	3.276	.927	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.550	5.311	2.492	3.715	1.294	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.651	5.409	2.851	3.992	1.539	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.371	5.413	4.273	4.427	3.197	3.090	2.292	2.124	1.896	0.000	0.000	0.000	0.000	0.000	0.000
3.419	5.032	4.683	4.275	4.012	3.294	3.698	2.731	3.829	2.033	4.529	0.000	0.000	0.000	0.000
4.007	4.795	4.636	4.127	4.102	3.252	3.895	2.755	4.309	2.163	5.563	1.185	7.329	0.000	0.000

THICK FILM APPROXIMATION RESULTS

THETA=THETAC + 2

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	1.134	1.430	1.015	1.418	.928	1.469	.675	1.851	.523	2.044	.470	1.970
1.350	1.199	1.367	1.036	1.351	.936	1.385	.669	1.753	.516	1.972	.464	1.922
1.400	1.283	1.374	1.059	1.302	.949	1.314	.663	1.653	.510	1.899	.459	1.872
1.450	0.000	0.000	1.121	1.277	.969	1.257	.659	1.560	.505	1.827	.453	1.821
1.455	0.000	0.000	1.128	1.276	.971	1.252	.658	1.551	.504	1.820	.453	1.816
1.500	0.000	0.000	1.208	1.288	.999	1.215	.655	1.473	.499	1.757	.448	1.769
1.550	0.000	0.000	0.000	0.000	1.042	1.192	.651	1.394	.494	1.688	.444	1.716
1.600	0.000	0.000	0.000	0.000	1.113	1.198	.649	1.320	.489	1.620	.439	1.663
1.650	0.000	0.000	0.000	0.000	1.129	1.144	.647	1.252	.485	1.555	.435	1.611
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.646	1.190	.481	1.492	.430	1.559

THETA=THETAC + 3

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.855	1.053	.776	1.077	.715	1.117	.523	1.352	.401	1.366	.359	1.274
1.350	.881	1.010	.788	1.021	.719	1.053	.518	1.284	.397	1.329	.355	1.252
1.400	.907	.972	.804	.976	.725	.998	.514	1.218	.393	1.291	.351	1.228
1.450	0.000	0.000	.827	.941	.736	.950	.510	1.157	.389	1.253	.347	1.204
1.455	0.000	0.000	.830	.938	.737	.946	.510	1.151	.388	1.249	.347	1.201
1.500	0.000	0.000	.849	.905	.750	.911	.507	1.099	.385	1.214	.344	1.178
1.550	0.000	0.000	0.000	0.000	.770	.880	.505	1.044	.381	1.176	.341	1.152
1.600	0.000	0.000	0.000	0.000	.791	.851	.503	.993	.378	1.137	.338	1.124
1.650	0.000	0.000	0.000	0.000	.591	.599	.501	.945	.375	1.099	.334	1.097
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.500	.901	.372	1.062	.332	1.069

THETA=THETAC + 4

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.682	.837	.629	.867	.583	.901	.430	1.056	.327	1.009	.291	.922
1.350	.688	.788	.633	.818	.585	.849	.426	1.007	.324	.987	.288	.910
1.400	.672	.719	.639	.774	.587	.802	.423	.961	.321	.964	.285	.897
1.450	0.000	0.000	.644	.731	.591	.761	.420	.916	.318	.940	.283	.883
1.455	0.000	0.000	.644	.727	.592	.757	.419	.912	.318	.938	.282	.881
1.500	0.000	0.000	.625	.666	.597	.722	.417	.874	.315	.916	.280	.868
1.550	0.000	0.000	0.000	0.000	.601	.685	.415	.833	.312	.891	.278	.852
1.600	0.000	0.000	0.000	0.000	.590	.634	.413	.795	.310	.866	.276	.836
1.650	0.000	0.000	0.000	0.000	.281	.285	.411	.759	.307	.841	.273	.819
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.410	.725	.305	.817	.271	.802

THETA=THETAC + 5

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.560	.685	.525	.719	.491	.751	.365	.859	.276	.789	.244	.712
1.350	.552	.631	.525	.675	.490	.707	.362	.823	.273	.774	.242	.705
1.400	.506	.542	.523	.631	.490	.666	.359	.788	.271	.759	.240	.696
1.450	0.000	0.000	.514	.583	.490	.627	.356	.754	.269	.743	.238	.687
1.455	0.000	0.000	.512	.577	.489	.623	.356	.751	.269	.742	.238	.686
1.500	0.000	0.000	.467	.497	.488	.589	.354	.721	.267	.727	.236	.678
1.550	0.000	0.000	0.000	0.000	.481	.548	.352	.690	.265	.710	.234	.668
1.600	0.000	0.000	0.000	0.000	.448	.481	.350	.659	.263	.692	.233	.657
1.650	0.000	0.000	0.000	0.000	.101	.102	.348	.630	.261	.675	.231	.646
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.347	.603	.259	.657	.229	.634

THETA=THETAC + 6

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.467	.570	.446	.608	.421	.639	.316	.718	.237	.641	.209	.573
1.350	.449	.513	.442	.567	.419	.600	.313	.690	.236	.631	.207	.568
1.400	.382	.409	.435	.524	.416	.563	.311	.663	.234	.620	.206	.563
1.450	0.000	0.000	.415	.471	.412	.526	.309	.636	.232	.608	.205	.557
1.455	0.000	0.000	.413	.465	.412	.523	.308	.633	.232	.607	.204	.556
1.500	0.000	0.000	.348	.371	.406	.489	.306	.609	.230	.596	.203	.550
1.550	0.000	0.000	0.000	0.000	.390	.444	.304	.584	.229	.584	.202	.543
1.600	0.000	0.000	0.000	0.000	.341	.366	.303	.559	.227	.571	.200	.535
1.650	0.000	0.000	0.000	0.000	.014	.014	.301	.536	.225	.558	.199	.527
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.299	.513	.224	.545	.198	.519

THETA=THETAC + 7

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.393	.479	.384	.521	.366	.550	.278	.612	.207	.535	.182	.475
1.350	.367	.419	.377	.481	.362	.515	.275	.590	.206	.527	.181	.471
1.400	.286	.305	.365	.438	.358	.481	.273	.567	.205	.519	.180	.468
1.450	0.000	0.000	.338	.383	.351	.447	.271	.545	.203	.510	.179	.463
1.455	0.000	0.000	.334	.376	.350	.443	.271	.543	.203	.509	.178	.463
1.500	0.000	0.000	.257	.274	.349	.409	.269	.524	.202	.501	.177	.458
1.550	0.000	0.000	0.000	0.000	.318	.362	.267	.503	.201	.492	.176	.453
1.600	0.000	0.000	0.000	0.000	.258	.277	.265	.482	.199	.482	.175	.448
1.650	0.000	0.000	0.000	0.000	.005	.006	.263	.462	.198	.472	.174	.442
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.262	.442	.197	.462	.173	.435

THETA=THETAC + 8

N1 =	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.333	.405	.333	.450	.321	.479	.246	.529	.183	.455	.160	.402
1.350	.301	.343	.323	.412	.316	.447	.244	.511	.182	.449	.159	.399
1.400	.209	.224	.307	.359	.310	.415	.242	.492	.181	.443	.158	.396
1.450	0.000	0.000	.275	.311	.301	.382	.240	.474	.180	.436	.158	.393
1.455	0.000	0.000	.270	.304	.300	.378	.240	.472	.180	.435	.158	.393
1.500	0.000	0.000	.185	.197	.287	.344	.238	.456	.179	.429	.157	.390
1.550	0.000	0.000	0.000	0.000	.260	.295	.237	.438	.178	.421	.156	.386
1.600	0.000	0.000	0.000	0.000	.192	.206	.235	.420	.177	.414	.155	.381
1.650	0.000	0.000	0.000	0.000	.077	.078	.233	.403	.176	.406	.154	.377
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.231	.386	.175	.397	.154	.372

THETA=THETAC + 9

N1 =	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.283	.343	.290	.390	.283	.420	.220	.463	.163	.392	.142	.345
1.350	.246	.280	.279	.354	.277	.390	.219	.447	.163	.388	.142	.344
1.400	.149	.159	.250	.311	.270	.360	.217	.432	.162	.383	.141	.341
1.450	0.000	0.000	.223	.252	.259	.328	.215	.416	.161	.378	.140	.339
1.455	0.000	0.000	.217	.244	.258	.324	.215	.415	.161	.377	.140	.339
1.500	0.000	0.000	.129	.137	.242	.290	.213	.400	.160	.372	.140	.336
1.550	0.000	0.000	0.000	0.000	.212	.240	.211	.385	.159	.366	.139	.333
1.600	0.000	0.000	0.000	0.000	.139	.149	.209	.370	.158	.360	.138	.330
1.650	0.000	0.000	0.000	0.000	.237	.240	.207	.354	.157	.353	.138	.326
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.205	.339	.156	.346	.137	.322

THETA=THETAC + 10

N1 =	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.300	.240	.290	.254	.340	.251	.369	.198	.408	.147	.343	.127	.301
1.350	.200	.227	.240	.304	.244	.342	.197	.395	.146	.339	.127	.299
1.400	.101	.108	.219	.252	.235	.313	.195	.382	.145	.335	.126	.298
1.450	0.000	0.000	.179	.202	.223	.282	.193	.368	.144	.331	.126	.296
1.455	0.000	0.000	.173	.195	.222	.279	.193	.367	.144	.330	.126	.295
1.500	0.000	0.000	.084	.090	.205	.245	.191	.354	.144	.326	.125	.294
1.550	0.000	0.000	0.000	0.000	.171	.194	.189	.341	.143	.321	.125	.291
1.600	0.000	0.000	0.000	0.000	.097	.104	.187	.327	.142	.316	.124	.288
1.650	0.000	0.000	0.000	0.000	.517	.524	.185	.314	.141	.310	.124	.285
1.700	0.000	0.000	0.000	0.000	0.000	0.000	.183	.300	.140	.305	.123	.282

THETA=THETAC + 2

N1=	1.450		1.550		1.651		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.647	1.081	.473	1.373	.423	1.457
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.650	1.034	.470	1.317	.419	1.407
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.653	.991	.467	1.263	.416	1.359
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.658	.953	.464	1.212	.413	1.312
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.665	.920	.461	1.164	.410	1.266
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.674	.891	.459	1.117	.407	1.222
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.686	.867	.456	1.074	.404	1.179
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.702	.848	.454	1.032	.402	1.138
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.723	.837	.453	.993	.399	1.099
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.753	.834	.451	.955	.397	1.061

THETA=THETAC + 3

N1=	1.450		1.550		1.651		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.500	.821	.365	.989	.326	1.013
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.501	.786	.364	.954	.324	.984
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.502	.754	.361	.921	.321	.957
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.505	.725	.359	.888	.319	.929
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.508	.699	.357	.856	.317	.902
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.513	.674	.355	.826	.315	.875
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.519	.653	.354	.797	.313	.849
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.527	.635	.352	.769	.311	.824
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.537	.620	.351	.742	.309	.799
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.548	.607	.350	.716	.308	.774

THETA=THETAC + 4

N1=	1.450		1.550		1.651		2.371		3.413		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.409	.662	.301	.768	.257	.765
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.409	.634	.299	.744	.255	.748
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.409	.608	.297	.720	.263	.730
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.410	.584	.295	.697	.262	.712
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.411	.562	.294	.675	.260	.694
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.413	.541	.292	.653	.258	.676
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.416	.521	.291	.632	.257	.658
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.418	.503	.290	.611	.256	.641
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.421	.485	.288	.591	.254	.624
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.420	.464	.287	.572	.253	.607

THETA=THETAC + 5

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.345	.552	.255	.622	.226	.610
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.344	.529	.254	.604	.225	.597
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.344	.507	.252	.587	.223	.584
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.343	.486	.251	.570	.222	.572
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.343	.466	.249	.553	.221	.559
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.343	.447	.248	.536	.219	.546
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.343	.428	.247	.520	.218	.533
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.342	.410	.246	.504	.217	.520
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.338	.389	.245	.489	.216	.507
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.329	.364	.244	.474	.215	.495

THETA=THETAC + 6

N1=	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.297	.470	.221	.518	.195	.501
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.295	.450	.220	.505	.194	.492
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.294	.430	.219	.491	.193	.483
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.293	.412	.217	.478	.192	.473
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.291	.394	.216	.464	.191	.463
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.290	.376	.215	.451	.190	.454
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.287	.358	.214	.439	.189	.444
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.283	.339	.213	.426	.188	.434
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.276	.317	.212	.413	.187	.424
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.261	.288	.211	.401	.186	.414

THETA=THETAC + 7

N1=	1.450		1.550		1.661		2.371		3.413		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.258	.405	.194	.440	.171	.422
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.257	.388	.193	.430	.170	.415
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.255	.370	.192	.419	.169	.408
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.253	.353	.191	.408	.169	.400
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.250	.337	.190	.398	.158	.393
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.247	.329	.189	.387	.167	.385
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.243	.322	.188	.376	.166	.377
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.237	.283	.187	.366	.155	.369
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.227	.250	.186	.356	.164	.362
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.207	.228	.185	.346	.153	.354

THETA=THETAC + 8

N1 =	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.227	.353	.172	.330	.152	.361
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.225	.337	.171	.371	.151	.356
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.223	.322	.170	.363	.150	.350
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.220	.306	.169	.354	.150	.344
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.217	.290	.168	.345	.149	.338
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.213	.274	.167	.336	.148	.332
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.207	.257	.167	.327	.147	.326
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.199	.239	.166	.318	.146	.319
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.187	.214	.165	.310	.146	.313
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.163	.180	.164	.301	.145	.306

THETA=THETAC + 9

N1 =	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.201	.310	.154	.332	.136	.314
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.199	.296	.153	.325	.135	.309
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.196	.281	.152	.317	.134	.304
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.193	.267	.152	.310	.134	.300
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.189	.252	.151	.302	.133	.295
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.184	.236	.150	.295	.132	.289
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.177	.219	.149	.287	.132	.284
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.168	.200	.148	.280	.131	.279
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.153	.175	.147	.272	.130	.274
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.128	.141	.146	.265	.130	.268

THETA=THETAC + 10

N1 =	1.450		1.550		1.661		2.371		3.418		4.007	
N2	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP	DS	DP
1.800	0.000	0.000	0.000	0.000	0.000	0.000	.179	.274	.139	.293	.122	.275
1.850	0.000	0.000	0.000	0.000	0.000	0.000	.176	.260	.138	.286	.122	.271
1.900	0.000	0.000	0.000	0.000	0.000	0.000	.173	.247	.137	.280	.121	.267
1.950	0.000	0.000	0.000	0.000	0.000	0.000	.169	.233	.136	.274	.120	.263
2.000	0.000	0.000	0.000	0.000	0.000	0.000	.165	.219	.135	.267	.120	.259
2.050	0.000	0.000	0.000	0.000	0.000	0.000	.159	.204	.135	.261	.119	.255
2.100	0.000	0.000	0.000	0.000	0.000	0.000	.152	.187	.134	.254	.119	.250
2.150	0.000	0.000	0.000	0.000	0.000	0.000	.141	.168	.133	.247	.118	.246
2.200	0.000	0.000	0.000	0.000	0.000	0.000	.125	.143	.132	.241	.117	.241
2.250	0.000	0.000	0.000	0.000	0.000	0.000	.098	.108	.131	.234	.117	.237