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REFLECTION OF POLARIZED LIGHT FROM ABSORBING MEDIA

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August 1966

ABSTRACT

Reflection of polarized light from absorbing media, such as a bare metal surface in contact with a dielectric, results in characteristic changes in the polarization state from which the optical constants of the reflecting interface can be determined. Starting from Maxwell's equations of electromagnetic theory, the basic relationships of metallic reflection and exact formulas for relating the optical constants with amplitude and phase changes upon reflection are derived and illustrated by extensive numerical data.

magnetic dipole moment per unit volume), $\vec{J}_{free}$ is the free current density, $\vec{H}$ is the magnetic field intensity, $\frac{\partial \vec{D}}{\partial t}$ is the displacement current density, ρ_{free} is the free charge density, $\vec{D}$ is the displacement vector, and c is the speed of light in vacuum.

At the outset, the following assumptions* will be made:

1. $\vec{E}$, $\vec{D}$, $\vec{P}$, $\vec{B}$, $\vec{H}$, $\vec{M}$ and $\vec{J}_{free}$ oscillate sinusoidally** at each point with frequency ω. That is,

$$\vec{E} = \vec{E}_s e^{-i\omega t} \qquad \vec{P} = \vec{P}_s e^{-i\omega t}$$

$$\vec{B} = \vec{B}_s e^{-i\omega t} \qquad \vec{M} = \vec{M}_s e^{-i\omega t} \tag{7a-g}$$

$$\vec{J}_{free} = \vec{J}_s e^{-i\omega t} \qquad \vec{D} = \vec{D}_s e^{-i\omega t} \qquad \vec{H} = \vec{H}_s e^{-i\omega t}$$

where the subscript s refers to the time independent quantity in each case.

2. The media to be considered are all linear and isotropic, that is,

$$\vec{P}_s = \chi_e \vec{E}_s, \quad \vec{M}_s = \chi_m \vec{H}_s, \quad \vec{J}_s = \sigma \vec{E}_s \tag{8a-c}$$

and the magnetic and electric susceptibilities χ_m and χ_e as well as the conductivity σ are constant throughout each medium.

3. The equation of continuity holds, i.e.,

$$\frac{\partial \rho_{free}}{\partial t} = -\operatorname{div} \vec{J}_{free} = -e^{-i\omega t} \operatorname{div} \vec{J}_s$$

---

* This treatment is given in Ref. 1, pp. 369-372.

** The choice of $e^{-i\omega t}$ instead of $e^{+i\omega t}$ to represent the time dependence is arbitrary, but is in keeping with current practice.

When this equation is integrated with respect to time, there results,

$$\rho_{free} = \rho_s e^{-i\omega t}$$

where

$$\rho_s \equiv -\frac{i}{\omega} \text{ div } \vec{J}_s = -\frac{i}{\omega} \text{div } \sigma \vec{E}_s \qquad (9)$$

Having made these assumptions, it is now possible to eliminate the time dependence from Eqs. (1) through (4). Substituting Eqs. (8a-b) into Eqs. (7a-d), then into Eqs. (5) and (6) and dividing out the common factor $e^{-i\omega t}$ leaves

$$\vec{D}_s = (1 + 4\pi\chi_e) \vec{E}_s \qquad (5a)$$

$$\vec{B}_s = (1 + 4\pi\chi_m) \vec{H}_s \qquad (6a)$$

so that

$$\vec{D}_s = \epsilon\vec{E}_s \qquad (5b)$$

$$\vec{B}_s = \mu\vec{H}_s \qquad (6b)$$

Due to the assumption 2 above, ϵ and μ will be considered as constants for each medium.

Substituting Eqs. (5b) and (9) into Eq. (1) gives

$$\text{div } (\epsilon + \frac{4\pi\sigma}{\omega} i) \vec{E}_s = 0 \qquad (1a)$$

Since

$$\frac{\partial \vec{B}}{\partial t} = - i\omega\vec{B}_s e^{-i\omega t} = - i\omega\mu\vec{H}_s e^{-i\omega t} \qquad (10)$$

Equation (2) can be written, cancelling the common factor $e^{-i\omega t}$, as

$$\text{curl } \vec{E}_s = \frac{i\omega\mu}{c} \vec{H}_s \qquad (2a)$$

with Eq. (6b), Eq. (3) becomes, dividing out the factor $e^{-i\omega t}$,

$$\mathrm{div}\ \mu\vec{H}_s = 0. \tag{3a}$$

Finally, using Eqs. (5b), (7e) and (8c) and cancelling the factor $e^{-i\omega t}$, Eq. (4) can be written

$$\mathrm{curl}\ \vec{H}_s = -i\frac{\omega}{c}\left(\epsilon + i\frac{4\pi\sigma}{\omega}\right)\vec{E}_s \tag{4a}$$

Taking the curl of Eq. (2a) and substituting curl $\vec{H}_s$ from Eq. (4a) one has

$$\mathrm{curl\ curl}\ \vec{E}_s = \frac{\omega^2\mu}{c^2}\left(\epsilon + i\frac{4\pi\sigma}{\omega}\right)\vec{E}_s \tag{11}$$

Applying the vector identity*

$$\mathrm{curl\ curl}\ \vec{E}_s = \mathrm{grad\ div}\ \vec{E}_s - \vec{\nabla}^2\vec{E}_s$$

where, if x, y, and z are cartesian coordinates

$$\nabla^2\vec{E}_s \equiv \frac{\partial^2\vec{E}_s}{\partial x^2} + \frac{\partial^2\vec{E}_s}{\partial y^2} + \frac{\partial^2\vec{E}_s}{\partial z^2}$$

and noting that by Eq. (1a)

$$\mathrm{div}\ \vec{E}_s = 0$$

since ϵ and σ are independent of position, there results

$$\nabla^2\vec{E}_s + \frac{\omega^2}{c^2}\mu\left(\epsilon + i\frac{4\pi\sigma}{\omega}\right)\vec{E}_s = 0. \tag{12}$$

Equation (12) is the wave equation.

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* See Reference 1, p. 27.

C. Solution of Wave Equation

Equation (12) can be simplified by making the definition

$$n_c^2 \equiv \mu \left(\epsilon + i \frac{4\pi\sigma}{\omega}\right) \tag{13}$$

so that

$$\nabla^2 \vec{E}_s + \frac{\omega^2}{c^2} n_c^2 \vec{E}_s = 0 \tag{12a}$$

The complex quantity n_c is called the complex index of refraction further defined by

$$n_c \equiv n (1 + i\kappa)^* \tag{14}$$

---

* In the literature one often finds these other forms for the complex index of refraction:

$$n_c = n + i\kappa \tag{14a}$$

$$n_c = n - i\kappa \tag{14b}$$

$$n_c = n(1 - i\kappa) \tag{14c}$$

Definitions (14b) and (14c) are rejected here because, together with choosing the sinusoidal time variation as $e^{-i\omega t}$, they would lead to the definition of an intrinsically negative absorption coefficient (see Eqs. (27b), (22a) and (17) below). If, on the other hand, one uses $e^{+i\omega t}$ to describe the time dependence of the fields, then one should represent the complex index of refraction by either Eq. (14b) or (14c). The choice made here, namely Eq. (14), is made to facilitate comparison of later equations with those given in the literature (see also Appendix I).

It will be shown in this section that the real quantities n and κ are related to the ratio n' of the phase velocity in the medium under consideration to that in vacuum and to the absorption coefficient α which is a measure of the energy absorbed when an electromagnetic wave passes through the medium.

To solve the wave equation one assumes a solution of the form

$$\vec{E}_s(x,y,z) = \vec{E}_0\, e^{i(\mu_1 x + \mu_2 y + \mu_3 z)} \tag{15}$$

where x, y, z are measured from an arbitrary reference 0. In Eq. (15) μ_1, μ_2, and μ_3 are constants, in general complex, and $\vec{E}_0$ is a constant vector, also complex in general. Substitution of Eq. (15) into Eq. (12a) leads to the relation

$$\frac{\omega^2}{c^2} n_c^2 = \mu_1^2 + \mu_2^2 + \mu_3^2 \tag{16}$$

Since n_c is complex, μ_1, μ_2, and μ_3 cannot all be real.

1. Transparent Media

When an electromagnetic wave propagates through a transparent medium(σ = 0) the solution to the wave equation is of the form

$$\vec{E}_s(x,y,z) = \vec{E}_0\, e^{i\vec{k} \cdot \vec{r}}$$

where $\vec{r}$ is a vector from an arbitrary reference point to the point of interest (x,y,z) and $\vec{k}$ is a real quantity giving the direction of propagation. The magnitude of $\vec{k}$ is

$$k = \frac{\omega}{v}$$

where v is the phase velocity of the wave. Planes of equal phase and planes of equal amplitude are normal to $\vec{k}$.

2. Absorbing Media

As discussed by Ditchburn* and Stone** when the medium is absorbing, planes of equal phase are normal to the direction of propagation $\vec{K}$, (Fig. 1) while planes of equal amplitude are parallel to the plane surface of the medium (normal to another direction $\vec{a}$). For such a medium, the solution of Eq. (12a) may be written

$$\vec{E}_s = \vec{E}_o\, e^{-\alpha z}\, e^{i\vec{K}\cdot\vec{r}} \tag{17}$$

Equation (17) represents a plane wave, moving in the direction of $\vec{K}$, that is reduced in amplitude as it passes through the medium. After travelling to a depth $z = \frac{1}{2\alpha}$ (known as the penetration depth), the intensity is diminished by a factor of 1/e.

The constant α is called the absorption coefficient and is taken positive by definition. With the inward normal to the surface of the reflecting medium oriented along the positive z axis, as shown in Fig. 1, the plane of incidence (the plane defined by z and $\vec{K}$) is the xz plane. Let $\vec{K}$ make an angle ϕ_r with the z axis.

From Fig. 1,

$$\vec{K} = k(\hat{x}\sin\phi_r + \hat{z}\cos\phi_r) \tag{18}$$

$$\vec{r} = x\hat{x} + y\hat{y} + z\hat{z} \tag{19}$$

$$k = |\vec{K}|$$

In all equations, the symbol "^" over a letter denotes a unit vector along the the axis denoted by the letter. By Eq. (18) and (19),

$$\vec{K}\cdot\vec{r} = k(x\sin\phi_r + z\cos\phi_r)$$

By definition,* the ratio of the vacuum phase velocity c to the phase

* Ref. 11, p. 590.

** Ref. 1, p. 392.

velocity v in the medium is the real index of refraction n'.

$$\frac{c}{v} \equiv n' \geq 0 \tag{20}$$

Thus

$$k \equiv \frac{\omega}{v} = \frac{\omega}{c/n'} = \frac{\omega}{c} n' = k_0 n' \tag{20a}$$

Here the subscript 0 denotes the value of the subscripted quantity in vacuum.

Equation (17) can now be written

$$\vec{E}_s = \vec{E}_0 \, e^{-\alpha z} \, e^{i \frac{\omega n'}{c} (x \sin \phi_r + z \cos \phi_r)}$$

or

$$\vec{E}_s = \vec{E}_0 \, e^{i[\frac{\omega n'}{c} (x \sin \phi_r + z \cos \phi_r) + i\alpha z]} \tag{21}$$

It is useful to define κ' so that

$$\kappa' \equiv \frac{\alpha}{k} = \frac{\alpha c}{\omega n'} \geq 0 \tag{22}$$

and to define n_c' by

$$n_c' \equiv n'(1 + i\,\kappa')$$

Equations (27a) and (27b) which will presently be derived relate n' and κ' to n and κ. Thus n_c' can also be considered as a complex index of refraction although not equivalent to n_c.

The solution of Eq. (22) for the absorption coefficient α results in

$$\alpha = \frac{\omega n'\kappa'}{c} = \frac{2\pi n'\kappa'}{\lambda_o} \geq 0^{*} \qquad (22a)$$

where λ_o is the vacuum wavelength.

---

* The absorption coefficient usually found in the literature is twice that given by Eq. (22a), e.g. Ref. [5] p. 614. The reason for the difference is that the absorption coefficient is usually regarded as the inverse of the distance travelled by the wave when the intensity decreases by 1/e. Since the intensity is proportional to the squared modulus of the electric field,

$$I \propto |E|^2$$

one has, from Eq. (17), $I \propto e^{-2\alpha z}$. Hence, the intensity diminishes by an amount 1/e after penetrating to a depth $z = 1/2\alpha$.

With these new definitions, Eq. (21) becomes

$$\vec{E}_s = \vec{E}_0 \, e^{i[\frac{\omega n'}{c}(x \sin \phi_r + z \cos \phi_r) + \frac{i\omega n'\kappa' z}{c}]} \tag{21a}$$

$$\vec{E}_s = \vec{E}_0 \, e^{i\frac{\omega n'}{c}[x \sin \phi_r + z (\cos \phi_r + i\kappa')]} \tag{21b}$$

An alternative and somewhat simpler way of handling the solution to Eq. (12a) and one that will be used in later sections is to introduce the complex propagation vector $\vec{k}_c$,

$$\vec{k}_c = \vec{k} + i\vec{a} \tag{23}$$

where $\vec{a}$ is called the attenuation vector. As mentioned above, planes of equal amplitude are normal to $\vec{a}$.

$$\vec{a} = |\vec{a}|\hat{z} = a\hat{z}$$

By analogy with the plane wave solution one writes

$$\vec{E}_s = \vec{E}_0 \, e^{i \vec{k}_c \cdot \vec{r}} \tag{24}$$

When Eqs. (23), (18), and (19) are substituted into Eq. (24), there results

$$\vec{E} = \vec{E}_s \, e^{-i\omega t} = E_0 \, e^{-i[\omega t - k(x \sin \phi_r + z \cos \phi_r) - iaz]} \tag{25}$$

or, since $k = n' k_o = \frac{n'\omega}{c}$

$$\vec{E}_s = \vec{E}_0 \, e^{i[\frac{\omega n'}{c}(x \sin \phi_r + z \cos \phi_r) + iaz]} \tag{25a}$$

Comparison of Eqs. (25a) and (21a) shows

$$a = \frac{\omega n' \kappa'}{c} = \alpha \tag{26}$$

It is important to keep in mind that $n \neq n'$ and $\kappa \neq \kappa'$. The following discussion will make this point clear.

Equation (21b) is in the form of Eq. (15) with

$$\mu_1 = \frac{\omega n'}{c} \sin \phi_r$$

$$\mu_2 = 0$$

$$\mu_3 = \frac{\omega n'}{c} (\cos \phi_r + i\kappa')$$

Substituting into Eq. (16),

$$\frac{\omega^2 n_c^2}{c^2} = \frac{\omega^2}{c^2} n'^2 \sin^2\phi_r + \frac{\omega^2 n'^2}{c^2} (\cos \phi_r + i\kappa')^2$$

$$n^2(1-\kappa^2) + 2in^2\kappa = n'^2\sin^2\phi_r + n'^2(\cos^2\phi_r - \kappa'^2) + 2i\kappa' n'^2 \cos\phi_r$$

Equating real parts,

$$n^2(1 - \kappa^2) = n'^2(1 - \kappa'^2) \tag{27a}$$

Equating imaginary parts,

$$n^2\kappa = n'^2 \kappa' \cos \phi_r \tag{27b}$$

Equations (27a) and (27b) show that

$$n \neq n'$$
$$\kappa \neq \kappa'$$

unless $\phi_r = 0$, (i.e., unless incidence is normal) or $\kappa = \kappa' = 0$ (non-absorbing media. Table 1 shows how n' and κ' differ from n and κ for the case of chromium ($n = 2.96$, $\kappa = 1.13$). Note that if one assumes n and κ to be independent of angle of incidence, then a slight dependence on incident angle is found for n' and κ'. Conversely, if one assumes n' and κ' are independent of incident angle, then a slight variation of n and κ with angle of incidence is found (see table 2). Included in Table 1 are the conductivity σ, the dielectric constant ε and the

Table I

OPTICAL CONSTANTS OF CHROMIUM

If the optical constants n and κ are assumed not to depend on angle of incidence ϕ, the auxiliary constants n' and κ' do.

ϕ (deg)	n	n'	κ	κ'	σ (gaussian)	ϵ	Pen. Depth (cm)
45	2.960	3.007	1.130	1.126	5.435×10^5	-2.429	1.283×10^{-6}
55	2.960	3.024	1.130	1.125	5.435	-2.528	1.278
65	2.960	3.038	1.130	1.124	5.434	-2.427	1.273
75	2.960	3.049	1.130	1.123	5.434	-2.427	1.269
85	2.959	3.054	1.130	1.123	5.432	-2.427	1.268

$\lambda = 5.461 \times 10^{-5}$ cm

σ = electrical conductivity

ϵ = dielectric constant

Table II

OPTICAL CONSTANTS OF CHROMIUM

If the auxiliary optical constants n' and κ' are assumed not to depend on angle of incidence ϕ, then the optical constants n and κ do.

(deg)	n'	κ'	n	κ
5	3.000	1.130	2.999	1.130
25	3.000	1.130	2.983	1.131
45	3.000	1.130	2.952	1.134
55	3.000	1.130	2.935	1.135
65	3.000	1.130	2.920	1.137
75	3.000	1.130	2.909	1.138
85	3.000	1.130	2.903	1.138

penetration depth $\frac{1}{2\alpha}$ (in cm.). The conductivity and dielectric constant are found by squaring Eq. (14) and substituting for n_c^2 in Eq. (13). Thus

$$n_c^2 = n^2(1 - \kappa^2) + i2n^2\kappa = \mu(\varepsilon + \frac{4\pi\sigma}{\omega} i)$$

from which it follows, for $\mu = 1$, that

$$\varepsilon = n^2(1 - \kappa^2)$$

$$\sigma = \frac{n^2\kappa\omega}{2\pi}$$

According to Ditchburn,* when light is incident from a medium of real refractive index n_o' in which the phase velocity is $v_o = c/n_o'$, then the angles of incidence ϕ and refraction ϕ_r (both real) are related by

$$\frac{\sin \phi}{\sin \phi_r} = \frac{v_o}{v} = \frac{c/n_o'}{c/n'} = \frac{n'}{n_o'}$$

or

$$n_o \sin \phi = n' \sin \phi_r$$

This equation is formally the same as Snell's Law for a transparent medium. Thus, if one requires that n' and κ' be independent of incident angle (n and κ will then be dependent on incident angle), Snell's Law can be said to hold for absorbing media as well as for transparent media. Since $n' \neq n$, Snell's Law holds only for n' and not for n, i.e.,

$$n_o \sin \phi \neq n \sin \phi_r$$

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*Ref. 11, pp. 54, 590.

where n is the real part of

$$n_c = n\,(1 + i\kappa). \tag{14}$$

In summary, the spatial description of a plane electromagnetic wave travelling in an absorbing medium characterized by a real refractive index $n' = \frac{c}{v}$ (where v is the phase velocity), and by a real absorption coefficient α,

$$\alpha = \frac{\omega n'\kappa'}{c} \quad , \quad \kappa' = \frac{\alpha c}{\omega n'}$$

and travelling in the direction

$$\vec{k} = \frac{\omega}{v}\,(\hat{x} \sin \phi_r + \hat{z} \cos \phi_r)$$

is given by

$$\vec{E}_s = \vec{E}_o e^{\,i \frac{\omega n'}{c} [x \sin \phi_r + z\,(\cos \phi_r + i\kappa']}$$

When the time dependence is taken into consideration, the electric field is given by

$$\vec{E} = \vec{E}_s e^{-i\omega t} = \vec{E}_o e^{-i\frac{2\pi}{\lambda_o} [ct - n'(x \sin \phi_r + z\,(\cos \phi_r + i\kappa'))]} \tag{21c}$$

where $\frac{2\pi}{\lambda_o} = \frac{\omega}{c}$, λ_o = vacuum wave length.

D. Reflection Coefficients for Absorbing Media

1. Evaluation of Boundary Conditions

Consider a plane wave that is incident from a non-absorbing medium of real refractive index $n_o = n_o'$ onto the plane surface of an absorbing medium of complex index of refraction $n_c = n(1 + i\kappa)$ or $n_c' = n'\,(1 + i\kappa')$ related by Eqs. (27a) and (27b). Figure 2 shows the parallel and normal components of the incident, refracted and reflected waves $\vec{E}$, $\vec{E}'$, and $\vec{E}''$.

The plane of incidence is the xz plane while the plane z = 0 is the boundary between the two media. In the figure the subscript s refers to polarization normal to the plane of incidence, and the subscript p refers to polarization parallel to the plane of incidence.

Inspection of Fig. 2 shows that the electric fields of the incident and reflected waves can be written in the form of Eq. (21c) with $\kappa = 0$ as

$$\vec{E} = (E_p \cos\phi\, \hat{x} + E_s\, \hat{y} - E_p \sin\phi\, \hat{z})\, e^{\frac{-2\pi i}{\lambda_0}[ct - n_0(x \sin\phi + z \cos\phi)]} \tag{28}$$

$$\vec{E}'' = (E''_p \cos\phi\, \hat{x} + E''_s\, \hat{y} + E''_p \sin\phi\, \hat{z})\, e^{\frac{-2\pi i}{\lambda_0}[ct - n_0(x \sin\phi - z \cos\phi)]} \tag{29}$$

The quantities within the parantheses that preceed the exponential factors of Eqs. (28) and (29) are the $\vec{E}_0$'s of Eq. (21c). They are found by resolving the electric field vector into components $\vec{E}_p$ parallel to the plane of incidence and $\vec{E}_s$ normal to the plane of incidence and then resolving these along the three coordinate axes.

For the refracted wave it can be assumed that $\vec{E}'_0$ is of the form

$$\vec{E}'_0 = \epsilon'_1 E'_p\, \hat{x} + E'_s\, \hat{y} + \epsilon'_3 E'_p\, \hat{z} \tag{30}$$

where ϵ_1 and ϵ_3 may be complex. An ϵ'_2 could be used here with E'_s, but it would serve no purpose, and is hence assumed to be part of E'_s.

In order to evaluate the epsilons, Maxwell's Equations (1a), (2a), (3a), and (4a) will be rewritten. Using the identities*

$$\text{curl}\,[\vec{C}\, e^{i\vec{k}_c \cdot \vec{r}}] = i\vec{k}_c \times \vec{C}\, e^{i\vec{k}_c \cdot \vec{r}}$$

*See [1] problem 4-10 and page 372.

$$\text{div}\, \vec{C}\, e^{i\vec{K}_c \cdot \vec{r}} = i\vec{K}_c \cdot \vec{C}\, e^{i\vec{k}_c \cdot \vec{r}}$$

and assuming $\vec{H}_s$ of the form

$$\vec{H}_s = \vec{H}_0\, e^{i\vec{k}'_c \cdot \vec{r}}$$

where $\vec{k}'_c$ is the complex wave vector for the second medium, Maxwell's equations become (setting $\mu = 1$)

$$\vec{k}_c \cdot \vec{E}_0 = 0 \qquad (1b)$$

$$\frac{c}{\omega}\vec{k}_c \times \vec{E}_0 = \vec{H}_0 \qquad (2b)$$

$$\vec{k}_c \cdot \vec{H}_0 = 0 \qquad (3b)$$

$$-\frac{c}{\omega}\vec{k}_c \times \vec{H}_0 = n_c^{\;2}\,\vec{E}_0 \qquad (4b)$$

By Eqs. (23), (18), (19), and (26),

$$\vec{k}'_c = \frac{\omega n'}{c}\left[\hat{x}\sin\phi_r + \hat{z}\left(\cos\phi_r + i\kappa'\right)\right] \qquad (31)$$

Using Eqs. (30), (31), Eq. (1b) becomes

$$\left[\hat{x}\sin\phi_r + \hat{z}\left(\cos\phi_r + i\kappa'\right)\right] \cdot \left[\varepsilon_1 E'_p\,\hat{x} + E'_s\,\hat{y} + \varepsilon_3 E'_p\,\hat{z}\right] = 0$$

$$0 = \varepsilon_1 E'_p \sin\phi_r + \varepsilon_3 E'_p\left(\cos\phi_r + i\kappa'\right)$$

$$\varepsilon_1 \sin\phi_r = -\varepsilon_3\left(\cos\phi_r + i\kappa'\right)$$

One solution to this equation is

$$\varepsilon_1 = \cos\phi_r + i\kappa'$$

$$\varepsilon_3 = -\sin\phi_r$$

The justification for choosing this solution will be the satisfaction of Maxwell's Equations (Eqs. (1b)-(4b)) by the resulting E_o' and H_o'.*

Thus,

$$\vec{E}_o' = E_p' (\cos \phi_r + i\kappa') \hat{x} + E_s' y - E_p' \sin \phi_r \hat{z} \quad (32)$$

Using Eqs. (31), (32), and (2b), one obtains

$$\vec{H}_o' = n'[\hat{x} \sin \phi_r + \hat{z} (\cos \phi_r + i\kappa')] \times [E_p' (\cos \phi_r + i\kappa')\hat{x} + E_s' \hat{y} - E_p' \sin \phi_r \hat{z}]$$

$$= n'[E_s' \sin \phi_r \hat{z} + E_p' \sin^2 \phi_r \hat{y} + E_p'(\cos \phi_r + i\kappa')^2\hat{y} - E_s'(\cos \phi_r + i\kappa') \hat{x}]$$

$$\vec{H}_o' = n'[-E_s'(\cos \phi_r + i\kappa') \hat{x} + E_p'(1-\kappa'^2 + 2i\kappa' \cos \phi_r) \hat{y} + E_s' \sin \phi_r \hat{z}] \quad (33)$$

It can be shown by forming the product $k_c' \cdot H_o'$ that Maxwell's equation (3b) is satisfied by Eq. (33), i.e.,

$$\vec{k}_c' \cdot \vec{H}_o' = 0$$

In order to further show that $\vec{H}_o'$ and $\vec{E}_o'$ are correct as given by Eqs. (32) and (33), evaluation of the fourth Maxwell equation (4b) is carried out.

From Eqs. (31) and (33),

$$\frac{c}{\omega} \vec{k}_c' \times \vec{H}_o' = n'^2 [\hat{x} \sin \phi_r + \hat{z}(\cos \phi_r + i\kappa')] \times [-E_s'(\cos \phi_r + i\kappa') \hat{x}$$

$$+ E_p' (1-\kappa'^2 + i2\kappa' \cos \phi_r) \hat{y} + E_s' \sin \phi_r \hat{z}]$$

$$= n'^2 [E_p' \sin \phi_r (1-\kappa'^2 + i2\kappa' \cos \phi_r)\hat{z} - E_s' \sin^2 \phi_r \hat{y} - E_s(\cos \phi_r + i\kappa')^2\hat{y}]$$

---

*A vector field is uniquely specified if its curl and divergence are given. Maxwell's equations give the curl and divergence of $\vec{E}$ and $\vec{H}$. Thus, if a particular $\vec{E}$ and $\vec{H}$ satisfy Maxwell's equations, they are the only solutions.

$$- E_p' (\cos \phi_r + i\kappa')(1-\kappa'^2 + i2\kappa' \cos \phi_r)\, \hat{x}\Big]$$

$$= -n'^2 \left[E_p'(\cos \phi_r + i\kappa')\, \hat{x} + E_s \hat{y} - E_p' \sin \phi_r \hat{z}\right] \cdot \left[1-\kappa'^2 + 2i\kappa' \cos \phi_r\right]$$

$$= -\vec{E}_o' \left[n'^2(1-\kappa'^2) + 2in'^2\kappa' \cos \phi_r\right]$$

Substituting from Eqs. (27a) and (27b),

$$\frac{c}{\omega} \vec{k}_c \times \vec{H}_o =$$

$$-\vec{E}_o' \left[n'^2(1-\kappa'^2) + 2in'^2 \kappa' \cos \phi_r\right] = -\vec{E}_o' \left|n^2(1-\kappa^2)+2in^2\kappa\right| = -n_c^2 \vec{E}_o'$$

Thus $\vec{E}_o'$ and $\vec{H}_o'$ given by Eqs. (32) and (33) satisfy Maxwell's Equations.

All three electric fields $\vec{E}$, $\vec{E}'$, and $\vec{E}''$ may be written in the form of Eq. (21c). In Eq. (35) below, Snell's law

$$n_o \sin \phi = n' \sin \phi_r \tag{34}$$

has been used in the exponent so that the coefficient of x is the same for all three fields

$$\vec{E} = (E_p \cos \phi\, \hat{x} + E_s \hat{y} - E_p \sin \phi\, \hat{z}) e^{-\frac{2\pi i}{\lambda_o}[ct-n_o(x \sin \phi + z \cos \phi)]} \tag{28}$$

$$\vec{E}'' = (E_p'' \cos \phi\, \hat{x} + E_s'' \hat{y} + E'' \sin \phi\, \hat{z}) e^{-\frac{2\pi i}{\lambda_o}[ct-n_o(x \sin \phi - z \cos \phi)]} \tag{29}$$

$$\vec{E}' = [E_p' (\cos \phi_r + i\kappa')\hat{x} + E_s'\hat{y} - E_p' \sin \phi_r \hat{z}] e^{-\frac{2\pi i}{\lambda_o}[ct-n_o\, x \sin\phi + n'z(\cos \phi_r + i\kappa')]} \tag{35}$$

The magnetic fields $\vec{H}$ and $\vec{H}''$ corresponding to $\vec{E}$ and $\vec{E}''$ can be found by applying Maxwell's Equation (2b) to Eqs. (28) and (29) remembering that in the incident medium $\kappa = 0$, $n' = n_o$. The resulting fields are (omitting the exponential factors for simplicity),

$$\vec{H} = n_o(-E_s \cos\phi\,\hat{x} + E_p\hat{y} + E_s \sin\phi\,\hat{z}) \tag{36}$$

$$\vec{H}'' = n_o\,(E_s'' \cos\phi\,\hat{x} - E_p''\hat{y} + E_s'' \sin\phi\,\hat{z}) \tag{37}$$

$$\vec{H}' = n'(-E_s(\cos\phi_r + i\kappa')\hat{x} + E_p'(1- {}'^2 + i2\kappa' \cos\phi_r)\hat{y} + E_s' \sin\phi_r\hat{z} \tag{38}$$

Assuming no surface charges or currents, the boundary conditions at the interface are that the components of B and $n_c^2 E$ normal to the boundary and the components of E and H parallel to the boundary be continuous.*

These conditions are expressed as follows:

$$n_o^2\,(\vec{E} + \vec{E}'') \cdot \hat{z} = n_c^2\vec{E}' \cdot \hat{z} \tag{39}$$

$$(\vec{H} + \vec{H}'') \cdot \hat{z} = \vec{H}' \cdot \hat{z} \tag{40}$$

$$(\vec{E} + \vec{E}'') \times \hat{z} = \vec{E}' \times \hat{z} \tag{41}$$

$$(\vec{H} + \vec{H}'') \times \hat{z} = \vec{H}' \times \hat{z} \tag{42}$$

Substitution of Eqs. (28), (29) and (35) into (39) and evaluation at $z = 0$ gives, when the common exponential factor is cancelled,

$$n_o^2\,(-E_p \sin\phi + E_p'' \sin\phi) = n_c^2(-E_p' \sin\phi_r)$$

or

$$n_o^2 \sin\phi\,(E_p - E_p'') = n_c^2 \sin\phi_r\, E_p'$$

applying Eq. (34),

$$n_o \sin\phi = n' \sin\phi_r$$

one has

$$n_o(E_p - E_p'') = \frac{n_c^2}{n'} \tag{43}$$

---

*These conditions can be derived mathematically from Maxwell's Equations ([1] pp. 388-390).

When Eqs. (28), (29), and (35) are evaluated at $z = 0$ and substituted into Eq. (41), there results, when the common exponential factor is cancelled,

$$(-E_p \cos \phi\hat{y} + E_s\hat{x} - E''_p \cos \phi\hat{y} + E''_s \hat{x}) = [-E'_p(\cos \phi_r + i\kappa')\hat{y} + E'_s\hat{x}]$$

Collecting terms,

$$-(E_p + E''_p \cos \phi\hat{y} + \hat{x}(E_s + E''_s) = -E'_p(\cos \phi_r + i\kappa')\hat{y} + E'_s\hat{x}$$

Hence,

$$\cos \phi(E_p + E''_p) = E'_p(\cos \phi_r + i\kappa') \tag{44}$$

and

$$E_s + E''_s = E'_s \tag{45}$$

When Eqs. (36), (37), and (38) are evaluated at $z = 0$ and substituted into Eq. (42), and the common exponential factor is cancelled, there results

$$n_o(\hat{y}E_s \cos \phi + \hat{x}E_p - E''_s \cos \phi\hat{y} - E''_p \hat{x})$$

$$= n'[\hat{y}E'_s (\cos \phi_r + i\kappa') + \hat{x}E'_p(1 - \kappa'^2 + 2i\kappa' \cos \phi_r)]$$

or

$$n_o [(E_s - E''_s \cos \phi\hat{y} + (E_p - E''_p)\hat{x}] = n'E'_s(\cos \phi_r + i\kappa')\hat{y}$$

$$+ n'E'_p(1 - \kappa^2 + 2i\kappa' \cos \phi_r)\hat{x}$$

This last equation implies that

$$n_o(E_s - E''_s) \cos \phi = n'E'_s(\cos \phi_r + i\kappa') \tag{46}$$

$$n_o(E_p - E''_p) = n'E'_p(1 - \kappa'^2 + 2i\kappa' \cos \phi_r) \tag{47}$$

Equation (47) is the same as Eq. (43) since

$$n_c^2 = n'^2(1 - \kappa'^2) + 2in'^2\kappa' \cos \phi_r$$

by Eqs. (27a) and (27b).

To summarize, the boundary conditions have given the following four relations

$$n_o(E_p - E_p'') = \frac{n_c^2}{n'} E_p' \tag{43}$$

$$\cos \phi \,(E_p + E_p'') = E_p'(\cos \phi_r + i\kappa') \tag{44}$$

$$E_s + E_s'' = E_s' \tag{45}$$

$$n_o(E_s - E_s'') \cos \phi = n'E_s' (\cos \phi_r + i\kappa') \tag{46}$$

2. Derivation of Equations

In the calculations which follow, it will be useful to know the reflection coefficients at each interface. They are defined, in general, as

$$r_\nu \equiv \frac{E_{\nu\text{reflected}}}{E_{\nu\text{incident}}} \tag{48}$$

where ν stands for either p or s.

The reflection coefficient for polarization normal to the plane of incidence,

$$r_s \equiv \frac{E_s''}{E_s} \tag{49}$$

can be found from Eqs. (45) and (46).

From Eq. (45)

$$1 + \frac{E''_s}{E_s} = \frac{E'_s}{E_s} \qquad (45a)$$

From Eq. (46)

$$\frac{E'_s}{E_s} = \frac{n_o \cos \emptyset}{n'(\cos \emptyset_r + i\kappa')} \left(1 - \frac{E''_s}{E_s}\right) \qquad (46a)$$

Equating (45a) and (46a),

$$1 + \frac{E''_s}{E_s} = \frac{n_o \cos \emptyset}{n'(\cos \emptyset_r + i\kappa')} \left(1 - \frac{E''_s}{E_s}\right) \qquad (50)$$

$$n'(\cos \emptyset_r + i\kappa') + n'(\cos \emptyset_r + i\kappa') \frac{E''_s}{E_s} = n_o \cos \emptyset - n_o \cos \emptyset \frac{E''_s}{E_s}$$

$$r_s \equiv \frac{E''_s}{E_s} = \frac{n_o \cos \emptyset - n'(\cos \emptyset_r + i\kappa')}{n_o \cos \emptyset + n'(\cos \emptyset_r + i\kappa')} \qquad (51)$$

The reflection coefficient for polarization parallel to the plane of incidence,

$$r_p \equiv \frac{E''_p}{E_s} \qquad (52)$$

is found from Eqs. (43) and (44) as follows:

First, divide Eq. (43) by E_p and multiply by n'/n_c^2

$$\frac{n' n_o}{n_c^2} \left(1 - \frac{E''_p}{E_p}\right) = \frac{E'_p}{E_p} \qquad (43b)$$

Then divide Eq. (44) by $E_p(\cos \phi_r + i\kappa')$

$$\frac{E'_p}{E_p} = \frac{\cos \phi}{\cos \phi_r + i\kappa'} \left(1 + \frac{E''_p}{E_p}\right) \tag{44b}$$

Equating Eqs. (43b) and (44b),

$$\frac{n'n_o}{n_c^2} \left(1 - \frac{E''_p}{E_p}\right) = \frac{\cos \phi}{(\cos \phi_r + i\kappa')} \left(1 + \frac{E''_p}{E_p}\right) \tag{52}$$

$$n'n_o(\cos \phi_r + i\kappa') - n'n_o(\cos \phi_r + i\kappa') \frac{E''_p}{E_p} = n_c^2 \cos \phi + n_c^2 \cos \phi \frac{E''_p}{E_p}$$

or

$$r_p \equiv \frac{E''_p}{E_p} = - \frac{n_c^2 \cos \phi - n_o n'(\cos \phi_r + i\kappa')}{n_c^2 \cos \phi + n_o n'(\cos \phi_r + i\kappa')} \tag{53}$$

E. Introduction of Complex Angle of Refraction and Formulation of the Fresnel Equations

Equations (51) and (53) can be written in a simpler form by defining the complex angle of refraction ϕ', by the complex form of Snell's Law.

$$n_o \sin \phi = n' \sin \phi_r \equiv n_c \sin \phi' \tag{54}$$

This equation is consistent with the equation

$$n'(\cos \phi_r + i\kappa') = n_c \cos \phi' \tag{55}$$

as will now be demonstrated.

Squaring Eqs. (54) and (55) and adding, one has

$$n_c^2 = n'^2 \sin \phi_r{}^2 + n'^2(\cos \phi_r + i\kappa')^2$$

$$= n'^2(\sin^2 \phi_r + \cos^2 \phi_r) - n'^2\kappa'^2 + n'^2 2i\kappa' \cos \phi_r$$

$$n_c^2 = n'^2(1 - \kappa'^2) + i2n'^2\kappa' \cos \phi_r \qquad (56)$$

But Eq. (56) is true because of Eqs. (27a) and (27b). Therefore, the consistency of Eq. (54) and (55) is established. Substituting Eq. (55) into Eq. (51) and (53), one has the Fresnel Equations

$$r_s = \frac{n_c \cos \phi - n_c \cos \phi'}{n_o \cos \phi + n_c \cos \phi'} \qquad (57)$$

$$r_p = - \frac{n_c \cos \phi - n_o \cos \phi'}{n_c \cos \phi + n_o \cos \phi'} \qquad (58)$$

Equation (54) will now be applied to (57) and (58) to arrive at alternate equations for r_s and r_p. In both Equations, n_c is replaced by

$$n_c = \frac{n_o \sin \phi}{\sin \phi'} \qquad (54a)$$

First, considering Eq. (57),

$$r_s = \frac{n_o \cos \phi - \dfrac{n_o \sin \phi}{\sin \phi'} \cos \phi'}{n_o \cos \phi + \dfrac{n_o \sin \phi \cos \phi'}{\sin \phi'}}$$

$$= \frac{\sin \phi' \cos \phi - \sin \phi \cos \phi'}{\sin \phi' \cos \phi + \sin \phi \cos \phi'}$$

$$r_s = - \frac{\sin (\phi-\phi')}{\sin (\phi+\phi')} \qquad (59)$$

Next, considering Eq. (58),

$$r_p = - \frac{n_o(\sin \phi/\sin \phi')\cos \phi - n_o \cos \phi'}{n_o(\sin \phi/\sin \phi')\cos \phi + n_o \cos \phi'}$$

$$= - \frac{\sin \phi \cos \phi - \sin \phi' \cos \phi'}{\sin \phi \cos \phi + \sin \phi' \cos \phi'}$$

divide top and bottom of the right side by $\cos^2 \phi \cdot \cos^2 \phi'$

$$r_p = - \frac{\tan \phi/\cos^2 \phi' - \tan \phi'/\cos^2 \phi}{\tan \phi/\cos^2 \phi' + \tan \phi'/\cos^2 \phi}$$

$$= - \frac{\sec^2 \phi' \tan \phi - \sec^2 \phi \tan \phi'}{\sec^2 \phi' \tan \phi + \sec^2 \phi \tan \phi'}$$

$$= - \frac{(1 + \tan^2 \phi')\tan \phi - (1 + \tan^2 \phi)\tan \phi'}{(1 + \tan^2 \phi')\tan \phi + (1 + \tan^2 \phi)\tan \phi'}$$

$$= - \frac{\tan \phi + \tan \phi \tan^2 \phi' - \tan \phi' - \tan \phi' \tan^2 \phi}{\tan \phi + \tan \phi \tan^2 \phi' + \tan \phi' + \tan \phi' \tan^2 \phi}$$

$$= - \frac{(\tan \phi - \tan \phi')\ (1 - \tan \phi \tan \phi')}{(\tan \phi + \tan \phi')\ (1 + \tan \phi \tan \phi')}$$

$$= - \frac{(\tan \phi - \text{tam } \phi')\ (1 + \tan \phi \tan \phi')}{(\tan \phi + \tan \phi')\ (1 - \tan \phi \tan \phi')}$$

$$r_p = - \frac{\tan (\phi - \phi')}{\tan (\phi + \phi')} \tag{60}$$

F. Summary

With the definitions

$$n_c \equiv \sqrt{\mu(\varepsilon + i\,4\pi\sigma/\omega)} \equiv n(1 + i\kappa) \qquad (13),(14)$$

$$n'_c \equiv n'(1 + i\kappa')$$

$$n' \equiv c/v \qquad (20)$$

$$\kappa' \equiv \alpha c/\omega n', \quad \alpha = \text{absorption coefficient} \qquad (22)$$

and the relations

$$n^2(1 - \kappa^2) = n'^2(1 - \kappa'^2) \qquad (27a)$$

$$n^2\kappa = n'^2\kappa' \cos \phi_r \qquad (27b)$$

$$n_o \sin \phi = n' \sin \phi_r \qquad (34)$$

The reflection coefficients can be written

$$r_s = \frac{n_o \cos \phi - n'(\cos \phi_r + i\kappa')}{n_o \cos \phi + n'(\cos \phi_r + i\kappa')} \equiv \frac{E_s \text{ reflected}}{E_s \text{ incident}} \qquad (51)$$

$$r_p = -\frac{n_c^2 \cos \phi - n_o n'(\cos \phi_r + i\kappa')}{n_c^2 \cos \phi + n_o n'(\cos \phi_r + i\kappa')} \equiv \frac{E_p \text{ reflected}}{E_p \text{ incident}} \qquad (53)$$

With the additional definition of the complex angle of refraction ϕ'

$$n' \sin \phi_r \equiv n_c \sin \phi' \qquad (54)$$

and the auxiliary equation

$$n'(\cos \phi_r + i\kappa') = n_c \cos \phi' \qquad (55)$$

The Fresnel equations can be written

$$r_s = \frac{n_o \cos \phi - n_c \cos \phi'}{n_o \cos \phi + n_c \cos \phi'} = - \frac{\sin (\phi - \phi')}{\sin (\phi + \phi')} \qquad (57),(59)$$

$$r_p = \frac{n_o \cos \phi' - n_c \cos \phi}{n_o \cos \phi' + n_c \cos \phi} = - \frac{\tan (\phi - \phi')}{\tan (\phi + \phi')} \qquad (58),(60)$$

Equations (51), (53), (57), (58), (59), and (60) assume that the incident medium is transparent (i.e., of zero conductivity).

Better suited for numerical purposes are the equations summarized in sections IIf and IIId as they contain all real quantities.

CHAPTER II

OPTICAL CONSTANTS n, κ AND ELLIPSOMETRIC PARAMETERS Δ, ψ

A. Introduction and Definition of Δ, ψ

When polarized light is reflected from a metallic surface, the components of the electric field parallel and normal to the plane of indicence undergo an unequal amplitude attenuation, and a phase difference Δ is introduced between them. When the electric field components are E_p and E_s before reflection, and E''_p and E''_s after reflection, then the ratios of s and p amplitudes in the incident and reflected light are defined by

$$\tan \psi_i \equiv \frac{|E_s|}{|E_p|} \tag{61}$$

$$\tan \psi_r \equiv \frac{|E''_s|}{|E''_p|} \tag{62}$$

Thus, the amplitude ratio is changed on reflection by the factor

$$\tan \psi \equiv \frac{\tan \psi_r}{\tan \psi_i} \tag{63}$$

tan ψ is the relative amplitude attenuation due to reflection. Figure 2 illustrates the coordinate system to be used. The x-z plane is the plane of incidence. The x-y plane defines the surface at which reflection and refraction occur. Figure 3 shows the relation of the magnetic and electric field vectors for the cases of polarization parallel (Fig. 3a) and normal (Fig. 3b) to the plane of incidence.

In this section, light will be incident from a medium of real refractive index n_o onto the plane surface of a metal of complex refractive index

$$n_c = n(1 + i\kappa) \text{ or } n'_c = n'(1 + i\kappa')$$

defined as in Chapter I.

The ratios E''_s/E_s and E''_p/E_p are related to the angles of incidence and refraction by the Fresnel Equations

$$r_s \equiv \frac{E''_s}{E_s} = -\frac{\sin(\phi-\phi')}{\sin(\phi+\phi')} \qquad (59)$$

$$r_p \equiv \frac{E''_p}{E_p} = -\frac{\tan(\phi-\phi')}{\tan(\phi+\phi')} \qquad (60)$$

The quantities r_s and r_p are called the reflection coefficients of the surface, and ϕ' is the complex angle of refraction introduced in Chapter I Section E.

The reflection coefficients are, in general, complex, so that they can be written as an amplitude ratio and a phase change

$$r_s = \frac{E''_s}{E_s} = \frac{|E''_s|}{|E_s|}\,\frac{e^{-i\varepsilon''_s}}{e^{-i\varepsilon_s}} = \frac{|E''_s|}{|E_s|}\, e^{-i(\varepsilon''_s - \varepsilon_s)} \qquad (59a)$$

$$r_p = \frac{E''_p}{E_p} = \frac{|E''_p|}{|E_p|}\,\frac{e^{-i\varepsilon''_p}}{e^{-i\varepsilon_p}} = \frac{|E''_p|}{|E_p|}\, e^{-i(\varepsilon''_p - \varepsilon_p)} \qquad (60a)$$

where the epsilons are the phases of the various components with respect to an arbitrary time origin. If we define the "absolute" phase changes of the reflected with respect to incident waves as

$$\delta_s \equiv \varepsilon''_s - \varepsilon_s, \quad \delta_p \equiv \varepsilon''_p - \varepsilon_p, \qquad (64)$$

where p refers to polarization parallel and s to polarization perpendicular to the plane of incidence, then the ratio of the reflection coefficients is

$$\rho \equiv \frac{r_s}{r_p} = \left(\frac{|E''_s|}{|E_s|} \bigg/ \frac{|E''_p|}{|E_p|} \right) \frac{e^{-i\delta_s}}{e^{-i\delta_p}} \tag{65}$$

$$\rho = \left(\frac{|E''_s|}{|E''_p|} \bigg/ \frac{|E_s|}{|E_p|} \right) e^{i(\delta_p - \delta_s)}$$

which equals, using Eqs. (61) and (62),

$$\rho = \frac{\tan \psi_r}{\tan \psi_i} e^{i(\delta_p - \delta_s)} \tag{65a}$$

But $\delta_p - \delta_s$ is the phase difference imposed between the p and s components on reflection. Thus, defining the relative phase change as

$$\Delta \equiv \delta_p - \delta_s \tag{66}$$

and using Eq. (63) one has

$$\rho = \tan \psi \, e^{i\Delta} \tag{67}$$

A word is in order concerning the definitions (64). Consider a harmonic oscillator vibrating with frequency ω and relative phase θ, represented in complex notation by $e^{-i(\omega t+\theta)}$. Figure 4b shows the oscillation in the complex plane. As time increases, the rotation of the radius vector proceeds clockwise. Suppose that at $t = t_o$ the phase of the oscillation is suddenly changed by reflection so that before the change it is θ_1, and after the change it is θ_2, the phase change being defined as θ_2-θ_1. When θ_2 is larger than θ_1, the total argument $\omega t_o + \theta_2$ is greater than the total argument $\omega t_o + \theta_1$ before the change and is equivalent to holding θ_1 constant and increasing t. That is, a positive phase change θ_2-θ_1 is equivalent to an advance in time. Therefore, with the definitions chosen in (64), a positive phase change

$\theta_2 - \theta_1$ is equivalent to an advance in time.*

B. Derivation of Equations

Equation (67) is the basic equation of ellipsometry. The quantities ψ and Δ, which are parameters used to describe the relation between the polarization states of the light before and after reflection, can be found from ellipsometer measurements [10]. The equations relating ψ and Δ to the optical constants n and κ which characterize the reflecting surface will now be derived.

By Eqs. (59) and (60),

$$\rho = \frac{r_s}{r_p} = \frac{\sin(\phi-\phi')}{\sin(\phi+\phi')} \Big/ \frac{\tan(\phi-\phi')}{\tan(\phi+\phi')} \tag{68}$$

$$\rho = \frac{\cos(\phi-\phi')}{\cos(\phi+\phi')} = \tan\psi\, e^{i\Delta} \tag{69}$$

rewriting Eq. (69),

$$1 - \tan\psi\, e^{i\Delta} = 1 - \frac{\cos\phi\cos\phi' + \sin\phi\sin\phi'}{\cos\phi\cos\phi' - \sin\phi\sin\phi'}$$

$$1 - \tan\psi\, e^{i\Delta} = \frac{\cos\phi\cos\phi' - \sin\phi\sin\phi' - \cos\phi\cos\phi' - \sin\phi\sin\phi'}{\cos\phi\cos\phi' - \sin\phi\sin\phi'} \tag{70}$$

Similarly,

$$1 + \tan\psi\, e^{i\Delta} = \frac{\cos\phi\cos\phi' - \sin\phi\sin\phi' + \cos\phi\cos\phi' + \sin\phi\sin\phi'}{\cos\phi\cos\phi' - \sin\phi\sin\phi'} \tag{71}$$

dividing Eq. (71) by Eq. (70) leaves

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*See Appendix I for a discussion of alternate representations of the phase of a harmonic oscillation.

$$\frac{1 + \tan\psi\, e^{i\Delta}}{1 - \tan\psi\, e^{i\Delta}} = -\frac{\cos\phi\, \cos\phi'}{\sin\phi\, \sin\phi'} \tag{72}$$

The left side of Eq. (72) can be rewritten as

$$\frac{1 + \tan\psi\, e^{i\Delta}}{1 - \tan\psi\, e^{i\Delta}} = \frac{1 + (\sin\psi/\cos\psi)\, e^{i\Delta}}{1 - (\sin\psi/\cos\psi)\, e^{i\Delta}}$$

$$= \frac{\cos\psi + (\cos\Delta + i \sin\Delta) \sin\psi}{\cos\psi - (\cos\Delta + i \sin\Delta) \sin\psi}$$

$$= \frac{(\cos\psi + \cos\Delta \sin\psi) + i \sin\Delta \sin\psi}{(\cos\psi - \cos\Delta \sin\psi) - i \sin\Delta \sin\psi}$$

$$= \left[\frac{(\cos\psi + \cos\Delta \sin\psi) + i \sin\Delta \sin\psi}{(\cos\psi - \cos\Delta \sin\psi) - i \sin\Delta \sin\psi}\right] \cdot \left[\frac{(\cos\psi - \cos\Delta \sin\psi) + i \sin\Delta \sin\psi}{(\cos\psi - \cos\Delta \sin\psi) + i \sin\Delta \sin\psi}\right]$$

$$= \frac{\cos^2\psi - \cos^2\Delta \sin^2\psi - \sin^2\Delta \sin^2\psi + i \sin\Delta \sin\psi(\cos\psi + \cos\Delta \sin\psi + \cos\psi - \cos\Delta \sin\psi)}{(\cos\psi - \cos\Delta \sin\psi)^2 + \sin^2\Delta \sin^2\psi}$$

$$= \frac{\cos^2\psi - \sin^2\psi\, (\sin^2\Delta + \cos^2\Delta) + i\, 2 \sin\psi \cos\psi \sin\Delta}{\cos^2\psi + \cos^2\Delta \sin^2\psi - \cos\Delta\, 2\cos\psi \sin\psi + \sin^2\Delta \sin^2\psi}$$

Finally,

$$\frac{1 + \tan\psi\, e^{i\Delta}}{1 - \tan\psi\, e^{i\Delta}} = \frac{\cos 2\psi + i \sin 2\psi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{73}$$

With Eq. (73), Eq. (72) becomes

$$\frac{\cos 2\psi + i \sin 2\psi \sin\Delta}{1 - \sin 2\psi \cos\Delta} = -\frac{\cos\phi\, \cos\phi'}{\sin\phi\, \sin\phi'} \tag{74}$$

Define a and b by the equation

$$n_c \cos \phi' = n'(\cos \phi_r + i\kappa') \equiv a + ib \qquad (75)$$

Since $0 \leq \phi_r \leq 90$, $\cos \phi_r$ is real and positive. Also n' and κ' are real and positive by definition. Therefore, by Eq. (75) a and b must be real and positive.

With the aid of Eqs. (54) and (75), Eq. (74) becomes

$$\frac{\cos 2\psi}{1 - \sin 2\psi \cos\Delta} + i \frac{\sin 2\psi \sin\Delta}{1 - \sin\psi 2 \cos\Delta} = - \frac{(a + ib)}{n_o \sin\phi \tan\phi} \qquad (76)$$

Equating real parts of Eq. (76)

$$a = - \frac{n_o \sin\phi \tan\phi \cos 2\psi}{1 - \sin\psi 2 \cos\Delta} \qquad (77)$$

A very important fact is contained in Eq. (77). Since the angle of incidence ϕ must be in the range $0 \leq \phi \leq 90$, $\sin\phi$ and $\tan\phi$ are positive. Furthermore, the denominator of Eq. (77) is positive because the product of a sine and cosine can never exceed unity. Also n_o is positive by definition. Therefore, in order that the right side of Eq. (77) be positive as required by Eq. (75), $\cos 2\psi$ must be negative, which would mean that ψ lies between 45° and 135°. However, for the most general use of elliptic polarization ψ has been found [10] to lie in the interval $0 \leq \psi \leq 90°$ under the conventions employed here. Therefore, for reflection from a metal surface:

$$45° \leq \psi \leq 90° . \qquad (78)$$

Equating imaginary parts of Eq. (76)

$$b = -\frac{n_o \sin\phi \tan\phi \sin 2\psi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{79}$$

There is also an important result contained in Eq. (79). Applying the same type of argument used to establish Eq. (78) to Eq. (79), one finds that $\sin\Delta$ has to be negative; therefore, the relative phase change Δ must lie in the range

$$-\pi \leq \Delta \leq 0 \tag{80}$$

or equivalently

$$\pi \leq \Delta \leq 2\pi, \text{ etc.}$$

The index of the incident (transparent) medium can be eliminated from the following equations by introducing A and B defined as

$$A \equiv a/n_o = -\frac{\sin\phi \tan\phi \cos 2\psi}{1 - \sin 2\psi \cos\Delta} \tag{81}$$

$$B \equiv b/n_o = -\frac{\sin\phi \tan\phi \sin 2\psi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{82}$$

It is now possible to obtain explicit expressions for n' and κ' in terms of the measured parameters ϕ, ψ, and Δ. The real part of Eq. (75) can be rewritten, with the aid of Eq. (34),

$$\cos\phi_r = \sqrt{1 - \sin^2\phi_r} = \sqrt{1 - \frac{n_o^2 \sin^2\phi}{n'^2}}$$

as

$$n'^2 \cos^2\phi_r = a^2 = n'^2 - n_o^2 \sin^2\phi$$

$$n' = +\sqrt{a^2 + n_o^2 \sin^2\phi} = n_o \sqrt{A^2 + \sin^2\phi} \qquad (83)$$

Since n' is defined as the ratio of light propagation rates, it must be a positive quantity. Therefore, the positive square root is taken in Eq. (83). Alternatively, Eq. (83a) is obtained from Eq. (83) by substituting A from Eq. (81).

$$n' = n_o \sin\phi \left[1 + \frac{\tan^2\phi \cos^2 2\psi}{(1 - \sin 2\psi \cos\Delta)^2} \right]^{1/2} \qquad (83a)$$

The imaginary part of Eq. (75) can be written as

$$\kappa' = \frac{b}{n'}$$

Substituting from Eq. (79) and Eq. (83a),

$$\kappa' = \frac{\dfrac{- n_o \sin\phi \tan\phi \sin 2\psi \sin\Delta}{1 - \sin 2\psi \cos\Delta}}{n_o \sin\phi \left[1 + \dfrac{\tan^2\phi \cos^2 2\psi}{(1 - \sin 2\psi \cos\Delta)^2} \right]^{1/2}}$$

or

$$\kappa' = \frac{- \tan\phi \sin 2\psi \sin\Delta}{\sqrt{(1 - \sin 2\psi \cos\Delta)^2 + \tan^2\phi \cos^2 2\psi}} \qquad (84)$$

As defined in Chapter I, Eq. (22a)

$$\kappa' = \frac{\lambda_o \alpha}{2\pi n'}$$

where α is the absorption coefficient.

Since α and n' are positive, κ' must also be positive. Since $\sin\Delta$ is negative and $\tan\phi$ and $\sin 2\psi$ are positive, the positive square root is taken in Eq. (84).

It is also possible to find explicit expressions for n and κ. Square Eq. (75) to obtain

$$(a + ib)^2 = n_c^2 \cos^2\phi' = n_c^2(1-\sin^2\phi') = n_c^2 - n_c^2 \sin^2\phi' = n_c^2 - n_o^2 \sin^2\phi$$

where the last step is made with the use of Eq. (54).

Next, expand $(a + ib)^2$,

$$a^2 - b^2 + 2iab = n_c^2 - n_o^2 \sin^2\phi$$

$$= n^2(1 + i\kappa)^2 - n_o^2 \sin^2\phi$$

$$= n^2(1 - \kappa^2 + 2i\kappa) - n_o^2 \sin^2\phi$$

$$\therefore a^2 - b^2 + 2abi = n^2(1 - \kappa^2) - n_o^2 \sin^2\phi + 2in^2\kappa \qquad (85)$$

Equate real parts of Eq. (85) to get

$$a^2 - b^2 = n^2(1 - \kappa^2) - n_o^2 \sin^2\phi \qquad (86)$$

Equate imaginary parts of Eq. (85) to get

$$n^2\kappa = ab \qquad (87)$$

Equations (86) and (87) can now be solved for n and κ in terms of a, b, and ϕ. From Eq. (86),

$$n^2 = \frac{a^2 - b^2 + n_o^2 \sin^2\phi}{(1 - \kappa^2)} \qquad (86a)$$

inserting κ from Eq. (87) into Eq. (86) yields

$$n^2 = \frac{a^2 - b^2 + n_o^2 \sin^2\phi}{1 - a^2b^2/n^4}$$

$$= \frac{n^4(a^2 - b^2 + n_o^2 \sin^2 \phi)}{n^4 - a^2b^2}$$

$$n^2(n^4 - a^2b^2) = n^4(a^2 - b^2 + n_o^2 \sin^2\phi)$$

$$n^4 - n^2(a^2 - b^2 + n_o^2 \sin^2 \phi) - a^2b^2 = 0 \qquad (87a)$$

Equation (87a) can be solved for n^2 by the quadratic formula. This results in agreement with Konig [3].*

$$n^2 = \frac{1}{2} [(a^2 - b^2+n_o^2\sin^2\phi) + \sqrt{(a^2 - b^2 + n_o^2 \sin^2\phi)^2 + 4a^2b^2}] \qquad (88)$$

Since n is real by definition, n^2 is positive. The second term in the bracket is larger than the first, therefore the positive sign has to be used for the square root in Eq. (88).

A similar expression for κ will now be obtained. Again, from Eq. (84),

---

* It should be noted that Konig's ψ is the complement of the ψ defined by Eq. (63). In addition, his ρ is the inverse of the ρ given by Eq. (67). Thus, his Δ is the same as ours. A further difference is that with Konig the time variation of the electric and magnetic fields is formulated as $e^{+i\omega t}$ while here it is $e^{-i\omega t}$.

$$n^2(1 - \kappa^2) = a^2 - b^2 + n_o^2 \sin^2\phi$$

by Eq. (85)

$$n^2 = \frac{ab}{\kappa}$$

Thus,

$$\frac{ab}{\kappa}(1 - \kappa^2) = a^2 - b^2 + n_o^2 \sin^2\phi$$

$$ab(1 - \kappa^2) = \kappa(a^2 - b^2 + n_o^2 \sin^2\phi)$$

$$\kappa^2 + \frac{\kappa}{ab}(a^2 - b^2 + n_o^2 \sin\phi) - 1 = 0 \qquad (89)$$

Equation (89) is also of the quadratic form. The solution for κ is

$$\kappa = \frac{1}{2ab}\left[\pm\sqrt{(a^2-b^2 + n_o^2\sin^2\phi)^2 + 4a^2b^2} - (a^2-b^2 + n_o^2 \sin^2\phi)\right] \qquad (90)$$

The ambiguities in sign in Eq. (90) and in Eq. (91) below will be discussed later.

Equation (90) can be manipulated to give an expression presented by Konig for κ^2 as follows.

From Eq. (85),

$$2ab = 2n^2\kappa$$

Thus, Eq. (90) can be written

$$\kappa = \frac{1}{2n^2\kappa}\left[\pm\sqrt{(a^2-b^2 + n_o^2 \sin^2\phi)^2 + 4a^2b^2} - (a^2-b^2 + n_o^2 \sin^2\phi)\right]$$

or

$$\kappa^2 = \frac{1}{2n^2}\left[\pm\sqrt{(a^2-b^2 + n_o^2 \sin^2\phi)^2 + 4a^2b^2} - (a^2-b^2 + n_o^2 \sin^2\phi)\right]$$

Substituting the value of $2n^2$ from Eq. (88),

$$\kappa^2 = \frac{\pm\sqrt{(a^2 - b^2 + n_o^2 \sin^2\phi)^2 + 4a^2b^2} - (a^2 - b^2 + n_o^2 \sin^2\phi)}{\pm\sqrt{(a^2 - b^2 + n_o^2 \sin^2\phi)^2 + 4a^2b^2} + (a^2 - b^2 + n_o^2 \sin^2\phi)} \tag{91}$$

If one defines the quantities

$$A \equiv a/n_o = -\frac{\sin\phi \tan\phi \cos 2\psi}{1 - \sin 2\psi \cos\Delta} \tag{81}$$

$$B \equiv b/n_o = -\frac{\sin 2\psi \sin\phi \tan\phi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{82}$$

$$N \equiv n/n_o \tag{92}$$

Equations (88) and (91) can be written

$$n^2 = (n_o^2/2)(A^2 - B^2 + \sin^2\phi + \sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2}) \tag{88a}$$

$$\kappa^2 = \frac{\pm\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} - (A^2 - B^2 + \sin^2\phi)}{\pm\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} + A^2 - B^2 + \sin^2\phi} \tag{91a}$$

and Eqs. (85) and (90) become

$$n = n_o\sqrt{\frac{AB}{\kappa}}$$

or

$$N = \sqrt{\frac{AB}{\kappa}} \tag{85a}$$

$$\kappa = \frac{1}{2AB}[\pm\sqrt{(A^2 - B^2 + \sin^2\phi) + 4A^2B^2} - (A^2 - B^2 + \sin^2\phi)] \tag{90a}$$

C. Discussion of Signs of n, κ

The ambiguity of sign in Eqs. (90) and (91) will now be resolved. Since $\sqrt{(a^2 - b^2 + n_o^2 \sin^2\phi)^2 + 4a^2b^2}$ is generally larger than $(a^2 - b^2 + n_o^2 \sin^2\phi)$, and since a and b are positive and κ^2 must be positive, the positive square root must be taken in Eq. (90). Thus the positive square root is taken also in the numerators of Eqs. (91) and (91a). Since κ^2 must be positive and the numerators are positive, the denominators of (91) and (91a) must be positive also. Hence, the positive square roots are taken in Eqs. (91) and (91a).

As mentioned in the last section, n' and κ' must be positive. Since the real angle of refraction ϕ_r is never greater than 90° and is never negative, $\cos \phi_r \geq 0$. The quantities n and n' are real so n^2 and n'^2 must be positive.

Therefore, Eq. (27b)

$$n^2\kappa = + n'^2\kappa' \cos\phi_r \tag{27b}$$

implies that

$$\kappa \geq 0$$

So, once κ^2 is found from Eqs. (91) or (91a), κ is found by taking the positive square root.

The sign of n can be determined from Eqs. (54) and (55),

$$n' \sin\phi_r = n_c \sin\phi' \tag{54}$$

$$n'(\cos\phi_r + i\kappa') = n_c \cos\phi' \tag{55}$$

Equation (54) implies that n_c and $\sin\phi'$ have the same sign, since $n' \sin\phi'_r$

is positive.

It follows that if n_c is negative, ϕ' is negative, and $\cos\phi'$ is positive. Then in Eq. (55), either n' or $\cos\phi_r + i\kappa'$ must be negative. But it has already been shown that these three quantities are all positive. Therefore, n_c cannot be negative. It follows that n cannot be negative, and the positive square root must be taken in Eqs. (88) or (88a).

D. Summary (Determination of Optical Constants From Ellipse Parameters)

Ellipsometric measurements are converted to values of Δ and ψ.[10] Then, Δ, ψ, and ϕ are used to find the intermediate variables A and B from

$$A = -\frac{\sin\phi \tan\phi \cos 2\psi}{1 - \sin 2\psi \cos\Delta} \tag{81}$$

$$B = -\frac{\sin 2\psi \sin\phi \tan\phi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{82}$$

Next the optical constants n and κ of the complex refractive index $n(1+i\kappa)$ are found from

$$n^2 = \frac{n_o^2}{2}\left(A^2 - B^2 + \sin^2\phi + \sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2b^2}\right) \tag{88a}$$

$$\kappa^2 = \frac{+\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} - (A^2 - B^2 + \sin^2\phi)}{+\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} + A^2 - B^2 + \sin^2\phi} \tag{91a}$$

$$n, \kappa \geq 0$$

Or, one can find κ from

$$\kappa = \frac{1}{2AB} \left[+ \sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} - (A^2 - B^2 + \sin^2\phi)\right] \quad (90a)$$

and n from

$$n = +n_o \sqrt{\frac{AB}{\kappa}} \quad (84)$$

Alternatively n' and κ' can be found directly from Δ, ψ, and φ by using

$$n' = n_o \sin\phi \left[1 + \frac{\tan^2\phi \cos^2 2\psi}{(1 - \sin 2\psi \cos\Delta)^2}\right]^{1/2} \quad (83a)$$

and

$$\kappa' = \frac{- \tan\phi \sin 2\psi \sin\Delta}{+\sqrt{(1 - \sin 2\psi \cos\Delta)^2 + \tan^2\phi \cos^2 2\psi}} \quad (84)$$

The positive square root is to be taken in Eq. (83a).

In these equations n' is the ratio of the (real) phase velocity of light in the medium to that in vacuum, κ' is directly related to the absorption coefficient α by $\alpha = \frac{n'\kappa'\omega}{c}$. The quantities n and κ can be related directly to the conductivity and dielectric constants (both real) of the medium through Eqs. (13) and (14).

A FORTRAN computer program (named MOC) is given in Chapter IV, Section A1, to determine the metal optical constants n and κ from measured values of ψ, Δ and φ, by use of Eqs. (81), (82), (88a), and (91a). A second program (named AUXCON) given in Chapter IV, Section A2, can be used to find the metal optical constants n and κ, the auxiliary constants n' and κ', the electrical constants σ (conductivity) and ε (dielectric constant), and the penetration depth from given values of ψ, Δ and ϕ.

E. Determination of ψ and Δ from n and κ

Equations (81), (82), (88a) and (91a) allow one to calculate the optical constants n and κ from measured values of ϕ, Δ, and ψ. Inverse equations will now be derived[3, 14] which allow calculation of ψ and Δ from known values of n and κ.

The first thing to do is to get A and B in terms of N, κ, and ϕ. The starting point is Eq. (75)

$$n_c \cos\phi' = \sqrt{n_c^2 - n_o^2 \sin^2\phi} = a + ib \qquad (75)$$

When Eq. (75) is multiplied by its complex conjugate, one obtains

$$(a-ib)(a+ib) = \sqrt{n^2(1-i\kappa)^2 - n_o^2 \sin^2\phi}\ \sqrt{n^2(1+i\kappa)^2 - n_o^2 \sin^2\phi}$$

$$a^2 + b^2 = \sqrt{[n^2(1-\kappa^2) - n_o^2\sin^2\phi - 2in^2\kappa][n^2(1-\kappa^2)-n_o^2\sin^2\phi + 2in^2\kappa]}$$

$$a^2 + b^2 = \sqrt{[n^2(1-\kappa^2) - n_o^2\sin^2\phi]^2 + 4n^4\kappa^2} \qquad (104)$$

In addition, one also has Eq. (86),

$$a^2 - b^2 = n^2(1 - \kappa^2) - n_o^2 \sin^2\phi$$

From Eqs. (86) and (104)

$$a^2 = \frac{1}{2}\left[+ \sqrt{[n^2(1-\kappa^2)-n_o^2\sin^2\phi]^2 + 4n^4\kappa^2} + n^2(1-\kappa^2)-n_o^2\sin^2\phi\right] \qquad (105)$$

$$b^2 = \frac{1}{2}\left[\sqrt{[n^2(1-\kappa^2) - n_o^2\sin^2\phi]^2 + 4n^4\kappa^2} - n^2(1-\kappa^2) + n_o^2\sin^2\phi\right] \quad (106)$$

Take the positive square roots of Eqs. (105) and (106) to get a and b. With

$$A \equiv a/n_o \quad (81)$$

$$B \equiv b/n_o \quad (82)$$

$$N \equiv n/n_o \quad (92)$$

Equations (105) and (106) can be written

$$A^2 = \frac{1}{2} \sqrt{[N^2(1-\kappa^2) - \sin^2\phi]^2 + 4N^4\kappa^2} + N^2(1-\kappa^2) - \sin^2\phi \quad (107)$$

Take the positive square root of Eq. (107) to get A.

$$B^2 = \frac{1}{2} \sqrt{[N^2(1-\kappa^2) - \sin^2\phi]^2 + 4N^4\kappa^2} - N^2(1-\kappa^2) + \sin^2\phi \quad (108)$$

Take the positive square root of Eq. (108) to get B.

An equation giving $\tan\Delta$ as a function of A, B, and ϕ can be found as follows. Returning to Eq. (69),

$$\tan\psi\, e^{i\Delta} = \frac{\cos(\phi-\phi')}{\cos(\phi+\phi')}$$

$$= \frac{\cos\phi\,\cos\phi' + \sin\phi\,\sin\phi'}{\cos\phi\,\cos\phi' - \sin\phi\,\sin\phi'}$$

Substituting from Eqs. (54) and (75) this becomes

$$\tan\psi\, e^{i\Delta} = \frac{\cos\phi\left(\frac{a+ib}{n_c}\right) + \sin\phi\,\frac{n_o\sin\phi}{n_c}}{\cos\phi\left(\frac{a+ib}{n_c}\right) - \sin\phi\,\frac{n_o\sin\phi}{n_c}}$$

Multiply the top and bottom of the right side by n_c/n_o and use Eqs. (81) and (82) to get

$$\tan\psi\, e^{i\Delta} = \frac{(A + iB)\cos\phi + \sin\phi \sin\phi}{(A + iB)\cos\phi - \sin\phi \sin\phi}$$

$$= \frac{A + iB + \sin\phi \tan\phi}{A + iB - \sin\ \ \tan\phi}$$

$$= \frac{A + \sin\phi \tan\phi + iB}{A - \sin\phi \tan\phi + iB} \tag{109}$$

$$\tan\psi\,(\cos\Delta + i \sin\Delta) = \frac{(A + \sin\phi \tan\phi + iB)(A - \sin\phi \tan\phi - iB)}{(A - \sin\phi \tan\phi + iB)(A - \sin\phi \tan\phi - iB)}$$

$$= \frac{A^2 + B^2 - \sin^2\phi \tan^2\phi - 2iB\sin\phi \tan\phi}{A^2 + B^2 - 2A\sin\phi \tan\phi + \sin^2\phi \tan^2\phi}$$

Equating the real and imaginary parts one has

$$\tan\psi \cos\Delta = \frac{A^2 + B^2 - \sin^2\phi \tan^2\phi}{A^2 + B^2 - 2A \sin\phi \tan\phi + \sin^2\phi \tan^2\phi} \tag{110}$$

and

$$\tan\psi \sin\Delta = - \frac{2B \sin\phi \tan\phi}{A^2 + B^2 - 2A \sin\phi \tan\phi + \sin^2\phi \tan^2\phi} \tag{111}$$

Dividing Eq. (111) by Eq. (110) leaves

$$\tan\Delta = - \frac{2B \sin\phi \tan\phi}{A^2 + B^2 - \sin^2\phi \tan^2\phi} \tag{112}$$

Two other quantities of interest are the reflectivities of the surface. These are the moduli of the reflection coefficients. Returning to Eq. (59),

$$r_s = -\frac{\sin(\phi-\phi')}{\sin(\phi+\phi')} \tag{59}$$

one may write

$$r_s = \frac{\sin\phi' \cos\phi - \sin\phi \cos\phi'}{\sin\phi' \cos\phi + \sin\phi \cos\phi'}$$

$$= \frac{\dfrac{n_o \sin\phi}{n_c} \cos\phi - \sin\phi \dfrac{(a+ib)}{n_c}}{\dfrac{n_o \sin\phi \cos\phi}{n_c} + \sin\phi \dfrac{(a+ib)}{n_c}}$$

Multiply the numerator and denominator by n_c/n_o and use Eqs. (81) and (82) to get

$$r_s = \frac{\cos\phi - A - iB}{\cos\phi + A + iB}$$

If one defines** the reflectivity R_s as the modulus of the reflection coefficient, r_s, i.e.

$$r_s r_s^* \equiv R_s^2$$

where r_s^* is the complex conjugate of the Fresnel coefficient r_s, then

---

** More commonly, the reflectivity is defined as the modulus squared of the complex reflection coefficients and therefore corresponds to the ratio of reflected to incident intensity. The reflectivities R_s and R_p used throughout this report represent the ratio of reflected to incident amplitude.

$$R_s = \sqrt{\frac{(\cos\phi - A)^2 + B^2}{(\cos\phi + A)^2 + B^2}}$$

$$R_s = \sqrt{\frac{A^2 + B^2 - 2A\cos\phi + \cos^2\phi}{A^2 + B^2 + 2A\cos\phi + \cos^2\phi}} \tag{114}$$

Taking the square of the modulus of Eq. (109)

$$\tan^2\psi = \frac{(A + \sin\phi\tan\phi)^2 + B^2}{(A - \sin\phi\tan\phi)^2 + B^2}$$

$$\tan^2\psi = \frac{A^2 + B^2 + 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi}{A^2 + B^2 - 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi} \tag{115}$$

But by Eqs. (65) and (67),

$$\tan^2\psi = |\rho|^2 = r_s r_s^* / r_p r_p^*$$

If

$$r_p r_p^* \equiv R_p^2$$

then

$$R_p^2 = \frac{R_s^2}{\tan^2\psi} \tag{116}$$

Thus, substituting from Eq. (115),

$$R_p = R_s \sqrt{\frac{A^2 + B^2 - 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi}{A^2 + B^2 + 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi}} \tag{116a}$$

F. Summary (Determination of Ellipse Parameters From Optical Constants)

Measured values of ψ and Δ can be predicted for given values of n, κ and ϕ as follows. One first finds the intermediate variables N, A and B from

$$N \equiv n/n_o \tag{92}$$

$$A^2 = \frac{1}{2}\left[+\sqrt{[N^2(1-\kappa^2) - \sin^2\phi]^2 + 4N^4\kappa^2} + N^2(1-\kappa^2) - \sin^2\phi \right] \tag{107}$$

$$B^2 = \frac{1}{2}\left[+\sqrt{[N^2(1-\kappa^2) - \sin^2\phi]^2 + 4N^4\kappa^2} - N^2(1-\kappa^2) + \sin^2\phi \right] \tag{108}$$

Take the positive square root each time to get A, B, ≥ 0. Then Δ can be computed for each angle of incidence ϕ from

$$\tan\Delta = -\frac{2B\sin\phi\tan\phi}{(A^2+B^2) - \sin^2\phi\tan^2\phi} \tag{112}$$

$$-\pi \leq \Delta \leq 0$$

In addition, $\tan\psi$ can be found from

$$\tan^2\psi = \frac{A^2 + B^2 + 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi}{A^2 + B^2 - 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi} \tag{115}$$

As discussed earlier, $\pi/4 \leq \psi \leq \pi/2$, so the positive square root of Eq. (115) gives $\tan\psi$.

If desired, the reflectivities (based on amplitude) may be calculated from

$$R_s \equiv \sqrt{r_s r_s^*} = \sqrt{\frac{A^2 + B^2 - 2A\cos\phi + \cos^2\phi}{A^2 + B^2 + 2A\cos\phi + \cos^2\phi}} \tag{114}$$

$$R_p \equiv \sqrt{r_p r_p^*} = R_s/\tan \psi \tag{116}$$

A FORTRAN program (named MER) which calculates ψ and Δ, R_s, R_p for metallic reflection from given values of n, κ and ϕ is given in Chapter IV, Section B.

The dependence of Δ, ψ, R_s and R_p on angle of incidence is illustrated in figures 5-8 (a,b,d) for four typical reflecting materials (well or poorly conducting metals and absorbing or transparent dielectrics). Figures 9-16 show the dependence of the same quantities on the optical constants n and κ of the reflecting surface for fixed angles of incidence (2°, 45°, 75°).

CHAPTER III

ABSOLUTE PHASE CHANGES UPON REFLECTION FROM ABSORBING MEDIA

A. Introduction

Measurements with the ellipsometer yield the relative difference in phase Δ between the s and p components of the reflected light. The phase change suffered by the two components relative to the respective incident waves, i.e., the "absolute phase changes[3]" can generally not be measured. Therefore, these quantities which are extremely important for the interpretation of thin film interference[15] have to be derived from ellipsometer measurements via the optical constants of the interface.

B. Derivation of Equations

The Fresnel equations in the form given by Eqs. (57) and (58) can be used to determine the phase changes δ_s and δ_p that the normal and parallel components of elliptically polarized light undergo upon reflection from absorbing media. As discussed in Chapter II, section A, a positive phase difference δ_s or δ_p will be interpreted as being equal to an advance in time while a negative phase difference will mean a retardation.

To simplify the following calculations, these definitions are used.

$$\left.\begin{aligned} R_s &\equiv \frac{|E''_s|}{|E_s|} \\ R_p &\equiv \frac{|E''_p|}{|E_p|} \end{aligned}\right\} \qquad (93)$$

The E's have their usual meaning illustrated in Fig. 2.

Then, by Eqs. (93), (58), (60a), and (64),

$$r_p = \frac{n_o \cos\phi' - n_c \cos\phi}{n_o \cos\phi' + n_c \cos\phi} = R_p e^{-i\delta_p} \tag{94}$$

By eq. (75)

$$n_c \cos\phi' = a + ib$$

$$r_p = \frac{n_o(a+ib) - n_c^2 \cos\phi}{n_o(a+ib) + n_c^2 \cos\phi} = R_p e^{-i\delta_p} \tag{95}$$

Let

$$A' \equiv n_o a$$

and

$$B' \equiv n_o b$$

Then,

$$r_p = \frac{(A' + iB') - n_c^2 \cos\phi}{A' + iB' + n_c^2 \cos\phi} = R_p e^{-i\delta_p}$$

Expand n_c^2 and write $e^{-i\delta_p} = \cos\delta_p - i \sin\delta_p$ to get

$$\frac{A' + iB' - n^2(1-\kappa^2)\cos\phi - 2in^2\kappa\cos\phi}{A' + iB' + n^2(1-\kappa^2)\cos\phi + 2in^2\kappa\cos\phi} = R_p(\cos\delta_p - i \sin\delta_p)$$

Multiply both sides by the denominator of the left side and collect real and imaginary parts to obtain

$$A' - n^2(1-\kappa^2)\cos\phi - i\,(2n^2\kappa\cos\phi - B') =$$

$$R_p \left\{ \left[A' + n^2(1-\kappa^2)\cos\phi\right] \cos\delta_p + (B' + 2n^2\kappa\cos\phi) \sin\delta_p \right\}$$
$$-iR_p \left\{ \left[A' + n^2(1-\kappa^2) \cos\phi\right] \sin\delta_p - (B' + 2n^2\kappa\cos\phi) \cos\delta_p \right\}$$

Equate real and imaginary parts of this last equation to get

$$A' - n^2(1-\kappa^2)\cos\phi = R_p \left\{ \left[A' + n^2(1-\kappa^2)\cos\phi\right]\cos\delta_p + (B'+2n^2\kappa\cos\phi)\sin\delta_p \right\} \tag{96a}$$

$$B' - 2n^2\kappa\cos\phi = R_p\left\{\left[B'+2n^2\kappa\cos\phi\right]\cos\delta_p - \left[A'+n^2(1-\kappa^2)\cos\phi\right]\sin\delta_p\right\} \tag{96b}$$

Equations (96a) and (96b) can be solved for $\cos\delta_p$ and $\sin\delta_p$ using determinates. When $\cos\delta_p$ and $\sin\delta_p$ are known, $\tan\delta_p$ can be calculated.

Let the determinant of the coefficients of Eqs. (96a) and (96b) be

$$D_p = R_p \begin{vmatrix} A'+n^2(1-\kappa^2)\cos\phi & B'+2n^2\kappa\cos\phi \\ B'+2n^2\kappa\cos\phi & -[A'+n^2(1-\kappa^2)\cos\phi] \end{vmatrix}$$

Then,

$$\cos\delta_p = \frac{1}{D_p} \begin{vmatrix} A'-n^2(1-\kappa^2)\cos\phi & R_p(B'+2n^2\kappa\cos\phi) \\ B'-2n^2\kappa\cos\phi & -R_p(A'+n^2(1-\kappa^2)\cos\phi) \end{vmatrix}$$

$$\cos\delta_p = -\frac{R_p}{D_p}\left[A'^2 - n^4(1-\kappa^2)^2\cos^2\phi + B'^2 - 4n^4\kappa^2\cos^2\phi\right]$$

$$\cos\delta_p = -\frac{R_p}{D_p}\left\{A'^2 + B'^2 - n^4\left[4\kappa^2 + \kappa^4 - 2\kappa^2 + 1\right]\cos^2\phi\right\}$$

$$\cos\delta_p = -\frac{R_p}{D_p}\left\{A'^2 + B'^2 - n^4(1+\kappa^2)^2\cos^2\phi\right\}$$

By Eqs. (81) and (82), $A' = n_o^2 A$, $B' = n_o^2 B$

$$\cos\delta_p = -\frac{R_p}{D_p} n_o^4 \left\{A^2 + B^2 - \frac{n^4}{n_o^4}(1+\kappa^2)^2\cos^2\phi\right\} \tag{97}$$

In the same way,

$$\sin\delta_p = \frac{1}{D_p} \begin{vmatrix} R_p\,(A' + n^2(1-\kappa^2)\cos\phi) & A'-n^2(1-\kappa^2)\cos\phi \\ R_p\,(B' + 2n^2\kappa\cos\phi) & B'-2n^2\kappa\cos\phi \end{vmatrix}$$

$$= \frac{R_p}{D_p}\left[A'B' - 2n^2A'\kappa\cos\phi + B'n^2(1-\kappa^2)\cos\phi - 2n^4\kappa\cos^2\phi(1-\kappa^2)\right.$$

$$\sin\delta_p = -\frac{R_p}{D_p} \; 2\cos\phi \left[2A'n^2\kappa - B'n^2(1-\kappa^2)\right] \quad \left. -A'B' - 2n^2A'\cos\phi + B'n^2(1-\kappa^2)\cos\phi + 2n^4\kappa\cos^2\phi(1-\kappa^2)\right]$$

By eq. (81),

$$A' \equiv n_o a = n_o^2 A$$

By Eq. (82)

$$B' \equiv n_o b = n_o^2 B$$

$$\sin\delta_p = -\frac{R_p}{D_p} \; 2n_o^2\cos\phi \left[2An^2\kappa - Bn^2(1-\kappa^2)\right]$$

By Eq. (85)

$$n^2\kappa = ab = n_o^2 AB$$

By Eq. (84)

$$n^2(1-\kappa^2) = n_o^2(A^2-B^2 + \sin^2\phi)$$

Thus,

$$\sin\delta_p = -\frac{R_p}{D_p} \; 2n_o^4 \cos\phi \left[2A^2B - B(A^2-B^2 + \sin^2\phi)\right]$$

$$\sin\delta_p = -\frac{R_p}{D_p} \; 2n_o^4 B\cos\phi \left[A^2 + B^2 - \sin^2\phi\right] \tag{98}$$

Dividing Eq. (98) by Eq. (97),

$$\tan\delta_p = \frac{-\frac{R_p}{D_p} \; 2n_o^4 B\cos\phi \left[A^2 + B^2 - \sin^2\phi\right]}{-\frac{R_p}{D_p} \; n_o^4 \left\{A^2 + B^2 - \frac{n^4}{n_o^4}(1+\kappa^2)^2\cos^2\phi\right\}}$$

$$\tan\delta_p = \frac{2B\cos\phi[A^2 + B^2 - \sin^2\phi]}{A^2 + B^2 - N^4(1+\kappa^2)^2\cos^2\phi} \tag{99}$$

where

$$N \equiv n/n_o \tag{92}$$

The same procedure can be used to determine $\tan\delta_s$. By Eqs. (59a), (64), and (91), Eq. (57) becomes

$$r_s = \frac{n_o \cos\phi - n_c \cos\phi'}{n_o \cos\phi + n_c \cos\phi'} = R_s e^{-i\delta_s} \tag{100}$$

By Eq. (75),

$$n_c \cos\phi' = a + ib$$

$$\frac{n_o \cos\phi - (a + ib)}{n_o \cos\phi + (a + ib)} = R_s e^{-i\delta_s}$$

If $a = n_o A$ (81)

$b = n_o B$ (82)

$$\frac{\cos\phi - A - iB}{\cos\phi + A + iB} = R_s e^{-i\delta_s}$$

$$\frac{(\cos\phi - A) - iB}{(\cos\phi + A) + iB} = R_s(\cos\delta_s - i \sin\delta_s)$$

$$\cos\phi - A - iB = R_s \left\{ \left[(\cos\phi + A) \cos\delta_s + B \sin\delta_s \right] + i \left[B \cos\delta_s - (\cos\phi + A) \sin\delta_s \right] \right\}$$

Equate real and imaginary parts to get

$$\cos\phi - A = R_s \left[(\cos\phi + A) \cos\delta_s + B \sin\delta_s \right] \tag{101a}$$

$$- B = R_s \left[B \cos\delta_s - (\cos\phi + A) \sin\delta_s \right] \tag{101b}$$

These two equations can be solved by determinants to yield $\cos \delta_s$ and $\sin \delta_s$. If the determinant of the coefficients is D_s,

$$D_s \equiv R_s \begin{vmatrix} \cos\phi + A & B \\ B & -(\cos\phi + A) \end{vmatrix}$$

Then,

$$\cos\delta_s = \frac{1}{D_s} \begin{vmatrix} \cos - A & R_s B \\ - B & -R_s(\cos\phi + A) \end{vmatrix}$$

$$\cos\phi_s = \frac{R_s}{D_s} \ (A^2 - \cos^2\phi + B^2) \qquad (102a)$$

$$\sin\phi_s = \frac{1}{D_s} \begin{vmatrix} R_s(\cos\phi + A) & \cos\phi - A \\ R_s B & - B \end{vmatrix}$$

$$\sin\phi_s = \frac{R_s}{D_s} \ (-B\cos\phi - AB - B\cos\phi + AB)$$

$$\sin\phi_s = -\frac{R_s}{D_s} \ 2B\cos\phi \qquad (102b)$$

Divide Eq. (102b) by Eq. (102a) to get

$$\tan\phi_s = -\frac{2B\cos\phi}{A^2 + B^2 - \cos^2\phi} \qquad (103)$$

C. RANGES OF δ_p, δ_s

The results of the previous section are equations which give the tangents of the absolute phase changes δ_s and δ_p. Evaluation of these equations for any given case does not yield δ_s and δ_p unambiguously on account of the identity

$$\tan(\alpha \pm 180°) = \tan\alpha$$

In this section, a method is presented whereby one can determine δ_s and δ_p

uniquely. Recalling equation (102b) of the previous section:

$$\sin \delta_s = -\frac{R_s}{D_s} 2B \cos\phi \qquad (102b)$$

where the positive quantity R_s was defined as

$$R_s \equiv \left| \frac{E_s''}{E_s} \right| = |r_s|$$

and D_s is the determinant of the coefficients of (101a) and (101b),

$$\cos\phi - A = R_s \left[(\cos\phi + A) \cos\delta_s + B \sin \delta_s\right] \qquad (101a)$$

$$-B = R_s \left[B \cos \delta_s - (\cos\phi + A) \sin \delta_s\right] \qquad (101b)$$

Thus,

$$D_s = \begin{vmatrix} \cos\phi + A & B \\ B & -(\cos\phi + A) \end{vmatrix} = -\left[(\cos\phi + A)^2 + B^2\right]$$

Since D_s is the negative of the sum of two squares,

$$D_s \leq 0 .$$

It has been shown that $b \geq 0$ (see discussion concerning Eq. (75)) and since

$$B \equiv b/n_o, \quad n_o > 0 .$$

B is also positive since the angle of incidence ϕ lies on the range

$0 \leq \phi \leq 90°$, $\cos\phi \geq 0$. With $R_s > 0$, $B > 0$, $\cos\phi > 0$ and $D < 0$, the right-hand side of Eq. (102b) is positive. Therefore, $\sin\,\delta_s$ is positive and

$$0 \leq \delta_s \leq \pi.$$

Given that δ_s lies in this range and given $\tan\,\delta_s$, it is possible to obtain δ_s unambiguously.

It has been shown (Eq. (80)) that the relative phase change Δ lies in the range

$$-\pi \leq \Delta \leq 0 \tag{80}$$

Thus, given $\tan\,\Delta$ one can determine Δ unambiguously. But

$$\Delta \equiv \delta_p - \delta_s \tag{66}$$

so that

$$\delta_p = \Delta + \delta_s \tag{66a}$$

When Δ and δ_s have been found, δ_p is found unambiguously from this equation.

D. Summary

The absolute phase changes undergone during reflection by the components polarized normal and parallel to the plane of incidence are given by

$$\tan\delta_s = \frac{-2B\,\cos\phi}{A^2 + B^2 - \cos^2\phi} \tag{103}$$

$$\tan\delta_p = \frac{2B\,\cos\phi\,[A^2 + B^2 - \sin^2\phi]}{A^2 + B^2 - N^4(1 + \kappa^2)^2\,\cos^2\phi} \tag{99}$$

where

$$N \equiv n/n_o \tag{92}$$

and

$$A = -\frac{\sin\phi \tan\phi \cos 2\phi}{1 - \sin 2\psi \cos\Delta} \tag{81}$$

$$B = -\frac{\sin\phi \tan\phi \sin 2\psi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{82}$$

Again, a positive phase change δ_s or δ_p is to be interpreted as an advance in time. An advance in time corresponds to a clockwise rotation of the electric vector in the complex plane, since the convention $e^{-i\omega t}$ has been adopted here to describe the time dependence of the wave. The proper quadrants for δ_s and δ_p can be found by knowing $\tan \delta_s$ and $\tan \Delta$ and by knowing that

$$0 \leq \delta_s \leq \pi$$

$$-\pi \leq \Delta \leq 0$$

$$\delta_p = \Delta + \delta_s$$

Figures 5-8 (parts c) contain plots showing how the absolute phase changes vary with angle of incidence in four specific cases: a good reflector (Fig. 5), a relatively poor reflector (Fig. 6), a transition material (Fig. 7), and a dielectric (Fig. 8). The dependence of δ_p and δ_s on the optical constants n and κ of the reflecting surface is illustrated in Figs. 9, 10, 12, 13, 15, and 16 for fixed angles of incidence of 2°, 45° and 75°.

CHAPTER IV

NUMERICAL RESULTS

Computer programs in FORTRAN - II language have been written for numerical application of the pertinent equations derived in the previous two chapters. For reference purposes, the complete programs are reproduced in this chapter together with typical results and some graphical representations.

A. Optical Constants From Phase Difference and Amplitude Ratio

1. Program MOC

The equations necessary for computing the metal optical constants n and κ from the measured values of ϕ, ψ and Δ have been derived in Chapter II, Section B. They are

$$A = -\frac{\sin\phi \tan\phi \cos 2\psi}{1 - \sin 2\psi \cos\Delta} \tag{81}$$

$$B = -\frac{\sin 2\psi \sin\phi \tan\phi \sin\Delta}{1 - \sin 2\psi \cos\Delta} \tag{82}$$

$$N^2 = \frac{n^2}{n_o^2} = \frac{1}{2}\left[+\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} + (A^2 - B^2 + \sin^2\phi)\right] \tag{88a}$$

$$\kappa^2 = \frac{+\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} - (A^2 - B^2 + \sin^2\phi)}{+\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} + (A^2 - B^2 + \sin^2\phi)} \tag{91a}$$

All square roots are positive so that $N, \kappa \geq 0$. n is the real part of the complex refractive index $n(1+i\kappa)$ of the reflecting medium; n_o is the refractive index of the transparent incident medium.

The following names of variables are employed in the program MOC (Metal Optical Constants):

Name	Symbol	Description
PHID	ϕ (degrees)	angle of incidence
PHI	ϕ (radians)	angle of incidence
DELD	Δ (degrees)	relative phase change
DEL	Δ (radians)	relative phase change
PSID	ψ (degrees)	where $\tan\psi$ = relative amplitude attenuation
PSI	ψ (radians)	
A	A	intermediate variable
B	B	intermediate variable
TN	N	n/n_o where n is real part of complex refractive index of metal, and n_o is index of transparent incident medium
TK	κ	absorption index

Input Cards for Program MOC

The input data for the program MOC are arranged on cards as illustrated below.

Card	Col 1	Col 11	Col 21	Col 31	Col 41	Col 51	Col 61
1	Title and comments (up to 80 columns may be used)						
2	ϕ_1	ϕ_2	ϕ_3	ϕ_4	ϕ_5	ϕ_6	ϕ_7
3	Δ_1	Δ_2	Δ_3	Δ_4	Δ_5	Δ_6	Δ_7
4	ψ_1	ψ_2	ψ_3	ψ_4	ψ_5	ψ_6	ψ_7

Card 1 is printed verbatum on the first page of the printout. Cards 2, 3, and 4 constitute a set of input data. Any number of sets may follow this first set. The last set of cards must be followed by a blank card. The data must contain a decimal point and may be located anywhere in the field beginning with the column indicated and ending in the column preceding the next field.

The program together with a sample output is reproduced on the next page.

```
      PROGRAM MCC (INPUT,OUTPUT,TAPE2=INPUT,TAPE3=OUTPUT)
C MCC METAL OPTICAL CONSTANTS
      DIMENSION PHID(7),PHI(7),DELD(7),DEL(7),PSID(7),PSI(7),A(7),ASQ(7)
     C,B(7),BSQ(7),TN(7),TNSQ(7),TK(7),TKSQ(7)
      DIMENSION TITLE (8)
    1 READ (2,2) TITLE
    2 FORMAT (8A10)
    3 WRITE (3,4) TITLE
    4 FORMAT (1H1, 8A10)
   10 FORMAT (7F10.5)
   11 FORMAT (7F10.0)
   12 FORMAT(////3X,4HPHID,6X,4HDELD,6X,4HPSID,8X,1HA,9X,1HB,9X,2HTN,7X,
     C2HTK)
   14 FORMAT(1H0//30X,43H----------METAL OPTICAL CONSTANTS---------- )
      WRITE(3,14)
   25 READ(2,11)(PHID(M),M=1,7)
      IF(PHID(1).EQ.0.0)GO TO 305
      READ(2,11)(DELD(M),M=1,7)
      READ(2,11)(PSID(M),M=1,7)
      DO 101 M=1,7
      PHI(M)=PHID(M)*0.0174533
      DEL(M)=DELD(M)*0.0174533
      PSI(M)=PSID(M)*0.0174533
  101 CONTINUE
      DO 201 M=1,7
      SPH=SIN (PHI(M))
      SPHQ=SPH*SPH
      CPH=COS (PHI(M))
      TPH=SPH/CPH
      SD=SIN (DEL(M))
      CD=COS (DEL(M))
      STPS=SIN (2.0*PSI(M))
      CTPS=COS (2.0*PSI(M))
      A(M)=-SPH*TPH*CTPS/(1.0-CD*STPS)
      ASQ(M)=A(M)*A(M)
      B(M)=-SPH*TPH*SD*STPS/(1.0-CD*STPS)
      BSQ(M)=B(M)*B(M)
      E=ASQ(M)-BSQ(M)+SPH*SPH
      TNSQ(M)=0.5*(SQRT (E*E+4.0*ASQ(M)*BSQ(M))+E)
      IF (TNSQ(M)) 150,152,152
  150 TN(M)=0
      GO TO 154
  152 TN(M)=SQRT (TNSQ(M))
  154 TKSQ(M)=(SQRT (E*E+4.0*ASQ(M)*BSQ(M))-E)/(SQRT (E*E+4.0*ASQ(M)*BSQ
     C(M))+E)
      IF (TKSQ(M)) 156,156,158
  156 TK(M)=0
      GO TO 201
  158 TK(M)=SQRT (TKSQ(M))
  201 CONTINUE
      WRITE(3,12)
      DO 301 M=1,7
  301 WRITE(3,10)PHID(M),DELD(M),PSID(M),A(M),B(M),TN(M),TK(M)
      GO TO 25
  305 RETURN
      END
```

PROGRAM MCC -- SAMPLE OUTPUT (SILVER)

----------METAL OPTICAL CONSTANTS----------

PHID	DELD	PSID	A	B	TN	TK
2.00000	-.03480	45.00090	.21143	4.00190	.21144	18.92630
40.00000	-15.13220	45.36450	.19748	4.05121	.20000	19.99961
45.00000	-19.70660	45.46830	.19653	4.06186	.19998	20.00194
50.00000	-25.21620	45.58860	.19644	4.07251	.20000	20.00028
70.00000	-64.20580	46.22160	.19471	4.10864	.20000	20.00020
75.00000	-82.37140	46.34070	.19443	4.11471	.20001	19.99548
80.00000	-107.13790	46.28980	.19421	4.11917	.19999	20.00072

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2. Program AUXCON

Like the program MOC just presented, the FORTRAN II program, AUXCON, calculates the metal optical constants n and κ from given values of ψ, Δ and ϕ. In addition, the program finds the auxilliary constants n', κ', σ, ε and the penetration depth. The equations evaluated by the program are summarized below.

$$A = -\frac{\sin\phi\ \tan\phi\ \cos 2\psi}{1 - \sin 2\psi\ \cos\Delta} \tag{81}$$

$$B = -\frac{\sin\phi\ \tan\phi\ \sin 2\psi\ \sin\Delta}{1 - \sin 2\psi\ \cos\Delta} \tag{82}$$

$$N^2 \equiv \left(\frac{n}{n_o}\right)^2 = \frac{1}{2}\left[A^2 - B^2 + \sin^2\phi + \sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2}\right] \tag{88a}$$

$$\kappa^2 = \frac{\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} - (A^2 - B^2 + \sin^2\phi)}{\sqrt{(A^2 - B^2 + \sin^2\phi)^2 + 4A^2B^2} + (A^2 - B^2 + \sin^2\phi)} \tag{91a}$$

$$\frac{n'}{n_o} = \sin\phi\sqrt{1 + \frac{\tan^2\phi\ \cos^2 2\psi}{(1 - \sin 2\psi\ \cos\Delta)^2}} \tag{83a}$$

$$\kappa' = \frac{-\tan\phi\ \sin 2\psi\ \sin\Delta}{\sqrt{\tan^2\phi\ \cos^2 2\psi + (1 - \sin 2\psi\ \cos\Delta)^2}} \tag{84}$$

$$\sigma = \frac{\omega n^2\kappa}{2\pi}$$

$$\varepsilon = n^2(1 - \kappa^2)$$

$$\text{penetration depth} = \frac{c}{2\omega n'\kappa'}$$

The last three equations are developed in Chapter I, Section C2.

The following names of variables are employed in the program AUXCON (auxiliary constants):

Name	Symbol	Description
C	c	speed of light in vacuum
PI	π	ratio of circumference to diameter of circle
WAVEL	λ_o	vacuum wavelength
OMEGA	ω	angular frequency
PHI	ϕ (radians)	angle of incidence
PHID	ϕ (degrees)	angle of incidence
DEL	Δ (radians)	relative phase change (of p with respect to s polarization)
DELD	Δ (degrees)	relative phase change
PSI	ψ (radians)	arc tangent of relative amplitude attenuation (of s with respect to p polarization)
PSID	ψ (degrees)	arc tangent of relative amplitude attenuation
A	A	intermediate variable
B	B	intermediate variable
TN	$N = n/n_o$	ratio of real part of complex index to index of (transparent) incident medium
TK		absorption index
TNP	n'/n_o	n' is ratio of phase velocity of light in metal to that in vacuum
TKP	κ'	auxiliary absorption index
SIGMA	σ	electrical conductivity
EPSILON	ε	dielectric constant
PD		penetration depth

Input Cards for Program AUXCON

The input data for the program AUXCON are punched on cards as illustrated below:

Card	Col 1	Col 11	Col 21
1	Title and comments (up to 80 columns)		
2	ϕ_1	Δ_1	ψ_1
3	ϕ_2	Δ_2	ψ_2
4	ϕ_3	Δ_3	ψ_3
5	ϕ_4	Δ_4	ψ_4

etc.

The first card is a title card and is printed verbatum at the head of the output. The cards that follow give Δ and ψ at various angles of incidence ϕ. There is no limit to the number of data cards that may be used. The last data card must be followed by a blank card.

The program as presented gives valid results only for light of wavelength 5461Å (Mercury green line). To analyze data obtained at another wavelength, the statement "WAVEL = 5461.0E-08" must be changed so that the quantity appearing to the right of the equals sign is the wavelength of the incident light. If this wavelength is given in cm (as in the program on the next page), then the penetration depth will also be given in centimeters and the other dimensional constants will be in gaussian units.

The program, together with a sample of output, is reproduced on the next page.

```
      FORTRAN II PROGRAM AUXCON(INPUT,OUTPUT,TAPE2=INPUT,TAPE3=OUTPUT)
C     THIS PROGRAM FINDS THE METAL OPTICAL CONSTANTS N AND KAPPA WHICH
C     APPEAR IN THE COMPLEX INDEX OF REFRACTION, THE (REAL) RATIO OF
C     PHASE VELOCITIES N PRIME, THE PARAMETER KAPPA PRIME, THE (REAL)
C     ELECTRICAL CONDUCTIVITY SIGMA, THE (REAL) DIELECTRIC CONSTANT
C     EPSILON, AND THE ABSORPTION COEFFICIENT ALPHA AT WAVELENGTH OF
C     5461 ANGSTROMS.
      DIMENSION TITLE (8)
      READ (2,5) TITLE
      WRITE (3,6) TITLE
      WRITE (3,2)
    2 FORMAT (//2X, 107H   PHI          PSI       DELTA          N       N PRIME
     C     KAPPA  KAPPA PRIME  SIGMA          EPSILON       PEN. DEPTH)
    3 FORMAT (7F10.5, 2X, 3(E11.4, 2X))
    4 FORMAT (3F10.0)
    5 FORMAT (8A10)
    6 FORMAT (1H1,///8A10)
      C = 2.99776
      PI = 3.1415927
      WAVEL = 5461.0E-08
      OMEGA = 2.0*PI*C/WAVEL
  100 CONTINUE
      READ (2,4) PHID, DELD, PSID
      IF (PHID.EQ.0.0) GO TO 400
  110 DEL = DELD*0.017453
      PSI = PSID*0.017453
      PHI = PHID*0.017453
   21 SPH = SINF(PHI)
      SPHQ = SPH*SPH
      CPH = COSF(PHI)
      TPH = SPH/CPH
      SD = SINF(DEL)
      CD = COSF(DEL)
      STPS = SINF(2.0*PSI)
      CTPS = COSF(2.0*PSI)
      A = -SPH*TPH*CTPS/(1.0 - CD*STPS)
      ASQ = A*A
      B = -SPH*TPH*SD*STPS/(1.0 - CD*STPS)
      BSQ = B*B
      E = ASQ - BSQ + SPH*SPH
      TNSQ = 0.5*(SQRTF(E*E + 4.0*ASQ*BSQ) + E)
      IF (TNSQ) 150, 152, 152
  150 TN = 0.0
      GO TO 154
  152 TN = SQRTF(TNSQ)
  154 TKSQ = (SQRTF(E*E + 4.0*ASQ*BSQ) - E)/(SQRTF(E*E + 4.0*ASQ*BSQ)+E)
      IF (TKSQ) 156, 158, 158
  156 TK = 0.0
      GO TO 160
  158 TK = SQRTF(TKSQ)
  160 CONTINUE
      TNP = SPH*SQRTF(1.0 + (TPH**2*CTPS**2)/((1.0 - STPS*CD)**2))
      TKP = -TPH*STPS*SD/SQRTF(TPH**2*CTPS**2 + (1.0 - STPS*CD)**2)
      SIGMA = OMEGA*TN*TN*TK/(2.0*PI)
      EPSILON = TN*TN*(1.0 - TK*TK)
      PD = C/(2.0*OMEGA*TNP*TKP)
      WRITE (3,3) PHID, PSID, DELD, TN, TNP, TK, TKP, SIGMA, EPSILON, PD
      GO TO 100
  400 CONTINUE
      END
```

PROGRAM AUXCON -- SAMPLE OUTPUT (SILVER)

PHI	PSI	DELTA	N	N PRIME	KAPPA	KAPPA PRIME	SIGMA	EPSILON	PEN. DEPTH
2.00000	45.00090	-.03480	.03362	.04846	119.34870	82.80797	7.4054E+03	-1.6100E+01	1.0830E-06
40.00000	45.36450	-15.13220	.19958	.67231	20.04215	6.02577	4.3822E+04	-1.5960E+01	1.0727E-06
45.00000	45.46830	-19.70660	.19965	.73392	20.03504	5.53438	4.3837E+04	-1.5960E+01	1.0659E-06
50.00000	45.58860	-25.21620	.19973	.79076	20.02661	5.15005	4.3855E+04	-1.5959E+01	1.0671E-06
70.00000	46.22160	-64.20580	.19986	.95962	20.01295	4.28132	4.3882E+04	-1.5958E+01	1.0578E-06
75.00000	46.34070	-82.37140	.19987	.98527	20.01117	4.17594	4.3884E+04	-1.5958E+01	1.0562E-06
80.00000	46.28980	-107.13790	.19985	1.00374	20.01302	4.10336	4.3876E+04	-1.5956E+01	1.0551E-06

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B. Phase Difference and Amplitude Ratio From Optical Constants

1. Program MER

The equations necessary for computing the parameters ψ, Δ, δ_s, δ_p, R_s and R_p, for metallic reflection from given values of n, κ, and ϕ have been derived in Section D of Chapter III and Section A of Chapter III. They are summarized below.

$$A^2 = \frac{1}{2}\left[+\sqrt{[N^2(1-\kappa^2) - \sin^2\phi]^2 + 4N^4\kappa^2} + N^2(1-\kappa^2) - \sin^2\phi\right] \qquad (107)$$

$$B^2 = \frac{1}{2}\left[+\sqrt{[N^2(1-\kappa^2) - \sin^2\phi]^2 + 4N^4\kappa^2} - N^2(1-\kappa^2) + \sin^2\phi\right] \qquad (108)$$

(Positive square root gives A and B)

$$R_s = \sqrt{\frac{A^2 + B^2 - 2A\cos\phi + \cos^2\phi}{A^2 + B^2 + 2A\cos\phi + \cos^2\phi}}\ * \qquad (114)$$

$$R_p = R_s\sqrt{\frac{A^2 + B^2 - 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi}{A^2 + B^2 + 2A\sin\phi\tan\phi + \sin^2\phi\tan^2\phi}}\ * \qquad (116a)$$

$$\tan\delta_s = -\frac{2B\cos\phi}{A^2 + B^2 - \cos^2\phi} \qquad (103)$$

---

* R_s and R_p are the amplitudes of the reflection coefficients. The ratios of reflected to incident intensity for polarization parallel and normal to the plane of incidence are R_p^2 and R_s^2 respectively.

$$\tan \delta_p = \frac{2B \cos\phi \, (A^2 + B^2 - \sin^2\phi)}{A^2 + B^2 - N^4(1 + \kappa^2)^2 \cos^2\phi} \tag{99}$$

$$\tan \Delta = - \frac{2B \sin\phi \tan\phi}{A^2 + B^2 - \sin^2\phi \tan^2\phi} \tag{112}$$

$$\tan^2\psi = \frac{A^2 + B^2 + 2A \sin\phi \tan\phi + \sin^2\phi \tan^2\phi}{A^2 + B^2 - 2A \sin\phi \tan\phi + \sin^2\phi \tan^2\phi} = \frac{R_s^{\,2}}{R_p^{\,2}} \tag{115}$$

The following names of variables are employed in program MER (metallic reflection).

Name	Symbol	Description
TN2, TN	$N = n/n_o$	ratio of real part of complex refractive index of metal to that of incident medium
TK	κ	absorption index
PHID	ϕ (degrees)	angle of incidence
PHI	ϕ (radians)	angle of incidence
A	A	intermediate variable
B	B	intermediate variable
RS	R_s	modulus of complex reflection coefficient, reflectivity based on amplitude or amplitude attenuation of s polarization
RP	R_p	modulus of complex reflection coefficient, reflectivity based on amplitude of amplitude attenuation of p polarization
DELD	Δ (degrees)	relative phase change $\delta_p - \delta_s$
DEL	Δ (radians)	relative phase change
TAND	$\tan\Delta$	
DELP	δ_p (radians)	"absolute" phase change with respect to incident wave (p polarization)
DELPD	δ_p (degrees)	" "
DELS	δ_s (radians)	" " (s polarization)
DELSD	δ_s (degrees)	" "
TANDP	$\tan\delta_p$	
TANDS	$\tan\delta_s$	
PSID	ψ (degrees)	arctangent of relative amplitude attenuation
PSI	ψ (radians)	" "
TAPSI	$\tan\psi$	relative amplitude attenuation of s to p polarization

Input Cards for Program MER

The input data for the program MER are punched on cards as illustrated below.

Card	Col 1	Col 11	Col 21	Col 31	Col 41	Col 51	Col 61
1	Title and comments (up to 80 columns may be used)						
2	n	κ					
3	ϕ_1	ϕ_2	ϕ_3	ϕ_4	ϕ_5	ϕ_6	ϕ_7

Card 1 is printed verbatum on the first page of the printout. Cards 2 and 3 constitute a set of input data. Any number of sets may follow the first one. The last set of cards must be followed by a blank card.

The program is reproduced on the next page.

2. Tables

Output tables produced by the program MER which give the complex reflection coefficients r_s and r_p separated into amplitude attenuation R and phase change δ along with the amplitude ratio $\tan\psi$ and relative phase change Δ of s and p component for various n and κ are reproduced in Appendix II.

3. Graphs

A quantitative illustration of the relationships discussed in this report has been attempted by the graphic representation of numerical results given in figures 9-16. Three sets of graphs correspond to incident angles 2°, 45°, and 75°. Each set contains a plot of amplitude R_p (or R_s) vs absolute phase change δ_p (or δ_s) for each n and κ. Included with the 45° and 75° sets are graphs of ψ vs Δ for constant n and κ. No graph of ψ vs Δ is included for 2° incidence since all the data for that case fit on the small rectangle defined by

$$45.00 \le \psi \le 45.73$$
$$-0.7185 \le \Delta \le -0.0014$$

for the range of $0.1 \leq n \leq 5$ and $0.1 \leq \kappa \leq 20$ considered here.

```
      PROGRAM MER(INPUT,OUTPUT,TAPE2=INPUT,TAPE3=OUTPUT)
C MER METALLIC REFLECTION
      DIMENSION PHI(7),PHID(7),ASQ(7),A(7),BSQ(7),B(7),RPSQ(7),
     CRP(7),RSSQ(7),RS(7),TAND(7),DEL(7),DELD(7),TANDS(7),DELS(7),
     CDELSD(7),TANDP(7),DELP(7),DELPD(7),TAPSI(7),PSI(7),PSID(7)
      DIMENSION TITLE (8)
    1 FORMAT (8A10)
    2 FORMAT (2F10.0)
    3 FORMAT (///)
    4 FORMAT (7F10.0)
    5 FORMAT (48X,4HTN2=,F7.4,10X,3HTK=,F7.4)
    6 FORMAT (///5X,4HPHID,7X,1HA,8X,1HB,7X,2HRS,7X,2HRP,6X,5HTANDS,4X,
     X5HTANDP,4X,4HTAND,4X,5HTAPSI,4X,5HDELSD,4X,5HDELPD,4X,4HDELD, 6X,
     X4HPSID/(1H ,13F9.4))
    7 FORMAT (1H1)
    8 FORMAT (1H1, ////8A10)
    9 READ (2,1) TITLE
      WRITE(3,8) TITLE
      N = 4
   20 READ(2,2)TN2,TK2
      N = N + 1
      IF (5 - N) 30, 40, 50
   30 STOP
   40 WRITE (3,7)
      N = 1
   50 CONTINUE
      IF(TN2.EQ.0.0)GO TO 310
      READ(2,4)(PHID(M),M=1,7)
      DO 100 M=1,7
      PHI(M)=PHID(M)*0.0174533
  100 CONTINUE
      DO 200 M=1,7
      TN=TN2
      TK=TK2
      SX=SIN (PHI(M))
      CX=COS (PHI(M))
      TX=SX/CX
      TEMP1=(TN**2)*(1.0-TK**2)-SX**2
      TEMP2=TEMP1**2+4.0*((TN**4)*(TK**2))
      ASQ(M)=0.5*(SQRT(TEMP2)+TEMP1)
      IF(ASQ(M))110,112,112
  110 A(M)=0
      GO TO 114
  112 A(M)=SQRT (ASQ(M))
  114 BSQ(M)=0.5*(SQRT(TEMP2)-TEMP1)
      IF(BSQ(M))116,118,118
  116 B(M)=0
      GO TO 120
  118 B(M)=SQRT (BSQ(M))
  120 RSSQ(M)=(ASQ(M)+BSQ(M)-2.0*A(M)*CX+CX*CX)/(ASQ(M)+BSQ(M)+2.0*A(M)
     C*CX+CX*CX)
      IF(RSSQ(M))122,124,124
  122 RS(M)=0
      GO TO 126
  124 RS(M)= SQRT (RSSQ(M))
  126 RPSQ(M)=RSSQ(M)*(ASQ(M)+BSQ(M)-2.0*A(M)*SX*TX+SX*SX*TX*TX)/(ASQ(M)
     C+BSQ(M)+2.0*A(M)*SX*TX+SX*SX*TX*TX)
      IF(RPSQ(M))128,130,130
  128 RP(M)=0
      GO TO 132
  130 RP(M)= SQRT (RPSQ(M))


  132 TEMP1=2.0*B(M)*CX
      TEMP2=ASQ(M)+BSQ(M)-CX*CX
      TANDS(M)=-TEMP1/TEMP2
      DELS(M) = ATANF(-TEMP1/TEMP2)
      DELSD(M)=DELS(M)/0.0174533
      IF(DELSD(M)) 133, 134, 134
  133 DELSD(M) = DELSD(M) + 180.0
  134 CONTINUE
      TEMP3=2.0*B(M)*CX*(ASQ(M)+BSQ(M)-SX*SX)
      TEMP4=(TN**4.0)*((1.0+TK*TK)**2.0)*CX*CX-(ASQ(M)+BSQ(M))
      TANDP(M)=-TEMP3/TEMP4
      TEMP5=2.0*B(M)*SX*TX
      TEMP6=ASQ(M)+BSQ(M)-SX*SX*TX*TX
      TAND(M)=-TEMP5/TEMP6
      DEL(M) = ATANF(-TEMP5/TEMP6)
      DELD(M)=DEL(M)/0.0174533
      IF(DELD(M)) 136, 136, 135
  135 DELD(M) = DELD(M) - 180.0
  136 CONTINUE
      DELPD(M) = DELSD(M) + DELD(M)
      TAPSI(M)=RS(M)/RP(M)
      PSI(M)=ATAN (TAPSI(M))
      PSID(M)=PSI(M)/0.0174533
  200 CONTINUE
      WRITE(3,5)TN2,TK2
      WRITE(3,6)(PHID(M),A(M),B(M),RS(M),RP(M),TANDS(M),TANDP(M),TAND(M)
     X,TAPSI(M),DELSD(M),DELPD(M),DELD(M),PSID(M),M=1,7)
      IF (N - 4) 250, 300, 30
  250 WRITE (3,3)
  300 GO TO 20
  310 RETURN
      END
```

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APPENDIX I

Phase Considerations

Interpretation of literature data on the phase change in reflection is often hindered by different sign conventions employed by the authors. The following brief analysis should be helpful to find a common basis for comparison. A graphic representation of the four possible sign combinations for a harmonic oscillator with phase is given in Fig. 4 in the complex plane.

The following algebraic discussion refers to Table III. A wave incident on a reflecting surface may alternately be described by the factors given in line 1 of Table III. If the corresponding reflected waves are given by line 2 the ratio of reflected to incident wave is of the form listed in line 3 with the phase difference δ defined as

$$\delta = \theta_2 - \theta_1$$

A comparison of line 3 with the original oscillation without phase (line 4) shows that an increase in δ (taken as a positive number) has the same effect as a change in time given in line 5.

Since the time dependence $e^{-i\omega t}$ has been chosen before in this report and since it is preferable to have a positive δ stand for a phase advance, alternate II has been adopted here and forms the basis for all numerical results contained in this report.

Table III Phase Considerations

Alternates	I	II	III	IV
1. Incident wave	$e^{i(\omega t+\theta_1)}$	$e^{-i(\omega t+\theta_1)}$	$e^{i(\omega t-\theta_1)}$	$e^{-i(\omega t-\theta_1)}$
2. Reflected wave	$e^{i(\omega t+\theta_2)}$	$e^{-i(\omega t+\theta_2)}$	$e^{i(\omega t-\theta_2)}$	$e^{-i(\omega t-\theta_2)}$
3. Ratio	$e^{i\delta}$	$e^{-i\delta}$	$e^{-i\delta}$	$e^{i\delta}$
4. Oscillation without phase	$e^{i\omega t}$	$e^{-i\omega t}$	$e^{i\omega t}$	$e^{-i\omega t}$
5. Effect of increase in pos. δ same as	advance	advance	delay in time	delay
6. Pos. δ corresponds to	advance	advance	retardation in time	retardation
7. Neg. δ corresponds to	retardation	retardation	advance in phase	advance

APPENDIX I1

Numerical Results: Reflection Coefficients, Amplitude Ratio, and Relative Phase Change for Reflection From Bare Metals

For reference purposes selected output data from the program MER are recorded on the following pages. The variables which appear in the output are

Name	Symbol	Description
TN2	$N = n/n_o$	ratio of real part of complex refractive index to that of incident medium
TK	κ	absorption index defined in Eq. (14)
PHID	ϕ	angle of incidence (deg.)
A, B	A, B	intermediate variables
RS, RP	R_s, R_p	amplitude reflectivity for s and p polarization
TANDS, TANDP	$\tan \delta_s$, $\tan \delta_p$	defined by δ_p and δ_s below
TAND	$\tan\Delta$	defined by Δ below
TAPSI	$\tan\psi \equiv R_s/R_p$	amplitude ratio of reflected s and p polarization for unit amplitude incidence
DELSD, DELPD	δ_s, δ_p	phase of reflected s or p polarization with respect to incident waves
DELD	$\Delta = \delta_p - \delta_s$	phase difference between reflected s and p polarization for in-phase incidence
PSID	ψ	defined by $\tan\psi$ above

For details, refer to program description in Chapter IV, Section B1.

TN2= .1000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0970	.1031	.0248	.8151	.2105	.1975	-.0125	1.0119	11.8886	11.1703	-.7185	45.3380
40.0000	.0196	.6430	.9769	.9535	5.6888	.0012	-5.6506	1.0241	80.0302	.0660	-79.9641	45.6872
45.0000	.0141	.7072	.9802	.9608	**49.7297	.0008	**50.5723	1.0202	90.0230	.0455	-89.9771	45.5776
50.0000	.0131	.7662	.9834	.9670	-5.6610	.0006	5.6799	1.0169	100.0179	.0328	-99.9851	45.4806
70.0000	.0106	.9358	.9927	.9859	-.8389	.0002	.8392	1.0073	140.0066	.0094	-139.9972	45.2085
75.0000	.0104	.9660	.9947	.9893	-.5772	.0001	.5774	1.0054	150.0048	.0066	-149.9982	45.1535
80.0000	.0102	.9849	.9965	.9930	-.3639	.0001	.3640	1.0035	160.0031	.0042	-159.9990	45.1030

TN2= .1000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0982	.1528	.0249	.8189	.3163	.3039	-.0113	1.0079	17.5503	16.9033	-.6470	45.2077
40.0000	.0230	.6528	.9659	.9331	6.2478	.0318	-5.1851	1.0352	80.9065	1.8225	-79.0840	45.9896
45.0000	.0209	.7162	.9712	.9432	-75.7107	.0264	-75.7185	1.0297	90.7568	1.5139	-89.2433	45.8374
50.0000	.0194	.7744	.9757	.9519	-5.3767	.0220	6.0586	1.0250	100.6321	1.2602	-99.3724	45.7068
70.0000	.0158	.9465	.9894	.9787	-.8310	.0094	.8470	1.0105	140.2724	.5383	-139.7341	45.3100
75.0000	.0154	.9725	.9921	.9843	-.5727	.0069	.5819	1.0080	150.2604	.3956	-149.8048	45.2785
80.0000	.0151	.9912	.9948	.9896	-.3614	.0045	.3665	1.0053	160.1319	.2601	-159.8718	45.1505

TN2= .1000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0988	.2024	.0266	.8227	.4268	.4153	-.0097	1.0048	23.1125	22.5553	-.5572	45.1359
40.0000	.0300	.6664	.9564	.9152	7.1977	.0732	-4.6659	1.0450	82.0503	4.1870	-77.9033	46.2607
45.0000	.0275	.7285	.9630	.9275	-32.6995	.0612	-32.7009	1.0384	91.7517	3.5033	-88.2484	46.0785
50.0000	.0255	.7858	.9688	.9382	-4.9291	.0512	6.6629	1.0325	101.4683	2.9328	-98.5355	45.9173
70.0000	.0209	.9558	.9862	.9722	-.8204	.0221	.8580	1.0144	140.6355	1.2657	-139.3698	45.4084
75.0000	.0204	.9815	.9898	.9795	-.5665	.0163	.5882	1.0106	150.4678	.9313	-149.5365	45.3015
80.0000	.0200	1.0001	.9933	.9864	-.3579	.0107	.3700	1.0070	160.3078	.6126	-159.6952	45.1988

TN2= .1000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0992	.2521	.0294	.8267	.5445	.5337	-.0084	1.0033	28.5686	28.0889	-.4797	45.0943
40.0000	.0366	.6834	.9482	.9002	8.8377	.1242	-4.1546	1.0534	83.5463	7.0779	-76.4684	46.4496
45.0000	.0336	.7441	.9559	.9138	-19.2164	.1044	-19.2169	1.0461	92.5790	5.5578	-87.0211	46.2910
50.0000	.0312	.8002	.9626	.9261	-4.5098	.0876	7.6026	1.0395	102.5023	5.0089	-97.4934	46.1084
70.0000	.0258	.9676	.9834	.9663	-.8073	.0381	.8721	1.0177	141.0875	2.1795	-138.9080	45.5027
75.0000	.0252	.9930	.9877	.9750	-.5589	.0280	.5962	1.0131	150.8008	1.6049	-149.1958	45.3719
80.0000	.0247	1.0114	.9919	.9834	-.3536	.0184	.3745	1.0086	160.5271	1.0563	-159.4707	45.2455

TN2= .1000 TK= 3.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0994	.3018	.0331	.8311	.6719	.6614	-.0073	1.0024	33.8991	33.4817	-.4174	45.0687
40.0000	.0426	.7096	.9414	.8880	11.9753	.1836	-3.6860	1.0602	85.2266	10.4054	-74.8212	46.6718
45.0000	.0393	.7626	.9499	.9023	-12.9786	.1550	-12.9788	1.0528	94.4060	8.8118	-85.5941	46.4722
50.0000	.0367	.8174	.9573	.9156	-4.0994	.1306	9.1042	1.0456	103.7089	7.4407	-96.2683	46.2777
70.0000	.0306	.9818	.9809	.9608	-.7921	.0571	.8893	1.0209	141.6186	3.2653	-138.3534	45.5924
75.0000	.0298	1.0069	.9858	.9708	-.5499	.0420	.6060	1.0155	151.1924	2.4067	-148.7857	45.4392
80.0000	.0293	1.0250	.9906	.9807	-.3485	.0277	.3799	1.0102	160.7850	1.5850	-159.2000	45.2904

TN2= .1000 TK= 4.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0996	.4014	.0420	.8409	.9694	.9584	-.0057	1.0014	44.1096	43.7819	-.3277	45.0407
40.0000	.0532	.7523	.9318	.8716	64.0572	.3251	-2.9202	1.0691	89.1056	18.0093	-71.0963	46.9125
45.0000	.0495	.8077	.9411	.8857	-7.3743	.2763	-7.3744	1.0626	97.7225	15.4450	-82.2775	46.7382
50.0000	.0465	.8596	.9495	.8995	-3.3695	.2339	17.0055	1.0555	106.5297	13.1643	-93.3654	46.5465
70.0000	.0393	1.0171	.9769	.9515	-.7570	.1031	.9330	1.0267	142.8753	5.8887	-136.9866	45.7554
75.0000	.0384	1.0414	.9829	.9638	-.5290	.0761	.6304	1.0199	152.1202	4.3495	-147.7707	45.5634
80.0000	.0378	1.0589	.9887	.9759	-.3366	.0501	.3933	1.0131	161.3968	2.8686	-158.5282	45.3740

TN2= .1000 TK= 6.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0998	.6010	.0635	.8630	1.9139	1.8957	-.0039	1.0007	62.4136	62.1875	-.2261	45.0188
40.0000	.0685	.8763	.9256	.8634	-7.2288	.6970	-1.9626	1.0720	97.8764	34.8766	-62.9998	46.9913
45.0000	.0649	.9242	.9346	.8734	-3.6467	.5930	-3.6467	1.0700	105.3349	30.6698	-74.6651	46.9376
50.0000	.0619	.9699	.9430	.8849	-2.3468	.5022	-15.9502	1.0657	113.0798	26.6673	-86.4125	46.8213
70.0000	.0540	1.1117	.9731	.9396	-.6779	.2213	1.0578	1.0359	145.8685	12.4775	-133.3910	46.0107
75.0000	.0529	1.1339	.9800	.9542	-.4805	.1631	.6984	1.0271	154.7366	9.2655	-145.4711	45.7657
80.0000	.0522	1.1500	.9867	.9692	-.3084	.1075	.4301	1.0181	162.8611	6.1331	-156.7279	45.5136

TN2= .1000 TK=10.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.0999	1.0006	.9051	.9049	-161.1351	-263.5737	-.0074	1.0002	90.3556	90.2174	-.1382	45.0069
40.0000	.0842	1.1875	.9376	.8890	-2.1907	2.2319	-1.1372	1.0547	114.5359	65.8617	-48.6741	46.5740
45.0000	.0817	1.2234	.9439	.8909	-1.7243	1.7476	-1.7243	1.0595	120.1109	60.2218	-59.8891	46.6539
50.0000	.0795	1.2582	.9502	.8949	-1.3751	1.3886	-3.0388	1.0618	126.0247	54.2397	-71.7850	46.7168
70.0000	.0730	1.3705	.9754	.9333	-.5306	.5317	1.4799	1.0451	152.0474	27.9996	-124.0478	46.2429
75.0000	.0720	1.3886	.9815	.9480	-.3851	.3855	.9050	1.0354	158.5373	21.0838	-137.4535	45.9965
80.0000	.0713	1.4018	.9877	.9642	-.2510	.2511	.5358	1.0243	165.9121	14.0945	-151.8177	45.6884

MUB-12608

TN2= .2000 TK= .5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1976	.1012	.6728	.6663	.2131	.2079	-.0050	1.0098	12.0302	11.7433	-.2869	45.2799
40.0000	.0323	.6199	.5504	.9027	4.7115	-.0691	-7.0873	1.0529	78.0165	-3.9518	-81.9687	46.4753
45.0000	.0291	.6862	.9584	.9186	34.2898	-.0584	34.2883	1.0434	88.3295	-3.3411	-91.6706	46.2156
50.0000	.0268	.7467	.9652	.9318	-6.6163	-.0492	4.9541	1.0358	98.5547	-2.8112	-101.4119	46.0069
70.0000	.0216	.9238	.9849	.9703	-.8575	-.0215	.8208	1.0150	135.3876	-1.2325	-140.6201	45.4259
75.0000	.0210	.9505	.9888	.9781	-.5879	-.0159	.5668	1.0110	149.5490	-.9081	-150.4571	45.3127
80.0000	.0206	.9697	.9926	.9856	-.3698	-.0104	.3580	1.0072	159.7031	-.5979	-160.3011	45.2054

TN2= .2000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1985	.2015	.6799	.6758	.4384	.4311	-.0061	1.0061	23.6737	23.3220	-.3518	45.1732
40.0000	.0619	.6458	.9099	.8281	5.9610	.0182	-5.3611	1.0987	80.4769	1.0428	-79.4341	47.6933
45.0000	.0564	.7094	.9237	.8532	-157.7263	.0127	-157.7599	1.0826	90.3633	.7265	-89.6368	47.2725
50.0000	.0521	.7678	.9355	.8750	-5.5121	.0091	5.8123	1.0651	100.2828	.5206	-99.7622	46.9127
70.0000	.0425	.9407	.9714	.9436	-.8360	.0026	.8405	1.0255	140.1041	.1505	-139.9536	45.8330
75.0000	.0414	.9668	.9789	.9581	-.5756	.0018	.5780	1.0216	150.0752	.1045	-145.9705	45.6134
80.0000	.0406	.9856	.9860	.9722	-.3630	.0012	.3643	1.0142	160.0488	.0664	-159.9824	45.4037

TN2= .2000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1991	.3014	.6920	.6895	.6938	.6855	-.0056	1.0037	34.7534	34.4308	-.3726	45.1065
40.0000	.0874	.6862	.8812	.7791	9.7020	.1469	-3.9465	1.1311	84.1152	8.3342	-75.7810	48.5211
45.0000	.0804	.7460	.8981	.8067	-16.7615	.1197	-16.7619	1.1114	92.4143	6.8285	-85.5858	48.0716
50.0000	.0745	.8015	.9131	.8324	-4.3874	.0984	7.8926	1.0969	102.8159	5.6189	-97.2210	47.6468
70.0000	.0620	.9779	.9607	.9211	-.8038	.0407	.8730	1.0430	141.2086	2.3294	-138.8787	46.2059
75.0000	.0604	.9933	.9709	.9411	-.5569	.0298	.5965	1.0316	150.8878	1.7055	-145.1818	45.8922
80.0000	.0593	1.0116	.9807	.9607	-.3525	.0195	.3746	1.0208	160.5834	1.1185	-159.4649	45.5891

TN2= .2000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1994	.4012	.7080	.7063	1.0049	.9951	-.0049	1.0024	45.1399	44.8604	-.2791	45.0695
40.0000	.1086	.7382	.8640	.7520	37.5015	.3044	-2.9964	1.1489	88.4725	16.9281	-71.5444	48.9640
45.0000	.1008	.7938	.8819	.7778	-8.0009	.2539	-8.0010	1.1339	97.1242	14.2484	-82.8759	48.5899
50.0000	.0946	.8450	.8983	.8037	-3.4912	.2118	14.2049	1.1177	105.5834	11.9565	-94.0269	48.1809
70.0000	.0796	1.0047	.9530	.9033	-.7667	.0902	.9182	1.0550	142.5598	5.1534	-137.4473	46.5342
75.0000	.0777	1.0291	.9651	.9273	-.5337	.0662	.6219	1.0407	151.5107	3.7891	-148.1216	46.1422
80.0000	.0764	1.0468	.9768	.9513	-.3393	.0435	.3886	1.0268	161.2573	2.4911	-158.7661	45.7574

TN2= .2000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1996	.5010	.7263	.7251	1.4167	1.4022	-.0042	1.0017	54.7455	54.5050	-.2406	45.0479
40.0000	.1291	.7951	.8558	.7613	-18.0987	.4083	-2.3715	1.1546	93.1626	26.0269	-67.1357	49.1058
45.0000	.1175	.8508	.8736	.7632	-5.0632	.3310	-5.0632	1.1447	101.1724	22.3443	-78.8277	48.8594
50.0000	.1112	.8595	.8902	.7870	-2.8319	.3450	137.8644	1.1312	105.4494	19.0338	-90.4156	48.5274
70.0000	.0553	1.0498	.9483	.8901	-.7229	.1488	.9759	1.0656	144.1593	8.4613	-135.6980	46.8131
75.0000	.0932	1.0732	.9614	.9168	-.5081	.1094	.6538	1.0486	153.0665	6.2421	-146.8744	46.3601
80.0000	.0917	1.0501	.9744	.9440	-.3245	.0719	.4059	1.0322	162.0200	4.1132	-157.5068	45.9065

TN2= .2000 TK= 3.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1997	.6009	.7458	.7449	2.0092	1.9909	-.0037	1.0012	63.5396	63.3303	-.2093	45.0348
40.0000	.1384	.8874	.8544	.7417	-1.1973	.7027	-1.9471	1.1519	97.9101	35.0950	-62.8151	49.0378
45.0000	.1311	.9150	.8713	.7591	-3.6512	.5922	-3.6512	1.1478	108.9168	30.6335	-74.6833	48.9354
50.0000	.1249	.9604	.8874	.7796	-2.3524	.4973	-16.7666	1.1383	113.0302	26.4435	-86.5867	48.6995
70.0000	.1089	1.1022	.9460	.8809	-.6794	.2145	1.0444	1.0740	145.8081	12.1035	-133.7006	47.0423
75.0000	.1067	1.1245	.9597	.9093	-.4819	.1577	.6918	1.0554	154.2884	8.9624	-145.3260	46.4651
80.0000	.1052	1.1406	.9731	.9386	-.3090	.1037	.4264	1.0368	162.8276	5.9193	-156.9083	46.0360

TN2= .2000 TK= 4.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1598	.8007	.7847	.7842	5.0375	4.9630	-.0029	1.0007	78.7721	78.6676	-.1642	45.0205
40.0000	.1571	1.0107	.8433	.7613	-3.2812	1.2810	-1.4249	1.1341	108.9496	52.0232	-54.9284	48.5955
45.0000	.1510	1.0556	.8777	.7703	-2.2711	1.0580	-2.2712	1.1354	113.3077	46.6149	-66.6526	48.7280
50.0000	.1456	1.0991	.8919	.7835	-1.7315	.8743	-5.0709	1.1384	120.6077	41.1636	-78.8441	48.7019
70.0000	.1306	1.2248	.9467	.8717	-.5984	.3631	1.2286	1.0861	145.1057	19.9572	-129.1486	47.3647
75.0000	.1285	1.2442	.9601	.9008	-.4298	.2657	.7852	1.0658	157.7402	14.8805	-141.8593	46.8246
80.0000	.1270	1.2558	.9733	.9321	-.2782	.1741	.4754	1.0443	164.4519	9.8779	-154.5743	46.2400

TN2= .2000 TK= 6.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.1999	1.2005	.8500	.8497	-4.9744	-5.0258	-.0020	1.0003	101.3664	101.2534	-.1132	45.0094
40.0000	.1767	1.3581	.8955	.8199	-1.6144	5.1553	-.9745	1.0922	121.7745	79.0274	-42.7520	47.9239
45.0000	.1728	1.3892	.9031	.8193	-1.3459	3.3172	-1.3459	1.1048	126.6122	73.2243	-53.3879	47.8503
50.0000	.1691	1.4156	.9131	.8217	-1.1191	2.3349	-2.1413	1.1137	131.7878	66.8157	-64.9671	48.0791
70.0000	.1580	1.5152	.9568	.8737	-.4490	.7255	1.8105	1.0952	154.8753	35.9625	-118.9128	47.6005
75.0000	.1561	1.5354	.9675	.8990	-.3433	.5152	1.0439	1.0767	161.0510	27.2571	-133.7939	47.1014
80.0000	.1551	1.5472	.9782	.9290	-.2250	.3309	.6006	1.0530	167.2177	18.3065	-149.0107	46.4774

TN2= .2000 TK=10.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2000	2.0003	.9236	.9235	-1.3141	-1.3174	-.0012	1.0001	127.2694	127.2003	-.0691	45.0036
40.0000	.1905	2.0559	.9436	.9035	-.8337	-2.5279	-.5452	1.0444	140.1820	111.5931	-28.5989	46.2432
45.0000	.1887	2.1203	.9483	.8993	-.7438	-3.3303	-.7438	1.0545	143.3569	106.7138	-36.6431	46.5199
50.0000	.1869	2.1405	.9533	.8954	-.6546	-5.2135	-1.0331	1.0647	146.7896	100.8580	-45.9316	46.7947
70.0000	.1811	2.2081	.9756	.8997	-.3152	2.0272	6.4895	1.0844	162.5039	63.7437	-98.7602	47.3177
75.0000	.1802	2.2193	.9816	.9129	-.2349	1.1965	1.9909	1.0752	166.7818	50.1115	-116.6703	47.0753
80.0000	.1796	2.2276	.9877	.9344	-.1558	.6915	.9497	1.0571	171.1422	34.6655	-136.4767	46.5087

TN2= .2000 TK=20.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2000	4.0002	.9768	.9768	-.5315	-.5323	-.0006	1.0000	152.0082	151.9734	-.0348	45.0009
40.0000	.1975	4.0512	.9824	.9700	-.3912	-.7400	-.2704	1.0128	158.6325	143.5009	-15.1322	45.3645
45.0000	.1970	4.0619	.9838	.9678	-.3582	-.8218	-.3582	1.0165	160.2535	140.5869	-19.7066	45.4683
50.0000	.1964	4.0725	.9853	.9652	-.3230	-.9363	-.4709	1.0208	162.1014	136.8852	-25.2162	45.5886
70.0000	.1947	4.1086	.9922	.9508	-.1673	-3.4201	-2.0691	1.0436	170.5040	106.2982	-64.2058	46.2716
75.0000	.1944	4.1147	.9941	.9486	-.1260	-128.4432	-7.4663	1.0479	172.8175	90.4461	-82.3714	46.3407
80.0000	.1942	4.1192	.9960	.9522	-.0843	2.4807	3.2429	1.0461	175.1828	68.0445	-107.1379	46.2898

TN2= .3000 TK= .1000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2980	.0302	.5410	.5366	.0664	.0656	-.0008	1.0081	3.7953	3.7523	-.0430	45.2319
40.0000	.0158	.5655	.5738	.9472	3.3271	-.2418	-18.2495	1.0281	73.2711	-13.5925	-86.8635	45.7936
45.0000	.0140	.6412	.5784	.9574	10.2220	-.1975	10.2219	1.0220	84.4126	-11.1748	-95.5875	45.6241
50.0000	.0128	.7096	.9822	.9651	-10.6878	-.1628	3.8412	1.0176	94.3454	-9.2465	-104.5922	45.5011
70.0000	.0101	.8911	.9924	.9855	-.9001	-.0683	.7836	1.0070	138.0081	-3.9081	-141.9163	45.2003
75.0000	.0098	.9187	.9944	.9894	-.6119	-.0501	.5451	1.0051	148.5353	-2.8694	-151.4051	45.1462
80.0000	.0096	.9385	.9964	.9930	-.3831	-.0329	.3458	1.0033	155.0373	-1.8848	-160.9222	45.0957

TN2= .3000 TK= .2000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2980	.0604	.5420	.5377	.1332	.1316	-.0016	1.0079	7.5868	7.4956	-.0912	45.2250
40.0000	.0314	.5725	.5487	.8981	3.3988	-.2288	-16.3206	1.0563	73.6050	-12.9887	-86.4937	46.5687
45.0000	.0280	.6437	.9577	.9172	10.7309	-.1880	10.7308	1.0442	84.6760	-10.6480	-95.3240	46.2383
50.0000	.0254	.7079	.9649	.9319	-10.2777	-.1555	3.8961	1.0354	95.5573	-8.8380	-104.3553	45.9964
70.0000	.0202	.8928	.9850	.9714	-.8975	-.0656	.7856	1.0140	138.0532	-3.7548	-141.8480	45.3996
75.0000	.0196	.9203	.9890	.9790	-.6105	-.0482	.5462	1.0107	148.5578	-2.7582	-151.3560	45.2918
80.0000	.0191	.9401	.9928	.9862	-.3823	-.0316	.3465	1.0067	159.0780	-1.8124	-160.8904	45.1910

TN2= .3000 TK= .3000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2981	.0906	.5436	.5396	.2008	.1984	-.0023	1.0075	11.3513	11.2210	-.1303	45.2144
40.0000	.0468	.5775	.9251	.8534	3.5223	-.2078	-13.9245	1.0840	74.1506	-11.7417	-85.8923	47.3086
45.0000	.0417	.6479	.9380	.8798	11.6840	-.1724	11.6838	1.0661	85.1081	-9.7835	-94.8920	46.8331
50.0000	.0379	.7116	.9484	.9006	-9.6674	-.1435	3.9898	1.0531	95.5058	-8.1650	-104.0708	46.4804
70.0000	.0301	.8956	.9778	.9577	-.8931	-.0632	.7889	1.0211	138.2336	-3.5012	-141.7348	45.5972
75.0000	.0293	.9230	.9837	.9688	-.6080	-.0450	.5481	1.0153	148.7004	-2.5742	-151.2746	45.4363
80.0000	.0286	.9427	.9892	.9794	-.3810	-.0295	.3475	1.0100	155.1451	-1.6925	-160.8377	45.2856

TN2= .3000 TK= .5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2984	.1508	.5488	.5453	.3399	.3362	-.0033	1.0065	18.7703	18.5819	-.1884	45.1864
40.0000	.0759	.5928	.8835	.7781	3.9954	-.1454	-9.6473	1.1354	75.8115	-8.2702	-84.0820	48.6291
45.0000	.0681	.6612	.9025	.8145	16.0562	-.1250	16.0558	1.1080	86.4361	-7.1279	-93.5640	47.9331
50.0000	.0622	.7233	.9183	.8449	-8.1648	-.1065	4.3105	1.0873	96.5827	-6.0784	-103.0611	47.3946
70.0000	.0458	.9044	.9643	.9318	-.8794	-.0472	.7990	1.0349	138.6710	-2.7052	-141.3762	45.9833
75.0000	.0483	.9316	.9737	.9495	-.6004	-.0349	.5539	1.0254	149.0702	-1.9962	-151.0164	45.7196
80.0000	.0473	.9511	.9826	.9666	-.3768	-.0230	.3508	1.0166	159.3546	-1.3156	-160.6702	45.4717

TN2= .3000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2990	.3010	.5720	.5657	.7348	.7286	-.0041	1.0041	36.3097	36.0762	-.2335	45.1160
40.0000	.1369	.6572	.8146	.6657	7.3960	.0875	-4.4374	1.2237	82.2999	4.9999	-77.3000	50.7450
45.0000	.1253	.7181	.8407	.7067	-32.3292	.0619	-32.3306	1.1895	91.7717	3.5434	-88.2283	49.9474
50.0000	.1162	.7748	.8638	.7452	-4.9646	.0448	6.4408	1.1591	101.3886	2.5633	-98.8253	49.2134
70.0000	.0953	.9449	.9379	.8788	-.8239	.0131	.8461	1.0673	140.5159	.7490	-139.7669	46.8641
75.0000	.0927	.9704	.9539	.9097	-.5687	.0091	.5808	1.0492	150.3729	.5223	-149.8506	46.3742
80.0000	.0910	.9850	.9694	.9392	-.3592	.0058	.3657	1.0321	160.2423	.3308	-159.9115	45.9051

TN2= .3000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2994	.4509	.6057	.6042	1.2770	1.2672	-.0038	1.0025	51.9361	51.7212	-.2150	45.0713
40.0000	.1807	.7472	.7870	.6286	-276.6733	.3764	-2.6863	1.2520	90.2071	20.6251	-69.5820	51.3939
45.0000	.1686	.8006	.8132	.6612	-6.6847	.3060	-6.6848	1.2258	98.5081	17.0161	-81.4920	50.8835
50.0000	.1586	.8512	.8376	.6961	-3.2522	.2494	18.5416	1.2032	107.0519	14.0047	-93.0872	50.2702
70.0000	.1341	1.0067	.9251	.8435	-.7530	.1003	.9226	1.0944	142.0196	5.7156	-137.3039	47.5406
75.0000	.1310	1.0209	.9425	.8813	-.5269	.0729	.6237	1.0695	152.2174	4.1713	-148.0462	46.9237
80.0000	.1288	1.0403	.9617	.9198	-.3354	.0477	.3893	1.0456	161.4567	2.7282	-159.7295	46.2759

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TN2= .3000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2996	.4008	.6444	.6436	2.1912	2.1725	-.0032	1.0016	65.4495	65.2039	-.1062	45.0464
40.0000	.2110	.8931	.7846	.6313	-7.0494	.7182	-1.9119	1.2429	98.0740	95.6859	-62.3884	51.1016
45.0000	.2000	.9000	.8084	.6536	-3.6365	.5950	-3.6366	1.2370	105.3756	90.7511	-74.6245	51.0469
50.0000	.1905	.9490	.8316	.6809	-2.3536	.4921	-17.9881	1.2213	113.0201	26.2020	-86.8180	50.6989
70.0000	.1651	1.0865	.9178	.8230	-.6813	.2039	1.0279	1.1159	149.7759	11.9249	-134.2107	48.1187
75.0000	.1623	1.1088	.9384	.8642	-.4028	.1491	.6809	1.0850	154.2281	8.4800	-145.7473	47.3555
80.0000	.1600	1.1249	.9580	.9074	-.3098	.0977	.4202	1.0566	162.7848	5.5779	-157.2070	46.5770

TN2= .3000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2997	.7507	.6839	.6832	4.3442	4.2892	-.0028	1.0011	77.0368	76.9769	-.1605	45.0320
40.0000	.2321	.9653	.7954	.6528	-3.6523	1.1589	-1.4884	1.2183	105.3129	49.2688	-96.1097	50.6212
45.0000	.2226	1.0110	.8163	.6663	-2.5014	.9517	-2.5014	1.2291	111.7905	43.5810	-68.2095	50.7766
50.0000	.2140	1.0313	.8371	.6857	-1.8318	.7819	-6.0458	1.2208	118.6202	38.0222	-80.6080	50.6788
70.0000	.1907	1.1358	.9189	.8131	-.6154	.3192	1.1632	1.1301	148.3502	17.7037	-130.6865	48.4941
75.0000	.1875	1.2003	.9390	.8550	-.4410	.2330	.7512	1.0982	156.2018	13.1166	-143.0852	47.6795
80.0000	.1852	1.2152	.9591	.9003	-.2850	.1524	.4573	1.0654	164.0921	8.6669	-155.4298	46.8179

TN2= .3000 TK= 3.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2958	.9006	.7214	.7208	18.4048	17.6125	-.0026	1.0008	86.8899	86.7503	-.1396	45.0232
40.0000	.2471	1.0528	.8118	.6821	-2.5047	1.8077	-1.2224	1.1902	111.7640	61.0450	-50.7150	49.9629
45.0000	.2389	1.1301	.8300	.6889	-1.9159	1.4348	-1.9159	1.2048	117.9823	55.1248	-62.4378	50.3077
50.0000	.2315	1.1664	.8485	.7014	-1.4982	1.1491	-3.6684	1.2096	123.7215	48.9700	-74.7515	50.4199
70.0000	.2104	1.2835	.9234	.8102	-.5576	.4449	1.3324	1.1356	150.8569	23.9667	-126.8901	48.7342
75.0000	.2073	1.3023	.9422	.8510	-.4032	.3225	.8341	1.1072	158.0415	17.8744	-140.1671	47.9113
80.0000	.2052	1.3160	.9613	.8966	-.2621	.2101	.4997	1.0721	165.3137	11.8640	-153.4497	46.9930

TN2= .3000 TK= 4.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2999	1.2005	.7894	.7851	-4.5078	-4.5489	-.0019	1.0005	102.5077	102.3982	-.1095	45.0137
40.0000	.2658	1.3542	.8479	.7435	-1.5745	5.0290	-.9053	1.1404	122.4201	80.2654	-42.1547	48.7527
45.0000	.2600	1.3848	.8615	.7423	-1.3186	3.5699	-1.3186	1.1607	127.1758	74.3519	-52.8243	49.2537
50.0000	.2545	1.4148	.8757	.7450	-1.1002	2.4482	-2.0955	1.1754	132.2485	67.7821	-64.4864	49.6099
70.0000	.2379	1.5132	.9360	.8160	-.4643	.7308	1.8089	1.1470	155.0943	36.1592	-118.9351	48.9174
75.0000	.2354	1.5252	.9516	.8519	-.3402	.5169	1.0400	1.1171	161.2124	27.3350	-133.8775	48.1661
80.0000	.2336	1.5409	.9675	.8951	-.2231	.3311	.5984	1.0809	167.4240	18.3197	-149.1043	47.2258

TN2= .3000 TK= 6.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.2999	1.8003	.8699	.8697	-1.5420	-1.5473	-.0013	1.0002	122.9496	122.8741	-.0755	45.0063
40.0000	.2829	1.9087	.9040	.8377	-.9324	-3.4770	-.5999	1.0792	137.0043	106.0457	-30.9586	47.1801
45.0000	.2797	1.9309	.9120	.8318	-.8259	-5.1948	-.8259	1.0965	140.4481	100.8962	-39.5519	47.6348
50.0000	.2765	1.9528	.9205	.8269	-.7221	-11.9841	-1.1666	1.1133	144.1672	94.7700	-49.3972	48.0683
70.0000	.2666	2.0259	.9584	.8435	-.3415	1.5852	4.2002	1.1367	161.1462	57.7543	-103.3919	48.6470
75.0000	.2650	2.0379	.9685	.8664	-.2538	.9973	1.6750	1.1179	165.7585	44.9217	-120.8372	48.1950
80.0000	.2638	2.0468	.9789	.9006	-.1681	.5957	.8488	1.0869	170.4582	30.7843	-139.6738	47.3841

TN2= .3000 TK=10.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.3000	3.0002	.9422	.9422	-.7410	-.7423	-.0008	1.0001	143.4603	143.4143	-.0461	45.0023
40.0000	.2934	3.0275	.9564	.9259	-.5275	-1.0946	-.3555	1.0329	152.1869	132.4133	-19.7732	45.9267
45.0000	.2921	3.0614	.9598	.9213	-.4799	-1.2470	-.4799	1.0418	154.9839	128.7269	-25.6366	46.1741
50.0000	.2908	3.0954	.9636	.9160	-.4301	-1.4762	-.6399	1.0519	156.7208	124.1142	-32.6146	46.4491
70.0000	.2864	3.1425	.9807	.8970	-.2184	66.9252	-4.9299	1.0933	167.6773	89.1440	-78.5334	47.5520
75.0000	.2857	3.1503	.9854	.9008	-.1641	3.3092	7.5989	1.0939	170.6729	73.1856	-97.4969	47.5688
80.0000	.2852	3.1561	.9902	.9165	-.1095	1.9170	1.6669	1.0805	173.7924	52.7905	-120.9619	47.2151

TN2= .3000 TK=20.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.3000	6.0001	.9840	.9839	-.3418	-.3422	-.0004	1.0000	161.1321	161.1088	-.0232	45.0006
40.0000	.2983	6.0242	.9878	.9792	-.2574	-.4584	-.1790	1.0088	165.9644	155.3735	-10.1909	45.2505
45.0000	.2979	6.0414	.9887	.9775	-.2368	-.5016	-.2368	1.0114	166.6803	153.3609	-13.3197	45.3255
50.0000	.2976	6.0486	.9897	.9755	-.2144	-.5596	-.3081	1.0146	167.8566	150.7703	-17.1263	45.4150
70.0000	.2964	6.0730	.9949	.9603	-.1127	-1.2991	-1.0348	1.0357	172.5684	127.5881	-45.5803	46.0050
75.0000	.2962	6.0771	.9959	.9542	-.0851	-2.2598	-1.8238	1.0437	175.1341	113.4699	-61.7642	46.2236
80.0000	.2960	6.0801	.9972	.9500	-.0570	-34.3320	-11.5872	1.0497	176.7359	91.6684	-85.0674	46.3886

TN2= .9000 TK= .1000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4988	.0901	.3356	.3340	.1340	.1335	-.0005	1.0048	7.6336	7.6058	-.0279	45.1386
40.0000	.0607	.4119	.8842	.7670	1.5238	-1.1162	3.7668	1.1528	56.7257	-48.1421	-104.8678	49.0597
45.0000	.0495	.5049	.9119	.8308	2.9435	-.7681	2.9435	1.0971	71.2355	-37.5290	-108.7645	47.6522
50.0000	.0428	.5841	.9257	.8699	10.6984	-.5782	7.1744	1.0688	84.6595	-30.0377	-114.6976	46.9045
70.0000	.0313	.7578	.9720	.9507	-1.0489	-.2127	.6834	1.0224	133.6447	-12.0070	-145.6518	45.6347
75.0000	.0302	.8285	.9795	.9641	-.6913	-.1543	.4853	1.0160	145.3427	-8.7688	-154.1115	45.4555
80.0000	.0294	.8904	.9866	.9765	-.4256	-.1005	.3119	1.0103	156.5449	-5.7390	-162.6843	45.2947

TN2= .5000 TK= .2000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4988	.1002	.3400	.3384	.2708	.2698	-.0009	1.0047	15.1509	15.0969	-.0541	45.1345
40.0000	.1150	.4319	.7951	.6130	1.7107	-.8801	5.1238	1.2970	55.6911	-41.3524	-101.0436	52.3682
45.0000	.0964	.5189	.8379	.7021	3.3142	-.6639	3.3142	1.1934	73.2098	-33.5805	-106.7901	50.0350
50.0000	.0840	.5949	.8689	.7636	14.6445	-.5187	2.2980	1.1379	88.0936	-27.4159	-115.5095	48.6910
70.0000	.0622	.7643	.9461	.9054	-1.0307	-.1988	.6905	1.0445	134.1339	-11.2410	-145.3765	46.2573
75.0000	.0579	.8346	.9604	.9305	-.6823	-.1446	.4894	1.0321	145.6544	-8.2275	-153.9218	45.9036
80.0000	.0544	.8963	.9739	.9542	-.4209	-.0944	.3141	1.0206	157.1729	-5.3935	-162.5650	45.5852

TN2= .5000 TK= .3000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4585	.1503	.3471	.3455	.4132	.4116	-.0013	1.0045	22.4484	22.3710	-.0775	45.1283
40.0000	.1628	.4606	.7320	.5186	2.0272	-.6311	9.5161	1.4115	63.7436	-32.2554	-95.9990	54.6840
45.0000	.1388	.5402	.7811	.6102	4.0431	-.5269	4.0430	1.2802	76.1074	-27.7852	-103.8926	52.0053
50.0000	.1226	.6118	.8196	.6811	33.0504	-.4330	2.5157	1.2074	88.2669	-23.4115	-111.6784	50.2732
70.0000	.0920	.8149	.9272	.8652	-1.0034	-.1768	.7021	1.0670	134.5018	-10.0269	-144.9781	46.8567
75.0000	.0888	.8446	.9433	.9002	-.6682	-.1292	.4961	1.0478	146.2485	-7.3637	-153.6122	46.3376
80.0000	.0866	.8659	.9625	.9339	-.4136	-.0846	.3178	1.0308	157.5122	-4.8374	-162.3696	45.8676

TN2= .5000 TK= .5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4990	.2505	.3683	.3669	.7288	.7258	-.0020	1.0039	36.0833	35.9711	-.1122	45.1117
40.0000	.2357	.5203	.6617	.4306	3.2496	-.2221	-12.4686	1.5368	72.8551	-12.5195	-85.4146	56.9477
45.0000	.2094	.5569	.7106	.5049	8.4587	-.2398	8.4586	1.4071	83.2577	-13.4048	-96.7424	54.6030
50.0000	.1895	.6557	.7537	.5744	-14.6351	-.2278	3.3245	1.3122	93.5089	-12.8323	-106.7412	52.6890
70.0000	.1476	.8469	.8883	.8011	-.9312	-.1146	.7379	1.1088	133.0309	-6.5373	-143.5762	47.9537
75.0000	.1428	.8752	.9168	.8507	-.6298	-.0852	.5168	1.0777	147.7581	-4.8713	-152.6695	47.1426
80.0000	.1398	.8955	.9446	.8997	-.3931	-.0564	.3293	1.0500	158.5416	-3.2304	-161.7720	46.3958

TN2= .5000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4954	.5006	.4478	.4467	2.0061	1.9939	-.0026	1.0024	63.5040	63.3649	-.1390	45.0697
40.0000	.3431	.7286	.6348	.4186	-18.0631	.5237	-2.1973	1.5166	93.1688	27.6395	-65.5292	56.5999
45.0000	.3218	.7765	.6776	.4524	-5.3049	.3909	-5.3049	1.4867	100.6753	21.3505	-79.3248	56.0742
50.0000	.3034	.8239	.7102	.4955	-2.9607	.2921	24.0688	1.4325	108.6631	16.2840	-92.3792	55.1001
70.0000	.2566	.9741	.8552	.7184	-.7422	.0893	.8901	1.1904	143.4173	5.0898	-138.3275	49.9679
75.0000	.2505	.9979	.8907	.7827	-.5209	.0622	.6027	1.1380	152.4831	3.5615	-148.9216	48.6922
80.0000	.2463	1.0151	.9264	.8506	-.3323	.0395	.3767	1.0892	161.6152	2.2600	-159.3592	47.4440

TN2= .5000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4996	.7506	.5379	.5371	8.0738	7.9275	-.0023	1.0015	82.9394	82.8105	-.1289	45.0429
40.0000	.3987	.9406	.6745	.4829	-3.1547	1.3844	-1.3480	1.3968	103.5875	56.1581	-53.4258	54.4005
45.0000	.3829	.9753	.7040	.4956	-2.2865	1.0816	-2.2865	1.4204	113.6224	47.2448	-66.3776	54.8543
50.0000	.3686	1.0174	.7345	.5180	-1.7259	.8507	-5.5033	1.4180	120.0875	40.3868	-79.7011	54.8086
70.0000	.3285	1.1417	.8624	.6960	-.6034	.3092	1.1220	1.2376	148.8548	17.1840	-131.7108	51.0608
75.0000	.3228	1.1618	.8956	.7613	-.4336	.2222	.7257	1.1764	156.9581	12.5281	-144.0259	49.6342
80.0000	.3188	1.1764	.9294	.8331	-.2807	.1438	.4425	1.1156	164.3195	8.1805	-156.1387	48.1276

TN2= .5000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4998	1.0005	.6205	.6199	-7.9371	-8.0639	-.0019	1.0010	97.1809	97.0692	-.1117	45.0279
40.0000	.4306	1.1413	.7249	.5588	-1.8785	3.2317	-1.0078	1.2972	118.0280	72.9060	-45.2220	52.3775
45.0000	.4188	1.1939	.7484	.5602	-1.5330	2.2679	-1.5330	1.3361	123.1027	66.2053	-56.8974	53.1876
50.0000	.4078	1.2260	.7732	.5689	-1.2546	1.6666	-2.6777	1.3590	128.5570	59.0354	-69.5216	53.6539
70.0000	.3754	1.3319	.8807	.6998	-.5067	.5627	1.4476	1.2984	152.1268	28.4908	-124.6360	51.5787
75.0000	.3708	1.3452	.9093	.7591	-.3694	.3862	.8813	1.1980	155.7265	21.1164	-138.6101	50.1466
80.0000	.3671	1.3615	.9387	.8291	-.2414	.2483	.5209	1.1323	166.4286	13.5432	-152.4856	48.5497

TN2= .5000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4998	1.2504	.6897	.6893	-3.0682	-3.0857	-.0017	1.0007	108.0523	107.9560	-.0963	45.0192
40.0000	.4501	1.3886	.7715	.6296	-1.3779	17.9990	-.8141	1.2254	125.5701	86.8200	-35.1501	50.7826
45.0000	.4412	1.4187	.7904	.6248	-1.1774	6.0976	-1.1774	1.2651	130.3433	80.6864	-45.6568	51.6757
50.0000	.4327	1.4445	.8105	.6290	-.9981	3.4184	-1.8312	1.2949	135.0552	73.6939	-61.3613	52.3647
70.0000	.4068	1.5265	.8997	.7130	-.4362	.8063	1.9168	1.2615	156.4320	38.8805	-117.5511	51.6042
75.0000	.4028	1.5517	.9238	.7649	-.3209	.5595	1.0731	1.2078	162.2086	29.2281	-132.9805	50.3763
80.0000	.3999	1.5628	.9486	.8305	-.2110	.3539	.6106	1.1422	168.0845	19.4909	-148.5937	48.7979

TN2= .5000 TK= 3.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4999	1.5004	.7459	.7452	-1.9964	-2.0037	-.0015	1.0005	116.6070	116.5232	-.0838	45.0139
40.0000	.4627	1.6209	.8107	.6904	-1.1015	-7.2979	-.6856	1.1744	132.2354	97.8024	-34.4329	49.5846
45.0000	.4558	1.6495	.8261	.6825	-.9634	-26.8282	-.9634	1.2105	136.0674	92.1147	-43.9527	50.4391
50.0000	.4491	1.6859	.8476	.6776	-.8330	12.6488	-1.4137	1.2434	140.2049	85.4797	-54.7252	51.1921
70.0000	.4283	1.7511	.9165	.7305	-.3023	1.1256	2.6477	1.2546	155.0761	48.3816	-110.6946	51.4437
75.0000	.4250	1.7646	.9366	.7742	-.2830	.7500	1.3116	1.2057	164.1574	36.8709	-127.3265	50.4216
80.0000	.4223	1.7744	.9572	.8341	-.1869	.4678	.7119	1.1436	165.4130	24.8359	-144.5771	48.9109

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TA2= .5000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.4999	2.0003	.8267	.8265	-1.2293	-1.2322	-.0011	1.0003	129.1267	129.0610	-.0657	45.0092
40.0000	.4772	2.0995	.8681	.7816	-.7963	-2.7974	-.5229	1.1110	141.4709	113.8924	-27.5784	48.0096
45.0000	.4728	2.1151	.8786	.7720	-.7127	-2.0969	-.7127	1.1381	144.5234	109.0467	-35.4767	48.4980
50.0000	.4685	2.1345	.8899	.7632	-.6290	-4.2777	-.9086	1.1661	147.0297	103.1579	-44.6718	49.3858
70.0000	.4566	2.1599	.9415	.7884	-.3059	2.1398	7.0149	1.2259	163.6239	64.5107	-98.1132	50.7804
75.0000	.4523	2.2160	.9556	.7944	-.2277	1.2260	2.0169	1.2000	167.1705	50.7977	-116.3731	50.1936
80.0000	.4507	2.2188	.9701	.8438	-.1512	.8991	.9509	1.1497	171.4011	34.9557	-136.4457	48.9838

TA2= .5000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5000	3.0002	.9068	.9067	-.7267	-.7279	-.0008	1.0001	143.5953	143.5506	-.0453	45.0098
40.0000	.4892	3.0663	.9292	.8011	-.5188	-1.0687	-.3537	1.0944	152.9787	133.0981	-15.4806	46.9227
45.0000	.4870	3.0801	.9348	.8738	-.4722	-1.7159	-.4722	1.0658	154.7222	129.4443	-25.2778	46.9312
50.0000	.4848	3.0528	.9408	.8655	-.4234	-1.4956	-.6299	1.0870	157.0920	124.8608	-32.1931	47.3861
70.0000	.4777	3.1463	.9685	.8350	-.2154	245.7388	-4.7361	1.1550	167.0442	89.7665	-76.0773	49.2326
75.0000	.4769	3.1480	.9761	.8409	-.1618	3.4044	7.9410	1.1614	170.8081	73.6307	-97.1774	49.2703
80.0000	.4756	3.1537	.9839	.8647	-.1080	1.3276	1.6758	1.1319	173.8364	53.0107	-120.8298	48.6896

TA2= .5000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5000	5.0001	.9626	.9626	-.4121	-.4127	-.0005	1.0000	157.4040	157.3763	-.0277	45.0014
40.0000	.4960	5.0407	.9719	.9516	-.3081	-.5594	-.2144	1.0208	162.8779	150.7274	-12.0959	45.5907
45.0000	.4951	5.0453	.9737	.9480	-.2829	-.6150	-.2829	1.0271	164.2032	148.4064	-15.7968	45.7645
50.0000	.4943	5.0578	.9761	.9436	-.2559	-.6907	-.3695	1.0344	165.6478	145.3679	-20.2799	45.9700
70.0000	.4919	5.0867	.9873	.9136	-.1338	-1.8116	-1.3504	1.0807	172.3773	118.8984	-53.4789	47.2280
75.0000	.4910	5.0516	.9904	.9045	-.1010	-4.0199	-2.7873	1.0949	174.2334	103.5696	-70.2638	47.5933
80.0000	.4907	5.0552	.9935	.9028	-.0676	6.3996	11.4000	1.1005	176.1319	81.1180	-95.0131	47.7198

TA2= .5000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5000	10.0001	.9902	.9902	-.2014	-.2016	-.0002	1.0000	168.6138	168.5999	-.0139	45.0003
40.0000	.4990	10.0206	.9925	.9872	-.1534	-.2655	-.1077	1.0059	171.2782	165.1314	-6.1468	45.1527
45.0000	.4988	10.0249	.9931	.9862	-.1414	-.2886	-.1414	1.0070	171.5504	163.9008	-8.0496	45.1896
50.0000	.4985	10.0292	.9937	.9848	-.1284	-.3190	-.1831	1.0090	172.4037	162.3061	-10.3770	45.2569
70.0000	.4978	10.0439	.9966	.9732	-.0680	-.6410	-.5450	1.0241	176.1089	147.3410	-28.7679	45.6832
75.0000	.4977	10.0464	.9975	.9666	-.0514	-.9113	-.8214	1.0319	177.0557	137.6569	-39.3993	45.9009
80.0000	.4976	10.0485	.9983	.9572	-.0345	-1.7333	-1.6030	1.0429	178.0247	119.9824	-58.0423	46.2029

TA2= .6000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5990	.0001	.2531	.2521	[illegible]	.1884	-.0004	1.0040	10.6899	10.6667	-.0232	45.1156
40.0000	.1321	.2329	.7351	.4971	-.8693	-9.5097	1.4753	1.4750	40.1334	-83.9973	-124.1305	55.9198
45.0000	.0923	.3600	.8105	.6700	1.0254	-1.9800	1.6253	1.2217	56.9580	-63.2041	-121.6021	50.6979
50.0000	.0741	.4957	.8636	.7610	1.6393	-1.1567	1.4980	1.1349	74.6198	-49.1066	-123.7262	48.6165
70.0000	.0491	.7276	.9491	.9160	-1.2002	-.3589	.6123	1.0362	129.8000	-18.7213	-148.5213	46.0174
75.0000	.0473	.7600	.9629	.9390	-.7661	-.2422	.4419	1.0255	142.5460	-13.6131	-156.1611	45.7199
80.0000	.0456	.7846	.9757	.9601	-.4618	-.1564	.2866	1.0162	155.1187	-6.8777	-164.0064	45.4616

TA2= .6000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5990	.1202	.2608	.2598	.3841	.3832	-.0008	1.0029	21.0108	20.9658	-.0450	45.1120
40.0000	.2139	.3366	.6241	.3542	1.2057	-1.7063	2.7563	1.7620	50.1282	-59.6269	-109.9547	60.4291
45.0000	.1184	.4275	.7058	.4982	2.0929	-1.2989	2.0929	1.4168	64.4617	-51.0767	-115.5384	54.7441
50.0000	.1409	.5110	.7655	.6092	4.9673	-.9010	1.6985	1.2651	79.6176	-42.0176	-120.6352	51.6743
70.0000	.0974	.7359	.9055	.9446	-1.1513	-.3060	.6751	1.0722	130.6781	-17.0143	-147.6926	46.9998
75.0000	.0933	.7721	.9306	.8856	-.7431	-.2203	.4493	1.0507	143.3937	-12.4230	-155.8075	46.4168
80.0000	.0503	.7953	.9542	.9243	-.4524	-.1429	.2907	1.0323	155.6979	-8.1308	-163.7883	45.9102

TA2= .6000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5991	.1803	.2729	.2719	.5933	.5917	-.0011	1.0037	30.6786	30.6143	-.0643	45.1069
40.0000	.2709	.3927	.5722	.3046	1.7291	-.7780	7.3419	1.8787	55.0717	-37.8849	-92.7566	61.9746
45.0000	.2280	.4737	.6427	.4131	2.9959	-.7514	2.9959	1.5558	71.5393	-36.0215	-108.4608	57.2696
50.0000	.1977	.5462	.7029	.5110	9.2491	-.6196	2.0105	1.3754	85.8424	-37.6029	-116.4453	53.9748
70.0000	.1429	.7587	.8716	.7676	-1.0876	-.2978	.6495	1.1069	132.7022	-14.4565	-147.1590	47.9046
75.0000	.1367	.7900	.9040	.8416	-.7102	-.1876	.4611	1.0791	144.6378	-10.0217	-154.7455	47.0772
80.0000	.1329	.8124	.9368	.8941	-.4358	-.1225	.2974	1.0477	156.4546	-6.9852	-163.4397	46.3393

TA2= .6000 TK= .5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5992	.3004	.3076	.3066	1.0927	1.0891	-.0016	1.0033	47.5361	47.4428	-.0934	45.0931
40.0000	.3495	.5151	.5392	.2081	3.9576	-.0757	-5.7569	1.8713	75.8135	-25.4209	-80.1458	61.8806
45.0000	.3140	.5732	.5736	.3523	11.1358	-.1013	11.1358	1.6847	84.6669	-10.2676	-95.1315	59.3080
50.0000	.2853	.6310	.6463	.4248	-12.2202	-.2198	3.2557	1.5215	94.6762	-12.3966	-107.0746	56.6850
70.0000	.2212	.8136	.8312	.7111	-.9370	-.1394	.7055	1.1240	136.8615	-7.9349	-144.7964	49.6544
75.0000	.2138	.8419	.8732	.7802	-.6339	-.1050	.4959	1.1192	147.6295	-5.9959	-153.6254	48.2186
80.0000	.2088	.8622	.9149	.8504	-.3956	-.0701	.3167	1.0758	158.4141	-4.0105	-162.4245	47.0907

TA2= .6000 TK= 1.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5995	.6003	.4224	.4216	4.3059	4.2661	-.0020	1.0020	76.9241	76.8077	-.1169	45.0581
40.0000	.4568	.7884	.5822	.3634	-4.9648	.9577	-1.9779	1.6023	101.3800	43.7620	-57.6260	58.0314
45.0000	.4335	.8258	.6191	.3833	-3.1156	.7157	-3.1156	1.6152	107.7950	35.5255	-72.2051	58.2369
50.0000	.4135	.8705	.6577	.4160	-2.1702	.5356	-10.6671	1.5809	114.7392	28.1738	-86.5654	57.6847
70.0000	.3580	1.0056	.8208	.6448	-.6728	.1635	.9396	1.2731	148.0673	9.2831	-138.7843	51.8507
75.0000	.3504	1.0275	.8636	.7212	-.4789	.1162	.6769	1.1974	156.4287	6.5125	-147.9158	50.1330
80.0000	.3450	1.0435	.9075	.8053	-.3077	.0724	.3887	1.1269	162.8565	4.1389	-158.7580	48.4153

TA2= .6000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5597	.9005	.5360	.5362	-10.4833	-10.6954	-.0019	1.0012	95.4490	95.3416	-.1074	45.0358
40.0000	.5096	1.0557	.6574	.4674	-2.0402	2.7169	-1.0471	1.4065	110.1114	65.7530	-44.3144	56.5805
45.0000	.4541	1.0528	.6856	.4700	-1.6469	1.9735	-1.6469	1.4588	121.2656	62.5312	-58.7345	55.5622
50.0000	.4797	1.1256	.7155	.4819	-1.3350	1.4141	-3.0967	1.4447	126.8363	54.7329	-72.1034	56.0384
70.0000	.4374	1.2346	.8481	.6434	-.5283	.4521	1.2879	1.3182	152.1557	24.3256	-127.8270	52.8161
75.0000	.4311	1.2525	.8842	.7139	-.3842	.3206	.8024	1.2385	158.5853	17.7436	-141.2217	51.0826
80.0000	.4267	1.2657	.5214	.7966	-.2506	.2053	.4807	1.1567	165.5255	11.6037	-154.3298	49.1547

TA2= .6000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5558	1.2004	.6327	.6322	-2.9919	-3.0081	-.0016	1.0008	108.4815	108.3886	-.0931	45.0232
40.0000	.5351	1.3356	.7255	.5644	-1.3755	19.6376	-.8078	1.2853	126.0166	87.0849	-38.9317	52.1162
45.0000	.5281	1.3674	.7475	.5587	-1.1773	6.0991	-1.1773	1.3376	130.3444	80.6887	-49.6557	53.2236
50.0000	.5176	1.3910	.7710	.5587	-.9992	3.3443	-1.8540	1.3758	135.0216	73.3573	-61.6643	54.0685
70.0000	.4856	1.4028	.8773	.6612	-.4377	.7856	1.8096	1.3269	152.3625	37.4375	-118.5249	52.5963
75.0000	.4806	1.4580	.9065	.7218	-.3220	.5295	1.0766	1.2559	162.1508	27.9014	-134.2473	51.4719
80.0000	.4771	1.5051	.9366	.7986	-.2118	.3342	.5876	1.1729	168.0432	18.4815	-149.5617	49.5456

TA2= .6000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5999	1.5003	.7080	.7076	-1.8602	-1.8665	-.0014	1.0006	118.2811	118.1809	-.0803	45.0160
40.0000	.5868	1.6165	.7806	.6459	-1.0601	-5.7859	-.6625	1.2081	133.3296	99.8058	-33.5237	50.3848
45.0000	.5486	1.6464	.7970	.6364	-.9309	-13.9630	-.9309	1.2539	137.0483	54.0589	-42.9518	51.4188
50.0000	.5408	1.6641	.8164	.6300	-.8077	21.4182	-1.3636	1.2958	141.0714	87.3269	-53.7445	52.3426
70.0000	.5162	1.7434	.9016	.6856	-.3740	1.1516	2.4755	1.3192	155.4962	45.0307	-110.4655	52.7523
75.0000	.5124	1.7566	.9251	.7350	-.2771	.7594	1.3128	1.2586	164.5106	37.2171	-127.2995	51.5316
80.0000	.5056	1.7662	.9494	.8040	-.1832	.4657	.7093	1.1807	169.6209	24.9651	-144.6517	49.7381

TA2= .6000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5999	1.8003	.7650	.7655	-1.3028	-1.3064	-.0012	1.0004	125.0726	125.0028	-.0698	45.0116
40.0000	.5680	1.9015	.8231	.7113	-.8692	-2.8007	-.5624	1.1571	135.0019	109.6453	-29.3522	49.1648
45.0000	.5618	1.5224	.8370	.7005	-.7743	-3.8667	-.7743	1.1548	142.2501	104.5001	-37.7500	50.0718
50.0000	.5558	1.5431	.8520	.6910	-.6804	-6.8796	-1.0913	1.2329	145.7891	98.2705	-47.4987	50.9541
70.0000	.5366	2.0127	.9208	.7119	-.3261	1.6855	4.4666	1.2925	161.5305	59.3194	-102.6154	52.2415
75.0000	.5335	2.0243	.9397	.7503	-.2428	1.0285	1.6945	1.2524	166.3517	45.8048	-120.5469	51.2943
80.0000	.5313	2.0328	.9593	.8108	-.1610	.6044	.8479	1.1837	170.8925	31.1475	-139.7051	49.7970

TA2= .6000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.5999	2.4002	.8436	.8434	-.9366	-.9384	-.0019	1.0002	136.8750	136.8207	-.0548	45.0068
40.0000	.5806	2.4800	.8812	.8032	-.6439	-1.4898	-.4717	1.0971	147.2213	123.8705	-23.3512	47.6510
45.0000	.5760	2.4565	.8505	.7930	-.5871	-1.7608	-.5821	1.1230	145.7569	119.5931	-30.2035	48.3148
50.0000	.5730	2.5130	.9005	.7822	-.5185	-2.2155	-.7897	1.1513	152.5917	114.2923	-38.2994	49.0719
70.0000	.5606	2.5685	.9468	.7625	-.2586	4.1861	-55.9124	1.2418	165.5015	76.5646	-88.9373	51.1554
75.0000	.5586	2.5778	.9596	.7820	-.1937	1.8071	3.0780	1.2271	165.0396	61.0413	-107.5983	50.8227
80.0000	.5571	2.5846	.9720	.8253	-.1290	.9221	1.1929	1.1787	172.6517	42.6778	-129.9739	49.6900

TA2= .6000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6000	3.6002	.9195	.9194	-.5840	-.5849	-.0007	1.0001	149.7162	149.6785	-.0377	45.0031
40.0000	.5905	3.6555	.9386	.8968	-.4267	-.8238	-.2938	1.0466	156.8914	140.5176	-16.3738	46.3045
45.0000	.5890	3.6670	.9433	.8859	-.3901	-.9202	-.3901	1.0601	158.6856	137.3787	-21.3107	46.6705
50.0000	.5872	3.6785	.9485	.8817	-.3513	-1.0575	-.5150	1.0757	160.6459	133.3959	-27.2464	47.0898
70.0000	.5810	3.7176	.9725	.8412	-.1811	-5.1179	-2.5620	1.1561	165.7345	101.0560	-68.6785	49.1418
75.0000	.5800	3.7242	.9792	.8386	-.1363	11.0250	-22.1804	1.1676	172.2358	84.8173	-87.4185	49.4716
80.0000	.5752	3.7250	.9860	.8543	-.0911	1.9331	2.4570	1.1542	174.7525	62.6468	-112.1461	49.0936

TA2= .6000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6000	6.0001	.9684	.9684	-.3391	-.3396	-.0004	1.0000	161.2660	161.2430	-.0230	45.0011
40.0000	.5966	6.0340	.9758	.9590	-.2555	-.4547	-.1785	1.0175	165.6660	155.5477	-10.1183	45.4976
45.0000	.5959	6.0411	.9777	.9559	-.2350	-.4975	-.2350	1.0228	166.7738	153.5475	-13.2262	45.6464
50.0000	.5952	6.0482	.9797	.9519	-.2129	-.5549	-.3059	1.0292	167.9814	150.5725	-17.0089	45.8244
70.0000	.5528	6.0724	.9892	.9225	-.1119	-1.2856	-1.0260	1.0724	173.6132	127.8774	-45.7359	46.9996
75.0000	.5524	6.0765	.9918	.9108	-.0845	-2.7289	-1.8044	1.0889	175.1679	114.1632	-61.0047	47.4371
80.0000	.5922	6.0759	.9945	.9027	-.0566	-30.0519	-11.1013	1.1017	176.7586	91.5095	-84.8527	47.7704

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TN2= .6000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6000	12.0001	.9918	.9918	-.1673	-.1675	-.0002	1.0000	170.5020	170.4904	-.0116	45.0003
40.0000	.5991	12.0172	.9937	.9893	-.1277	-.2109	-.0897	1.0045	172.7231	167.5961	-5.1270	45.1276
45.0000	.5990	12.0208	.9942	.9884	-.1178	-.2380	-.1178	1.0058	173.2836	166.5673	-6.7164	45.1669
50.0000	.5986	12.0244	.9947	.9873	-.1070	-.2636	-.1523	1.0075	173.8552	165.2329	-8.6623	45.2148
70.0000	.5982	12.0366	.9972	.9771	-.0567	-.5184	-.4685	1.0209	176.7628	152.5950	-24.1570	45.5825
75.0000	.5981	12.0387	.9979	.9710	-.0429	-.7193	-.6961	1.0274	177.5429	144.2743	-33.2686	45.7809
80.0000	.5980	12.0402	.9986	.9615	-.0288	-1.2496	-1.1784	1.0386	178.3519	128.6696	-49.6819	46.0843

TN2= .7000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6991	.0701	.1214	.1207	.2774	.2770	-.0003	1.0035	15.5018	15.4820	-.0198	45.0989
40.0000	.3110	.1575	.4423	.1419	.5188	3.1751	1.0035	3.1177	27.4188	-107.4817	-134.9005	72.2165
45.0000	.2052	.2388	.5894	.3473	.8424	5.8006	.8424	1.6560	40.1093	-99.7815	-135.9908	59.4866
50.0000	.1406	.3488	.7130	.5444	1.6478	-4.9847	.9196	1.3096	58.7483	-78.6563	-137.4047	52.6343
70.0000	.0771	.6359	.9044	.8549	-1.4849	-.5397	.5245	1.0579	123.5659	-28.3553	-152.4206	46.6128
75.0000	.0728	.6732	.9307	.8951	-.8901	-.3740	.3872	1.0398	138.3290	-20.5067	-158.8357	46.1177
80.0000	.0700	.6557	.9547	.9314	-.5233	-.2371	.2546	1.0250	152.3770	-13.3383	-165.7153	45.7072

TN2= .7000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6992	.1402	.1944	.1938	.5714	.5705	-.0007	1.0034	29.7439	29.7054	-.0385	45.0960
40.0000	.3615	.2711	.4199	.1447	1.0894	-1.6759	3.3715	2.9019	47.3440	-59.1769	-106.5206	70.9859
45.0000	.2904	.3375	.5093	.2594	1.5817	-2.1066	1.5817	1.9636	57.8969	-64.6062	-122.3032	63.0117
50.0000	.2362	.4150	.5977	.3884	2.8804	-1.5864	1.2514	1.5350	70.8545	-57.7749	-128.8295	56.9847
70.0000	.1488	.6553	.8360	.7503	-1.3272	-.4508	.5483	1.1142	126.5978	-24.2645	-151.2626	48.0930
75.0000	.1411	.6548	.8790	.8151	-.8258	-.3192	.4009	1.0784	140.4511	-17.7039	-158.1550	47.1609
80.0000	.1362	.7157	.9198	.8767	-.4936	-.2049	.2622	1.0491	153.7285	-11.5774	-165.3059	46.3738

TN2= .7000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6992	.2102	.2141	.2134	.9024	.9006	-.0010	1.0032	42.0815	42.0065	-.0551	45.0916
40.0000	.4053	.3627	.4172	.1594	1.9095	-.5078	-79.8018	2.6169	62.3585	-26.9231	-89.2820	69.0866
45.0000	.3455	.4201	.4848	.2351	2.9551	-.7643	2.9551	2.0625	71.3044	-37.3912	-108.6557	64.1138
50.0000	.3042	.4832	.5590	.3293	7.1281	-.7782	1.7387	1.6850	82.0141	-37.8911	-119.9052	59.3124
70.0000	.2117	.6542	.7954	.6824	-1.1588	-.3428	.5839	1.1656	130.7538	-16.9238	-149.7176	49.3719
75.0000	.2023	.7267	.8469	.7602	-.7493	-.2490	.4216	1.1140	143.1944	-13.9847	-157.1392	48.0863
80.0000	.1960	.7499	.8973	.8375	-.4564	-.1623	.2738	1.0714	155.4680	-9.2190	-164.6870	46.9745

TN2= .7000 TK= .5000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6993	.3503	.2660	.2652	1.8096	1.8035	-.0014	1.0028	61.0722	60.9523	-.0800	45.0798
40.0000	.4725	.5186	.4438	.2041	8.3896	.2306	-2.7801	2.1745	85.2025	12.9864	-70.2161	65.3039
45.0000	.4331	.5657	.4939	.2439	-105.2860	.0190	-105.3048	2.0248	95.5442	1.0883	-85.4559	63.7165
50.0000	.3984	.6149	.5472	.3029	-6.3919	-.1035	3.7851	1.8066	98.9518	-5.5071	-104.7989	61.0337
70.0000	.3120	.7832	.7677	.6145	-.9015	-.1379	.6792	1.2463	137.5652	-7.8516	-145.8168	51.3242
75.0000	.3023	.8105	.8234	.7017	-.6158	-.1072	.4771	1.1734	140.2749	-6.1177	-154.4927	49.9622
80.0000	.2951	.8103	.8801	.7936	-.3864	-.0729	.3049	1.1090	158.8747	-4.1675	-163.0426	47.9587

TN2= .7000 TK= 1.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6996	.7006	.4146	.4139	74.5433	65.9740	-.0017	1.0017	89.2314	89.1316	-.0998	45.0498
40.0000	.5702	.8553	.3567	.3399	-2.7616	1.7126	-1.1957	1.6322	105.5055	-59.7184	-50.1875	58.5935
45.0000	.5478	.8945	.5896	.3476	-2.1077	1.2246	-2.1077	1.4922	115.3824	50.7648	-64.6175	58.4781
50.0000	.5270	.9298	.6270	.3683	-1.6395	.8907	-5.4976	1.7026	121.3808	41.6900	-79.6508	55.5725
70.0000	.4670	1.0493	.7976	.5840	-.5971	.2594	1.0136	1.3657	145.1597	14.5417	-134.6180	51.7882
75.0000	.4583	1.0651	.8448	.6682	-.4303	.1904	.6621	1.2643	156.7175	10.2261	-146.4914	51.6571
80.0000	.4522	1.0837	.8941	.7647	-.2791	.1140	.4060	1.1652	164.4078	6.5044	-157.9032	49.4603

TN2= .7000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6597	1.0504	.5468	.5462	-3.5334	-3.5552	-.0016	1.0011	105.0621	105.7100	-.0921	45.0107
40.0000	.6192	1.1870	.6397	.4703	-1.5085	8.2449	-.8428	1.3542	125.5415	83.0846	-40.4570	54.3496
45.0000	.6046	1.2157	.6822	.4654	-1.2797	4.0138	-1.2797	1.4659	128.0052	76.0103	-51.5949	55.6987
50.0000	.5907	1.2443	.7108	.4681	-1.0779	2.4479	-2.1819	1.6184	132.8521	67.9420	-64.9107	56.3719
70.0000	.5484	1.3403	.8427	.6027	-.4630	.6182	1.5148	1.3982	155.1593	31.7241	-127.4311	54.4770
75.0000	.5420	1.3562	.8767	.6754	-.3398	.4291	.9002	1.3025	161.2124	23.2246	-138.0078	52.4842
80.0000	.5373	1.3679	.9181	.7654	-.2231	.2713	.5263	1.1995	167.4250	15.1812	-152.2439	50.1435

TN2= .7000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6598	1.4003	.6564	.6499	-1.9277	-1.9343	-.0016	1.0007	117.4176	117.3370	-.0798	45.0199
40.0000	.6461	1.5168	.7342	.5799	-1.0904	-6.6592	-.6741	1.2661	132.5247	98.9462	-33.9946	51.6969
45.0000	.6360	1.5409	.7566	.5695	-.9962	-22.3395	-.9962	1.3251	136.2818	92.5631	-43.7185	52.9061
50.0000	.6262	1.5649	.7768	.5630	-.8286	12.9610	-1.4232	1.3797	140.3568	85.4482	-54.9065	54.0648
70.0000	.5956	1.6495	.8791	.6337	-.3022	1.0393	2.3581	1.3813	155.0856	46.1071	-112.9805	54.2142
75.0000	.5907	1.6585	.9077	.6922	-.2830	.6898	1.2088	1.3113	164.1568	34.5575	-125.5993	52.4718
80.0000	.5873	1.6688	.9374	.7725	-.1870	.4249	.6642	1.2135	169.4085	23.0812	-146.4077	50.5091

TN2= .7000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6999	1.7503	.7279	.7276	-1.3695	-1.3729	-.0012	1.0005	126.1371	126.0684	-.0688	45.0137
40.0000	.6620	1.8504	.7929	.6665	-.8655	-2.7593	-.5589	1.1097	135.1220	109.9212	-29.2016	49.9507
45.0000	.6547	1.8711	.8089	.6542	-.7719	-3.8127	-.7719	1.2343	142.3484	104.6568	-37.6516	51.0322
50.0000	.6476	1.8917	.8261	.6435	-.6774	-6.0199	-1.0915	1.2838	145.8467	98.3418	-47.5049	52.0827
70.0000	.6247	1.9611	.9062	.6680	-.3257	1.6798	4.1676	1.2566	161.9805	58.4681	-103.4578	53.6090
75.0000	.6210	1.9726	.9285	.7122	-.2425	.9450	1.6313	1.3038	166.2662	44.9565	-121.5093	52.5170
80.0000	.6183	1.9811	.9517	.7814	-.1609	.5848	.8731	1.2178	170.8812	30.3174	-140.9437	50.6095

TN2= .7000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6999	2.1003	.7853	.7850	-1.0758	-1.0781	-.0010	1.0003	132.9088	132.8490	-.0599	45.0100
40.0000	.6720	2.1874	.8364	.7330	-.7208	-1.8258	-.4771	1.1410	144.2168	118.7098	-25.5070	48.7681
45.0000	.6665	2.2055	.8490	.7208	-.6487	-2.2397	-.6487	1.1779	141.0303	114.0806	-32.9657	49.6696
50.0000	.6611	2.2235	.8626	.7086	-.5754	-3.0189	-.8927	1.2174	150.0841	108.3272	-41.7569	50.6003
70.0000	.6436	2.2841	.9261	.7020	-.2833	2.6283	11.4038	1.3153	164.1807	65.1652	-99.0115	52.8392
75.0000	.6407	2.2942	.9438	.7331	-.2118	1.3849	2.2593	1.2875	168.0415	54.1670	-113.8749	52.1630
80.0000	.6387	2.3017	.9620	.7910	-.1408	.7599	1.0087	1.2163	171.5825	37.2316	-134.7513	50.5738

TN2= .7000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.6999	2.8002	.8598	.8596	-.7633	-.7646	-.0008	1.0002	142.6442	142.5973	-.0469	45.0058
40.0000	.6832	2.8608	.8929	.8275	-.5420	-1.1370	-.3682	1.0857	151.5441	131.3320	-20.2114	47.3518
45.0000	.6798	2.8831	.9012	.8121	-.4928	-1.3016	-.4928	1.1096	153.7676	127.5351	-26.2324	47.9751
50.0000	.6765	2.8573	.9102	.8006	-.4414	-1.5535	-.6597	1.1368	156.1846	122.7706	-33.4140	48.6634
70.0000	.6654	2.9455	.9519	.7630	-.2238	16.5655	-6.2003	1.2476	167.3839	86.5455	-80.8381	51.2865
75.0000	.6636	2.9525	.9635	.7737	-.1681	2.7867	5.5577	1.2453	170.4597	70.2596	-100.2001	51.2346
80.0000	.6623	2.9555	.9754	.8104	-.1121	1.1902	1.5029	1.2035	173.6026	49.9630	-123.6397	50.2768

TN2= .7000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7000	4.2001	.9294	.9293	-.4900	-.4907	-.0006	1.0001	153.8543	153.8620	-.0324	45.0027
40.0000	.6922	4.2476	.9460	.9091	-.3629	-.6758	-.2513	1.0405	160.0562	145.9437	-14.1084	46.1373
45.0000	.6905	4.2536	.9501	.9027	-.3326	-.7479	-.3326	1.0525	161.6034	143.7048	-18.3986	46.4651
50.0000	.6889	4.2675	.9547	.8950	-.3002	-.8478	-.4365	1.0667	163.2884	139.7092	-23.5792	46.8474
70.0000	.6835	4.3012	.9758	.8495	-.1561	-2.7310	-1.8054	1.1486	171.1285	110.1105	-61.0180	48.9571
75.0000	.6826	4.3069	.9817	.8407	-.1177	-13.4219	-5.1983	1.1676	173.2895	94.2610	-79.0285	49.4222
80.0000	.6820	4.3110	.9877	.8477	-.0787	2.9621	3.9656	1.1651	175.4591	71.3454	-104.1537	49.3603

TN2= .7000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7000	7.0001	.9727	.9726	-.2885	-.2989	-.0003	1.0000	163.9054	163.8857	-.0198	45.0010
40.0000	.6971	7.0252	.9791	.9645	-.2184	-.3841	-.1529	1.0151	167.6796	158.9886	-8.6910	45.4293
45.0000	.6965	7.0333	.9807	.9617	-.2011	-.4191	-.2011	1.0197	168.6303	157.2614	-11.3653	45.5590
50.0000	.6959	7.0414	.9824	.9582	-.1823	-.4656	-.2611	1.0253	169.6677	155.0321	-14.6357	45.7152
70.0000	.6938	7.0622	.9906	.9302	-.0962	-1.0120	-.8347	1.0649	174.5075	134.6874	-39.8901	46.8011
75.0000	.6935	7.0657	.9929	.9175	-.0727	-1.5919	-1.3617	1.0822	175.8443	122.1362	-53.7081	47.2616
80.0000	.6932	7.0683	.9952	.9049	-.0487	-5.1869	-4.1021	1.0558	177.2122	100.9123	-76.2599	47.7215

TN2= .7000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7000	14.0000	.9929	.9929	-.1431	-.1433	-.0002	1.0000	171.8535	171.8440	-.0100	45.0002
40.0000	.6993	14.0147	.9946	.9908	-.1094	-.1878	-.0769	1.0038	173.7581	169.3611	-4.3970	45.1096
45.0000	.6991	14.0178	.9950	.9900	-.1009	-.2039	-.1009	1.0050	174.2308	168.4775	-5.7612	45.1434
50.0000	.6990	14.0209	.9955	.9891	-.0917	-.2248	-.1305	1.0065	174.7632	167.3307	-7.4325	45.1847
70.0000	.6984	14.0314	.9976	.9801	-.0487	-.4367	-.3799	1.0178	177.2142	156.4114	-20.8029	45.5064
75.0000	.6983	14.0332	.9982	.9746	-.0368	-.5975	-.5486	1.0242	177.8520	149.1426	-28.7496	45.6956
80.0000	.6983	14.0345	.9988	.9653	-.0247	-.9907	-.9429	1.0347	178.5857	135.2698	-43.3169	45.9774

TN2= .8000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7992	.0801	.1197	.1194	.4527	.4523	-.0003	1.0030	24.3549	24.3375	-.0173	45.0865
40.0000	.4875	.1313	.2443	.0333	.6060	-3.2824	3.9317	7.3340	31.2139	-73.0564	-104.2703	82.2355
45.0000	.3991	.1603	.3166	.0965	.7199	2.9891	.7199	3.2194	35.7513	-108.4574	-144.2497	72.7441
50.0000	.3025	.2115	.4136	.2166	.9822	3.3700	.5540	1.9058	44.4845	-106.5278	-151.0172	62.3622
70.0000	.1244	.5147	.8046	.7333	-2.1549	-.9166	.4182	1.0971	114.6528	-42.5053	-157.4070	47.6520
75.0000	.1145	.5590	.8589	.8072	-1.1188	-.5905	.3181	1.0640	131.7897	-30.5632	-162.3529	46.7762
80.0000	.1085	.5859	.9076	.8734	-.6215	-.3600	.2137	1.0392	146.1374	-15.7991	-167.9366	46.1005

TN2= .8000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7993	.1601	.1419	.1415	.9575	.9564	-.0006	1.0029	43.7562	43.7229	-.0337	45.0840
40.0000	.5132	.2454	.2725	.0632	1.4628	-.9097	-7.7518	4.3129	59.6427	-27.0066	-92.6493	76.9489
45.0000	.4443	.2881	.3286	.1079	1.8553	-1.5194	1.8553	3.0436	61.6757	-56.6480	-118.3245	71.8118
50.0000	.3775	.3390	.4004	.1902	2.7995	-1.9286	1.0748	2.1054	70.3430	-62.5929	-132.9393	64.5938
70.0000	.2263	.5656	.7200	.6098	-1.5229	-.6204	.4639	1.1825	123.2975	-31.8149	-155.1118	49.7800
75.0000	.2123	.6030	.7904	.7048	-.9135	-.4318	.3454	1.1219	137.5854	-23.3535	-160.9433	48.2778
80.0000	.2032	.6259	.8591	.7995	-.5363	-.2739	.2288	1.0745	151.7950	-15.3154	-167.1144	47.0576

MUB-12612

TN2= .8000 TK= .3000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7993	.2402	.1723	.1718	1.5889	1.5958	-.0008	1.0028	57.8131	57.7649	-.0482	45.0801
40.0000	.5426	.3538	.3087	.0960	3.2475	.0261	-2.9653	3.2170	72.8602	1.4955	-71.3643	72.7322
45.0000	.4874	.3939	.3586	.1286	5.1938	-.3999	5.1938	2.7087	75.1018	-21.7984	-100.8983	70.2724
50.0000	.4357	.4407	.4180	.1914	19.4362	-.6280	1.7905	2.1840	87.0547	-32.1255	-119.1842	69.3980
70.0000	.3058	.6278	.6971	.5569	-1.1585	-.3941	.5247	1.2516	130.8000	-21.5118	-152.3126	51.3767
75.0000	.2910	.6558	.7691	.6577	-.7539	-.2894	.3813	1.1694	142.5868	-16.1413	-159.1282	49.4654
80.0000	.2611	.6830	.8426	.7630	-.4603	-.1896	.2489	1.1046	155.2848	-10.7360	-166.0217	47.8189

TN2= .8000 TK= .5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7994	.4003	.2428	.2422	4.0104	3.9896	-.0012	1.0024	75.9987	75.9287	-.0699	45.0698
40.0000	.5959	.5370	.3847	.1654	-14.5206	.7072	-1.6429	2.3260	93.5396	35.2675	-58.6721	66.7360
45.0000	.5565	.5746	.4277	.1830	-5.7913	.3560	-5.7914	2.3379	99.7568	19.5935	-80.2033	66.8422
50.0000	.5206	.6147	.4763	.2227	-3.3530	.1275	6.0798	2.1389	106.6068	7.2665	-99.3403	64.9426
70.0000	.4203	.7614	.7104	.5256	-.8146	-.0968	.6653	1.3515	140.8343	-5.5308	-146.3649	53.5011
75.0000	.4069	.7869	.7767	.6257	-.5677	-.0818	.4644	1.2413	150.4161	-4.6756	-155.0917	51.1458
80.0000	.3976	.8049	.8465	.7361	-.3603	-.0582	.2959	1.1459	160.1842	-3.3334	-163.5179	48.5885

TN2= .8000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7996	.8004	.4190	.4183	-5.6888	-5.7401	-.0015	1.0015	95.9695	99.8826	-.0873	45.0436
40.0000	.6826	.5376	.5455	.3359	-1.8946	3.4898	-.9595	1.6239	111.6260	74.0109	-43.8157	58.3748
45.0000	.6611	.5680	.5782	.3343	-1.5660	2.1564	-1.5660	1.7295	122.5606	65.1211	-57.4355	59.9627
50.0000	.6408	.5987	.6141	.3442	-1.2905	1.4472	-3.1733	1.7843	127.7722	55.2632	-72.5089	60.7325
70.0000	.5757	1.1041	.7853	.5361	-.5252	.3723	1.1155	1.4646	152.2522	20.4183	-131.8739	55.6760
75.0000	.5705	1.1218	.8346	.6245	-.3828	.2564	.7088	1.3364	155.0531	14.3813	-144.6718	53.1936
80.0000	.5640	1.1349	.8867	.7300	-.2901	.1611	.4284	1.2147	165.5574	9.1498	-156.8078	50.5365

TN2= .8000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7998	1.2004	.5626	.5621	-2.2181	-2.2264	-.0014	1.0009	114.2680	114.1875	-.0806	45.0268
40.0000	.7273	1.3199	.6629	.4828	-1.2006	-14.0371	-.7190	1.3721	129.7515	94.0749	-35.7166	53.9160
45.0000	.7137	1.3451	.6875	.4727	-1.0460	22.2477	-1.0460	1.4545	133.7132	87.4264	-46.2868	55.4910
50.0000	.7006	1.3703	.7147	.4682	-.9009	5.4028	-1.6299	1.5266	137.5834	79.5138	-58.4696	56.7736
70.0000	.6556	1.4554	.8431	.5721	-.4086	.8122	1.8274	1.4737	157.7734	39.0846	-118.6888	55.8412
75.0000	.6532	1.4656	.8797	.6439	-.3019	.5477	1.0179	1.3662	163.1590	28.7083	-134.4907	53.7966
80.0000	.6486	1.4801	.9181	.7385	-.1991	.3401	.5784	1.2432	168.7372	18.7830	-149.9542	51.1880

TN2= .8000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7598	1.6003	.6697	.6693	-1.4526	-1.4564	-.0012	1.0006	124.5434	124.4736	-.0698	45.0174
40.0000	.7518	1.7025	.7464	.5994	-.9067	-3.1260	-.5788	1.2454	137.8028	107.7352	-30.0635	51.2373
45.0000	.7426	1.7238	.7655	.5860	-.8065	-4.6136	-.8065	1.3063	141.1149	102.2290	-38.8851	52.5661
50.0000	.7335	1.7490	.7862	.5749	-.7077	-10.3733	-1.1588	1.3677	144.7128	95.5064	-49.2065	53.8269
70.0000	.7047	1.8165	.8835	.6146	-.3377	1.3931	3.2687	1.4375	161.3389	54.3282	-107.0107	55.1763
75.0000	.7001	1.8284	.9110	.6686	-.2513	.8722	1.4388	1.3627	165.8535	41.0935	-124.8001	53.7266
80.0000	.6567	1.8372	.9396	.7497	-.1666	.5193	.7508	1.2533	170.5431	27.4426	-143.1005	51.4136

TN2= .8000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7999	2.0003	.7472	.7468	-1.0977	-1.1001	-.0011	1.0004	132.3323	132.2721	-.0602	45.0120
40.0000	.7662	2.0881	.8062	.6876	-.7337	-1.8872	-.4837	1.1729	143.7339	117.9191	-25.8148	49.5393
45.0000	.7596	2.1064	.8209	.6739	-.6599	-2.3382	-.6599	1.2182	146.5777	113.1554	-33.4223	50.6170
50.0000	.7531	2.1246	.8369	.6604	-.5851	-3.2181	-.9133	1.2672	149.6668	107.2620	-42.4047	51.7216
70.0000	.7319	2.1860	.9117	.6577	-.2877	2.3700	8.3539	1.3863	163.5493	67.1231	-56.8261	54.1945
75.0000	.7285	2.1563	.9327	.6948	-.2150	1.2049	2.0724	1.3424	167.8633	52.1064	-115.7598	53.3163
80.0000	.7260	2.2038	.9545	.7618	-.1430	.7136	.9538	1.2529	171.8642	35.5098	-136.3544	51.4047

TN2= .8000 TK= 3.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.7999	2.4002	.8029	.8027	-.8881	-.8897	-.0009	1.0003	138.3927	138.3403	-.0524	45.0087
40.0000	.7752	2.4767	.8490	.7533	-.6172	-1.3865	-.4146	1.1270	148.3182	125.7998	-22.5184	48.4178
45.0000	.7703	2.4527	.8605	.7405	-.5590	-1.6259	-.5590	1.1621	150.7966	121.5932	-29.2034	49.2870
50.0000	.7654	2.5085	.8730	.7269	-.4988	-2.0199	-.7577	1.2011	153.4900	116.3353	-37.1507	50.2202
70.0000	.7494	2.5621	.9316	.6982	-.2500	4.6865	-28.7289	1.3341	165.5613	77.9545	-88.0064	53.1468
75.0000	.7468	2.5711	.9479	.7210	-.1874	1.8756	3.1813	1.3147	169.3849	61.9350	-107.4499	52.7433
80.0000	.7448	2.5777	.5648	.7741	-.1249	.9350	1.2000	1.2463	172.8823	43.0773	-125.8050	51.2579

TN2= .8000 TK= 4.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.8000	3.2002	.8734	.8732	-.6473	-.6483	-.0007	1.0002	147.0865	147.0456	-.0411	45.0051
40.0000	.7852	3.2603	.5030	.8390	-.4686	-.9295	-.3210	1.0763	154.8518	137.0536	-17.7982	47.1051
45.0000	.7822	3.2729	.9104	.8289	-.4276	-1.0467	-.4276	1.0984	156.8467	133.6935	-23.1533	47.6941
50.0000	.7792	3.2856	.9185	.8173	-.3844	-1.2178	-.5677	1.1239	158.9738	129.3923	-29.5815	48.3389
70.0000	.7693	3.3275	.9563	.7673	-.1971	-11.2573	-3.4361	1.2463	168.8500	95.0764	-73.7736	51.2569
75.0000	.7676	3.3350	.9668	.7698	-.1483	4.9700	18.7797	1.2559	171.5672	78.5110	-93.0562	51.4721
80.0000	.7664	3.3402	.5776	.7588	-.0990	1.5269	1.9184	1.2240	174.3446	56.8131	-117.5315	50.7503

TN2= .8000 TK= 6.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.8000	4.0001	.9372	.9371	-.4230	-.4236	-.0005	1.0001	157.0722	157.0439	-.0283	45.0023
40.0000	.7931	4.0417	.9519	.9190	-.3159	-.5756	-.2196	1.0398	162.4704	150.0832	-12.3812	46.0062
45.0000	.7917	4.0564	.9556	.9131	-.2900	-.6333	-.2900	1.0465	163.8278	147.6555	-16.1722	46.3914
50.0000	.7903	4.0591	.9596	.9059	-.2622	-.7121	-.3791	1.0553	165.3067	144.5442	-20.7625	46.6458
70.0000	.7855	4.0888	.9784	.8585	-.1371	-1.9740	-1.4141	1.1358	172.1960	117.4627	-54.7334	49.7367
75.0000	.7847	4.0937	.9836	.8451	-.1034	-4.6055	-3.0497	1.1635	174.0563	102.2505	-71.8457	49.3315
80.0000	.7841	4.0574	.9890	.8442	-.0692	5.2256	8.2954	1.1715	176.0355	79.1684	-96.8735	49.5159

TN2= .8000 TK=10.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.8000	8.0001	.9759	.9759	-.2513	-.2516	-.0003	1.0000	165.8562	165.8789	-.0173	45.0008
40.0000	.7975	8.0255	.9816	.9687	-.1908	-.3329	-.1337	1.0133	165.2002	161.5652	-7.6130	45.3772
45.0000	.7965	8.0309	.9830	.9662	-.1757	-.3627	-.1757	1.0175	170.0332	160.0665	-9.9668	45.4920
50.0000	.7964	8.0362	.9845	.9631	-.1594	-.4019	-.2279	1.0223	170.5418	158.1025	-12.8359	45.6307
70.0000	.7946	8.0545	.9918	.9369	-.0863	-.8412	-.7064	1.0586	175.1877	135.5700	-35.2537	46.6295
75.0000	.7943	8.0575	.9938	.9238	-.0637	-1.2575	-1.1053	1.0748	176.3558	128.4925	-47.8629	47.0904
80.0000	.7941	8.0558	.9958	.9084	-.0427	-2.9947	-2.6174	1.0963	177.5552	108.4652	-65.0900	47.6291

TN2= .8000 TK=20.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.8000	16.0000	.9938	.9938	-.1251	-.1253	-.0002	1.0000	172.8694	172.8607	-.0093	45.0002
40.0000	.7994	16.0129	.9953	.9919	-.0957	-.1640	-.0673	1.0034	174.4358	170.6670	-3.8477	45.0960
45.0000	.7992	16.0156	.9956	.9913	-.0883	-.1779	-.0883	1.0044	174.5565	169.9125	-5.0436	45.1257
50.0000	.7991	16.0183	.9960	.9904	-.0802	-.1961	-.1141	1.0057	175.4155	168.5077	-6.5078	45.1620
70.0000	.7986	16.0275	.9979	.9824	-.0426	-.3778	-.3299	1.0157	177.3611	159.3028	-18.2583	45.4477
75.0000	.7985	16.0291	.9984	.9774	-.0322	-.5125	-.4725	1.0215	178.1544	152.8627	-25.2913	45.6096
80.0000	.7985	16.0302	.9989	.9685	-.0216	-.8266	-.7909	1.0314	178.7618	140.4224	-38.3396	45.8849

TN2= 1.0000 TK= .1000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9994	.1001	.0500	.0499	-19.9517	-20.0486	-.0002	1.0024	52.8694	92.4559	-.0139	45.0692
40.0000	.7705	.1258	.0642	.0170	-8.3940	3.2992	-.4381	4.4878	56.7328	73.1376	-23.6563	78.6136
45.0000	.7139	.1401	.0962	.0096	-6.7740	.3018	-6.7743	10.1814	58.2576	16.7949	-81.6028	86.3905
50.0000	.6532	.1531	.1176	.0275	-5.3340	-.9420	.7291	5.2184	100.6129	-43.2503	-141.9033	79.1520
70.0000	.4605	.2448	.3213	.2142	-1.5245	-1.0227	.1963	1.3715	122.2637	-45.6305	-168.8940	53.9108
75.0000	.3640	.2747	.4322	.3533	-1.0088	-.7385	.1549	1.2232	134.3478	-36.4465	-171.1943	50.7319
80.0000	.3325	.3007	.5777	.5129	-.6112	-.4716	.1084	1.1262	148.5445	-25.2494	-173.8143	48.3975

TN2= 1.0000 TK= .2000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9994	.2001	.0996	.0994	-9.9764	-10.0238	-.0005	1.0023	55.7241	55.6972	-.0269	45.0672
40.0000	.7824	.2556	.1632	.0478	-4.3187	2.4108	-.7133	3.8168	103.0372	67.5383	-35.4989	75.3184
45.0000	.7313	.2735	.1875	.0352	-3.5292	.6162	-3.5293	5.3329	105.8200	31.6358	-74.1802	79.3755
50.0000	.6783	.2548	.2194	.0511	-2.8315	-.1505	1.8757	4.2949	105.4520	-8.5612	-118.0132	76.8930
70.0000	.4921	.4064	.4665	.3206	-.9575	-.4709	.3353	1.4565	136.2450	-25.2131	-161.4621	55.5271
75.0000	.4625	.4324	.5683	.4407	-.6703	-.3626	.2475	1.2895	146.1665	-19.9303	-166.0972	52.2074
80.0000	.4417	.4528	.6887	.5884	-.4250	-.2438	.1642	1.1705	156.9742	-13.6991	-170.6734	49.4927

TN2= 1.0000 TK= .3000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9994	.3002	.1485	.1482	-6.6519	-6.6820	-.0007	1.0022	58.5500	98.5115	-.0385	45.0641
40.0000	.7987	.3756	.2343	.0769	-2.9946	2.5739	-.8302	3.0448	108.4661	68.7681	-39.6980	71.8184
45.0000	.7535	.3579	.2646	.0700	-2.4826	.9618	-2.4826	3.7792	111.5416	43.8831	-68.0585	75.1787
50.0000	.7038	.4223	.3025	.0848	-2.0280	.2703	5.0061	3.5664	116.2482	15.1248	-101.1236	74.3360
70.0000	.5602	.5356	.5512	.3617	-.7575	-.2241	.4560	1.5740	142.8565	-12.6324	-155.4893	56.7288
75.0000	.5373	.5583	.6416	.4787	-.5418	-.1845	.3248	1.3405	151.5525	-10.4555	-162.0080	53.2776
80.0000	.5211	.5757	.7452	.6153	-.3490	-.1293	.2102	1.2024	160.7595	-7.3651	-168.1286	50.2743

TN2= 1.0000 TK= .5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9595	.5002	.2428	.2423	-3.9917	-4.0083	-.0010	1.0020	104.0642	104.0083	-.0555	45.0558
40.0000	.8343	.5553	.3530	.1573	-1.9604	4.2629	-.8459	2.2437	117.0255	76.7583	-40.2276	65.9778
45.0000	.8002	.6248	.3871	.1499	-1.6648	1.8796	-1.6648	2.5830	120.9527	61.9854	-55.0074	68.8362
50.0000	.7665	.6519	.4273	.1584	-1.3967	.9721	-6.6215	2.6972	125.6008	44.1885	-81.4119	69.6573
70.0000	.6617	.7556	.6530	.4046	-.5795	.0787	.6897	1.6140	145.5060	4.5002	-145.4058	58.2151
75.0000	.6456	.7745	.7270	.5148	-.4222	.0367	.4661	1.4124	157.1123	2.1046	-155.0076	54.7009
80.0000	.6340	.7886	.8089	.6469	-.2756	.0152	.2920	1.2504	164.5518	.8680	-163.7238	51.3456

TN2= 1.0000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9997	1.0003	.4475	.4469	-1.9970	-2.0031	-.0012	1.0012	116.6000	116.5301	-.0698	45.0349
40.0000	.9029	1.1000	.5574	.3574	-1.1664	-9.0652	-.6825	1.5595	130.6075	96.2550	-34.3129	57.3313
45.0000	.8836	1.1317	.5867	.3442	-1.0249	40.6023	-1.0249	1.7044	134.2548	88.5852	-45.7054	59.5952
50.0000	.8651	1.1557	.6194	.3378	-.8890	5.1547	-1.6869	1.8336	138.3618	79.0211	-59.3407	61.3924
70.0000	.8072	1.2388	.7831	.4657	-.4095	.6427	1.4280	1.6673	157.7204	32.7281	-125.0073	59.0457
75.0000	.7981	1.2530	.8322	.5588	-.3031	.4261	.8374	1.4893	163.1385	23.0801	-140.0585	56.1205
80.0000	.7915	1.2634	.8846	.6746	-.2001	.2615	.4871	1.3113	168.6823	14.6560	-154.0271	52.6708

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TN2= 1.2000 TK= .1000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1999	.1201	.1060	.1058	-.5280	-.5283	-.0002	1.0020	152.1441	152.1926	-.0115	45.0576
40.0000	1.0161	.1417	.1608	.0512	-.4662	-.7357	-.7007	3.1469	155.0071	143.6584	-11.3487	72.3366
45.0000	.9734	.1479	.1806	.0326	-.4457	-1.1125	-.4457	5.5781	155.5759	131.9517	-24.0242	79.7645
50.0000	.9289	.1550	.2060	.0174	-.4208	6.6494	-5.3020	11.8601	171.1908	77.8619	-75.3189	85.1806
70.0000	.7605	.1953	.4166	.2246	-.2606	-.0949	.1616	1.8283	165.4023	-5.4262	-170.8225	61.3230
75.0000	.7291	.1575	.5063	.3366	-.2030	-.0864	.1146	1.5051	168.9268	-4.5372	-173.4670	56.3993
80.0000	.7053	.2042	.6311	.4898	-.1393	-.0643	.0744	1.2886	172.0085	-3.6763	-175.7452	52.1876

TN2= 1.2000 TK= .2000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1995	.2401	.1413	.1410	-.9643	-.9650	-.0004	1.0020	136.0426	136.0202	-.0274	45.0560
40.0000	1.0235	.2813	.2106	.0743	-.7971	-1.6315	-.3677	2.8291	141.4413	121.9091	-19.4363	70.5710
45.0000	.9859	.2927	.2347	.0551	-.7475	-3.3887	-.7475	4.2959	143.2206	106.4411	-36.7795	76.7852
50.0000	.9428	.3055	.2652	.0433	-.6901	2.7962	-3.7497	6.1276	145.3890	70.3216	-75.0674	80.7317
70.0000	.7943	.3626	.4960	.2611	-.3863	-.0599	.3172	1.8616	158.5766	-3.4263	-162.4029	61.7568
75.0000	.7681	.3350	.5785	.3772	-.2925	-.0677	.2206	1.5378	163.6564	-3.8735	-167.5659	56.8973
80.0000	.7461	.3947	.6923	.5293	-.1969	-.0545	.1410	1.3079	168.8586	-3.1193	-171.9770	52.5987

TN2= 1.2000 TK= .3000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1995	.3601	.1846	.1846	-1.2633	-1.2648	-.0006	1.0019	128.3840	128.3319	-.0521	45.0534
40.0000	1.0351	.4174	.2696	.1069	-.9706	-2.6596	-.4716	2.5135	135.9538	110.6060	-25.2478	68.3051
45.0000	.9987	.4325	.2964	.0879	-.8935	-8.8655	-.8935	3.3734	138.2179	96.4356	-41.7822	73.4883
50.0000	.9619	.4451	.3306	.0775	-.8089	2.8597	-2.7938	4.2674	141.0720	70.7262	-70.3057	76.8116
70.0000	.8341	.5120	.5559	.2933	-.4183	-.0474	.4401	1.8951	157.2982	2.4289	-154.4703	62.1930
75.0000	.8125	.5317	.6418	.4101	-.3143	-.0035	.3181	1.5652	162.5565	-.1989	-162.7554	57.4747
80.0000	.7566	.5423	.7431	.5591	-.2096	-.0091	.2001	1.3790	168.1623	-.5197	-168.6820	53.0612

TN2= 1.2000 TK= .5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1996	.6002	.2776	.2771	-1.4987	-1.5013	-.0008	1.0016	123.7134	123.6668	-.0466	45.0465
40.0000	1.0615	.6783	.3795	.1868	-1.0393	-3.8793	-.5646	2.0312	133.5021	104.4550	-29.4472	63.7878
45.0000	1.0326	.6573	.4106	.1686	-.9370	-15.3563	-.9370	2.4356	136.8830	93.7255	-43.1371	67.6782
50.0000	1.0038	.7173	.4471	.1579	-.8315	4.7019	-1.9017	2.8303	140.2500	77.9532	-62.2628	70.5429
70.0000	.9084	.7926	.6580	.3404	-.4057	.2878	.7852	1.6329	157.5184	16.0575	-141.4609	62.6454
75.0000	.8929	.8064	.7256	.4518	-.3074	.1745	.5035	1.6150	163.1766	9.8955	-153.7767	58.2348
80.0000	.8816	.8167	.8100	.5933	-.2006	.0999	.3067	1.3653	168.6577	5.7063	-162.9514	53.7804

TN2= 1.2000 TK= 1.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1597	1.2003	.4857	.4852	-1.2753	-1.2779	-.0010	1.0010	128.1019	128.0437	-.0582	45.0291
40.0000	1.1172	1.2889	.5854	.3939	-.8502	-2.5178	-.5310	1.4859	135.6289	111.6613	-23.9672	56.0606
45.0000	1.1007	1.3083	.6122	.3748	-.7636	-3.6623	-.7636	1.6224	142.6363	105.2725	-37.3638	58.5242
50.0000	1.0845	1.3278	.6423	.3585	-.6758	-8.2305	-1.1513	1.7915	145.5505	96.5275	-49.0234	60.0102
70.0000	1.0318	1.3556	.7949	.4280	-.3297	.9954	1.5725	1.8573	161.7515	44.8689	-116.8834	61.7012
75.0000	1.0233	1.4072	.8412	.5113	-.2461	.6172	1.0178	1.6453	166.1767	31.6827	-134.4940	58.7086
80.0000	1.0171	1.4158	.8908	.6309	-.1634	.3648	.5617	1.4119	170.7185	20.0415	-150.6773	54.6918

TN2= 1.2000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1998	1.8002	.6373	.6369	-.9773	-.9792	-.0009	1.0006	135.6565	135.6028	-.0537	45.0179
40.0000	1.1491	1.8758	.7149	.5591	-.6749	-1.9989	-.4444	1.2786	145.9835	122.0236	-23.9559	51.9707
45.0000	1.1389	1.8966	.7349	.5401	-.6104	-1.5458	-.6104	1.3607	148.6000	117.1999	-31.4001	53.6864
50.0000	1.1285	1.9134	.7571	.5210	-.5439	-2.6002	-.8517	1.4532	151.4565	111.0364	-40.4205	55.4668
70.0000	1.0960	1.5708	.8649	.5116	-.2713	2.2452	6.4398	1.6906	164.8188	65.9922	-98.8267	59.3947
75.0000	1.0906	1.9805	.8963	.5629	-.2032	1.1754	1.8113	1.5972	168.5132	49.6107	-118.9025	57.8690
80.0000	1.0867	1.9877	.9294	.6565	-.1353	.6425	.8519	1.4159	172.2540	32.7221	-139.5719	54.7610

TN2= 1.2000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1999	2.4002	.7399	.7396	-.7735	-.7748	-.0008	1.0004	142.2765	142.2299	-.0466	45.0116
40.0000	1.1666	2.4686	.7977	.6771	-.5507	-1.1597	-.3717	1.1781	151.1601	130.7659	-20.3902	49.6750
45.0000	1.1555	2.4830	.8124	.6601	-.5009	-1.3373	-.5009	1.2308	153.3946	126.7892	-26.6054	50.9029
50.0000	1.1532	2.4573	.8286	.6414	-.4488	-1.6177	-.6772	1.2919	155.8792	121.7227	-34.1065	52.2585
70.0000	1.1312	2.5461	.9062	.5898	-.2278	7.0563	-11.9910	1.5364	167.1665	81.9337	-85.2328	56.9403
75.0000	1.1275	2.5543	.9283	.6143	-.1711	2.0989	3.5417	1.5113	170.2920	64.5252	-105.7669	56.5083
80.0000	1.1249	2.5603	.9514	.6813	-.1141	.9735	1.2236	1.3965	173.4685	44.2305	-129.2380	54.3938

TN2= 1.2000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.1999	3.0002	.8083	.8081	-.6351	-.6361	-.0007	1.0003	147.5803	147.5402	-.0401	45.0080
40.0000	1.1768	3.0591	.8517	.7588	-.4615	-.9097	-.3157	1.1225	155.2275	137.7059	-17.5220	48.3033
45.0000	1.1721	3.0714	.8627	.7443	-.4214	-1.0248	-.4214	1.1591	157.1491	134.2582	-22.8905	49.2147
50.0000	1.1674	3.0838	.8748	.7277	-.3790	-1.1937	-.5609	1.2022	159.2417	129.9545	-29.2867	50.2457
70.0000	1.1518	3.1256	.9320	.6579	-.1947	-13.2050	-3.6428	1.4166	168.9803	94.3307	-74.6456	54.7812
75.0000	1.1492	3.1327	.9482	.6629	-.1465	4.3156	12.1363	1.4303	171.6643	76.9539	-94.7104	55.0411
80.0000	1.1473	3.1379	.9650	.7061	-.0979	1.4103	1.7498	1.3666	174.4050	54.6610	-119.7480	53.8058

TN2= 1.0000 TK= 1.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9998	1.5003	.6002	.5998	-1.3318	-1.3349	-.0011	1.0008	126.9021	126.8377	-.0649	45.0215
40.0000	.9399	1.5558	.6872	.5196	-.8599	-2.6648	-.5484	1.3225	135.3083	110.5695	-28.7388	52.9061
45.0000	.9282	1.6140	.7095	.5033	-.7687	-3.7579	-.7687	1.4095	142.4508	104.9015	-37.5493	54.6462
50.0000	.9167	1.6362	.7339	.4893	-.6776	-7.2829	-1.1130	1.5001	145.8798	97.8184	-48.0614	56.3124
70.0000	.8798	1.7050	.8523	.5321	-.3272	1.3344	2.9497	1.6017	161.8799	53.1926	-108.7274	58.0218
75.0000	.8738	1.7166	.8866	.5963	-.2439	.0218	1.3329	1.4869	166.2935	39.4147	-126.8788	56.0781
80.0000	.8695	1.7251	.9227	.6935	-.1618	.4848	.7017	1.3306	170.8068	25.8628	-144.9431	53.0734

TN2= 1.0000 TK= 2.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9999	2.0002	.7073	.7069	-.9990	-1.0010	-.0010	1.0005	135.0279	134.9721	-.0559	45.0139
40.0000	.9605	2.0822	.7731	.6400	-.6829	-1.6422	-.4522	1.2080	145.6706	121.3389	-24.3317	50.3805
45.0000	.9526	2.0994	.7898	.6238	-.6166	-1.9897	-.6166	1.2661	148.3417	116.6833	-31.6584	51.6980
50.0000	.9449	2.1165	.8081	.6073	-.5486	-2.6271	-.8514	1.3305	151.2490	110.8390	-40.4101	53.0706
70.0000	.9197	2.1746	.8950	.5943	-.2725	2.6333	10.2932	1.5059	164.7544	69.2054	-95.5490	56.4143
75.0000	.9156	2.1843	.9197	.6347	-.2040	1.3438	2.1324	1.4491	168.4700	53.3450	-115.1250	55.3911
80.0000	.9126	2.1515	.9455	.7116	-.1358	.7274	.9578	1.3287	172.2677	36.0330	-136.2347	53.0345

TN2= 1.0000 TK= 2.5000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9999	2.5002	.7810	.7807	-.7993	-.8007	-.0008	1.0003	141.3643	141.3161	-.0482	45.0096
40.0000	.9725	2.5708	.8310	.7264	-.5653	-1.2077	-.3818	1.1440	150.5215	129.6258	-20.8961	48.8420
45.0000	.9669	2.5855	.8436	.7117	-.5136	-1.3951	-.5136	1.1853	152.8168	125.6336	-27.1832	49.8476
50.0000	.9615	2.6002	.8574	.6957	-.4597	-1.6911	-.6929	1.2325	155.3140	120.5568	-34.7172	50.9459
70.0000	.9434	2.6501	.9226	.6518	-.2325	7.2231	-10.9712	1.4195	166.9058	82.1178	-84.7920	54.7558
75.0000	.9404	2.6585	.9410	.6726	-.1745	2.1799	3.8003	1.3990	170.0599	65.3574	-104.7426	54.4427
80.0000	.9382	2.6646	.9601	.7299	-.1164	1.0144	1.2822	1.3155	173.2607	45.4098	-127.9509	52.7586

TN2= 1.0000 TK= 3.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	.9599	3.0002	.8322	.8319	-.6661	-.6672	-.0007	1.0002	146.3309	146.2890	-.0415	45.0070
40.0000	.9799	3.0616	.8708	.7881	-.4813	-.9624	-.3289	1.1050	154.3007	136.0966	-18.2040	47.8549
45.0000	.9758	3.0744	.8805	.7753	-.4390	-1.0876	-.4390	1.1357	156.2950	132.5979	-23.7011	48.6352
50.0000	.9717	3.0872	.8912	.7608	-.3944	-1.2725	-.5846	1.1714	158.4740	128.1623	-30.3117	49.5133
70.0000	.9583	3.1307	.9412	.7024	-.2020	-21.5340	-3.9877	1.3400	168.5809	92.6588	-75.9221	53.2678
75.0000	.9560	3.1380	.9553	.7086	-.1519	3.9298	10.1260	1.3481	171.3632	75.7232	-95.6400	53.4333
80.0000	.9544	3.1434	.9698	.7481	-.1014	1.3788	1.7210	1.2964	174.2075	54.0485	-120.1591	52.3547

TN2= 1.0000 TK= 4.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.0000	4.0001	.8945	.8944	-.4996	-.5004	-.0006	1.0001	153.4514	153.4185	-.0329	45.0041
40.0000	.9880	4.0484	.9190	.8651	-.3697	-.6907	-.2558	1.0623	159.7128	145.3660	-14.3466	46.7304
45.0000	.9858	4.0585	.9251	.8558	-.3388	-.7654	-.3388	1.0809	161.2855	142.5711	-18.7145	47.2277
50.0000	.9831	4.0686	.9318	.8447	-.3058	-.8693	-.4452	1.1031	162.9588	139.0005	-23.9983	47.8064
70.0000	.9749	4.1029	.9634	.7818	-.1589	-2.9604	-1.9054	1.2323	170.9736	108.6646	-62.3090	50.9410
75.0000	.9736	4.1086	.9722	.7711	-.1197	-23.4767	-6.1287	1.2608	173.1719	92.4391	-80.7328	51.5814
80.0000	.9726	4.1129	.9813	.7834	-.0801	2.6377	3.4459	1.2526	175.4201	69.2375	-106.1826	51.3973

TN2= 1.0000 TK= 6.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.0000	6.0001	.9487	.9487	-.3331	-.3336	-.0004	1.0001	161.5764	161.5537	-.0226	45.0019
40.0000	.9945	6.0324	.9607	.9337	-.2512	-.4462	-.1754	1.0289	165.9013	155.9512	-9.9500	45.8157
45.0000	.9933	6.0404	.9637	.9287	-.2310	-.4881	-.2310	1.0377	166.9509	153.9809	-13.0095	46.0600
50.0000	.9922	6.0474	.9670	.9224	-.2093	-.5443	-.3007	1.0484	168.1779	151.4426	-16.7353	46.3524
70.0000	.9883	6.0712	.9823	.8755	-.1101	-1.2548	-1.0057	1.1221	173.7170	128.5534	-45.1635	48.2922
75.0000	.9876	6.0752	.9866	.8570	-.0832	-2.1590	-1.7599	1.1513	175.2463	114.8524	-60.3940	49.0274
80.0000	.9871	6.0782	.9910	.8437	-.0557	-23.2035	-10.0960	1.1746	176.8111	92.4678	-84.3433	49.5902

TN2= 1.0000 TK=10.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.0000	10.0001	.9806	.9806	-.1999	-.2001	-.0002	1.0000	168.6970	168.6832	-.0138	45.0007
40.0000	.9980	10.0204	.9851	.9747	-.1523	-.2635	-.1069	1.0106	171.3417	165.2398	-6.1019	45.3032
45.0000	.9975	10.0247	.9863	.9727	-.1404	-.2864	-.1404	1.0139	172.0090	164.0180	-7.9910	45.3963
50.0000	.9971	10.0290	.9875	.9701	-.1274	-.3166	-.1818	1.0179	172.7369	162.4348	-10.3021	45.5093
70.0000	.9957	10.0426	.9933	.9474	-.0675	-.6357	-.5448	1.0485	176.1372	147.5515	-28.5797	46.3575
75.0000	.9954	10.0461	.9950	.9346	-.0511	-.9032	-.8146	1.0645	177.0771	137.9123	-39.1648	46.7904
80.0000	.9952	10.0479	.9966	.9166	-.0342	-1.7135	-1.5862	1.0873	178.0391	120.2672	-57.7718	47.3947

TN2= 1.0000 TK=20.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.0000	20.0000	.9950	.9950	-.0999	-.1001	-.0001	1.0000	174.2929	174.2859	-.0070	45.0002
40.0000	.9995	20.0103	.9962	.9935	-.0765	-.1308	-.0538	1.0027	175.6262	172.5455	-3.0803	45.0769
45.0000	.9994	20.0125	.9965	.9930	-.0706	-.1419	-.0706	1.0035	175.9628	171.9257	-4.0372	45.1007
50.0000	.9993	20.0146	.9968	.9923	-.0641	-.1562	-.0912	1.0045	176.3303	171.1198	-5.2104	45.1299
70.0000	.9989	20.0220	.9983	.9858	-.0341	-.2983	-.2616	1.0127	178.0478	163.3875	-14.6597	45.3617
75.0000	.9988	20.0233	.9987	.9815	-.0258	-.4008	-.3712	1.0175	178.5226	158.1588	-20.3638	45.4972
80.0000	.9988	20.0242	.9991	.9737	-.0173	-.6271	-.6033	1.0261	179.0088	147.9074	-31.1014	45.7379

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TH2= 1.2000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.1999	3.6002	.8547	.8545	-.5369	-.5377	-.0006	1.0002	151.7677	151.7328	-.0349	45.0058
40.0000	1.1831	3.6514	.8879	.8154	-.3955	-.7490	-.2727	1.0889	158.4229	143.1665	-15.2560	47.4369
45.0000	1.1796	3.6622	.8963	.8034	-.3621	-.8335	-.3621	1.1157	160.0540	140.1896	-19.9052	48.1292
50.0000	1.1762	3.6729	.9055	.7691	-.3265	-.9528	-.4776	1.1479	161.9165	136.3851	-25.5314	48.9292
70.0000	1.1644	3.7094	.9450	.7148	-.1692	-3.9508	-2.2667	1.3277	170.3581	104.2040	-66.1941	53.0135
75.0000	1.1627	3.7155	.9612	.7071	-.1275	21.6028	-12.3932	1.3594	172.7365	87.3457	-85.3868	53.6618
80.0000	1.1613	3.7200	.9738	.7306	-.0852	2.0550	2.9960	1.3329	175.1280	64.0608	-111.0672	53.1206

TH2= 1.2000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.2000	4.8001	.9059	.9098	-.4086	-.4091	-.0005	1.0001	157.7761	157.7487	-.0274	45.0034
40.0000	1.1900	4.8464	.9307	.8843	-.3057	-.5544	-.2126	1.0524	163.0019	150.9965	-12.0050	46.4636
45.0000	1.1875	4.8488	.9360	.8760	-.2808	-.6096	-.2808	1.0684	164.3164	148.6327	-15.6837	46.8945
50.0000	1.1859	4.8573	.9417	.8658	-.2540	-.6848	-.3670	1.0876	165.7494	145.5964	-20.1525	47.4040
70.0000	1.1785	4.8866	.9687	.7987	-.1329	-1.8172	-1.3566	1.2129	172.4290	118.8237	-53.6053	50.4955
75.0000	1.1777	4.8508	.9763	.7792	-.1003	-4.1592	-2.8641	1.2529	174.2722	103.5191	-70.7531	51.4040
80.0000	1.1769	4.8944	.9840	.7765	-.0672	5.6981	9.3392	1.2673	176.1578	80.0461	-96.1117	51.7231

TH2= 1.2000 TK= 6.0000

PHIC	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	CELD	PSID
2.0000	1.2000	7.2001	.9567	.9567	-.2751	-.2756	-.0003	1.0001	164.6098	164.5909	-.0189	45.0016
40.0000	1.1954	7.2279	.9668	.9440	-.2086	-.3658	-.1461	1.0242	168.2167	159.9066	-8.3101	45.6846
45.0000	1.1944	7.2337	.9693	.9398	-.1921	-.3989	-.1921	1.0316	169.1299	158.2517	-10.8741	45.8921
50.0000	1.1934	7.2396	.9721	.9341	-.1742	-.4429	-.2494	1.0407	170.1174	156.1137	-14.0037	46.1422
70.0000	1.1902	7.2554	.9851	.8901	-.0920	-.9510	-.7900	1.1068	174.7459	136.4380	-38.3079	47.9015
75.0000	1.1896	7.2628	.9887	.8696	-.0695	-1.4715	-1.2719	1.1370	176.0246	124.1992	-51.8254	48.6687
80.0000	1.1892	7.2653	.9924	.8404	-.0466	-4.2772	-3.9278	1.1698	177.3331	103.1552	-74.1739	49.4747

TH2= 1.2000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	CELD	PSID
2.0000	1.2000	12.0001	.9838	.9837	-.1661	-.1663	-.0002	1.0000	170.5717	170.5602	-.0115	45.0006
40.0000	1.1983	12.0170	.9875	.9788	-.1267	-.2183	-.0891	1.0089	172.7764	167.6871	-5.0894	45.2534
45.0000	1.1979	12.0206	.9885	.9771	-.1169	-.2370	-.1169	1.0116	173.3320	166.6658	-6.6672	45.3314
50.0000	1.1976	12.0242	.9895	.9749	-.1062	-.2616	-.1512	1.0150	173.9398	165.3408	-8.5992	45.4266
70.0000	1.1964	12.0364	.9944	.9550	-.0563	-.5143	-.4451	1.0412	176.7765	152.7837	-23.9928	46.1572
75.0000	1.1962	12.0384	.9958	.9433	-.0426	-.7132	-.6508	1.0557	177.5608	144.5035	-33.0573	46.5512
80.0000	1.1960	12.0399	.9972	.9248	-.0286	-1.2373	-1.1675	1.0783	178.3635	128.9452	-49.4183	47.1572

TH2= 1.2000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.2000	24.0000	.9959	.9959	-.0832	-.0833	-.0001	1.0000	175.2429	175.2371	-.0098	45.0001
40.0000	1.1996	24.0086	.9968	.9946	-.0637	-.1089	-.0448	1.0022	176.2940	173.7865	-2.5675	45.0641
45.0000	1.1995	24.0104	.9971	.9942	-.0588	-.1160	-.0588	1.0029	176.4940	173.2693	-3.3654	45.0840
50.0000	1.1994	24.0122	.9973	.9936	-.0534	-.1299	-.0760	1.0038	176.9408	172.5970	-4.3438	45.1086
70.0000	1.1991	24.0183	.9986	.9881	-.0284	-.2469	-.2170	1.0106	178.3724	166.1317	-12.2407	45.3032
75.0000	1.1990	24.0194	.9989	.9844	-.0215	-.3300	-.3063	1.0147	178.7063	161.7385	-17.0299	45.4188
80.0000	1.1990	24.0201	.9993	.9776	-.0144	-.5083	-.4903	1.0222	179.1737	153.0538	-26.1159	45.6294

TH2= 1.5000 TK= .1000

PHIC	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSIC
2.0000	1.4996	.1500	.2086	.2083	-.2357	-.2358	-.0002	1.0036	166.7390	166.7298	-.0092	45.0461
40.0000	1.3531	.1458	.2883	.1263	-.1981	-.3185	-.1133	2.2815	161.7570	142.3329	-4.4665	66.3321
45.0000	1.3223	.1458	.3163	.0989	-.1869	-.3872	-.1160	3.2016	165.4174	138.4351	-10.1825	72.5908
50.0000	1.2927	.1741	.3462	.0654	-.1737	-.5766	-.3662	5.2966	170.1450	150.0313	-20.1137	79.3083
70.0000	1.1752	.1515	.5550	.2110	-.1007	.0861	-.1864	2.6501	174.2510	4.5193	-165.3317	69.1260
75.0000	1.1543	.1949	.6425	.3316	-.0774	.0631	.1209	1.9376	175.5738	2.4669	-173.1070	62.7016
80.0000	1.1387	.1976	.7423	.4911	-.0526	.0213	.0759	1.5114	176.5513	1.2189	-175.7723	56.5051

TH2= 1.5000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.4996	.3001	.2318	.2316	-.4476	-.4478	-.0003	1.0016	155.8880	155.8701	-.0179	45.0448
40.0000	1.3623	.3303	.3165	.1454	-.3672	-.6292	-.2128	2.1766	156.0376	147.0215	-12.0155	65.3744
45.0000	1.3120	.3378	.3437	.1181	-.3442	-.7808	-.3442	2.9057	161.6000	142.0175	-16.5913	71.0531
50.0000	1.3011	.3459	.3766	.0876	-.3178	-1.2111	-.6491	4.3103	162.3713	129.9462	-32.8751	76.9386
70.0000	1.1915	.3777	.5086	.2236	-.1788	.1904	.3821	2.6321	165.8693	10.7790	-155.0863	69.1973
75.0000	1.1723	.3839	.6687	.3436	-.1346	.1033	.2412	1.9461	172.2220	5.7032	-166.4389	62.8037
80.0000	1.1581	.3886	.7629	.5020	-.0923	.0531	.1461	1.5159	174.3262	3.0403	-171.6859	56.6569

TH2= 1.5000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.4996	.4501	.2650	.2646	-.6195	-.6199	-.0004	1.0015	148.2296	148.2035	-.0256	45.0627
40.0000	1.3701	.4527	.3556	.1741	-.4974	-.9137	-.2906	2.0418	151.7692	137.5808	-10.2037	65.9057
45.0000	1.3418	.4530	.3839	.1474	-.4579	-1.1588	-.4579	2.6050	155.2966	130.7031	-24.6035	68.9944
50.0000	1.3133	.5140	.4177	.1191	-.4193	-1.8673	-.8121	3.5069	157.2518	110.1712	-35.0806	74.0346
70.0000	1.2139	.5560	.6259	.2409	-.2283	.3171	.5880	2.5583	167.1386	17.5947	-149.5439	66.9486
75.0000	1.1969	.5640	.7011	.3586	-.1736	.1771	.7616	1.9549	170.1631	10.0425	-160.1201	62.9086
80.0000	1.1843	.5700	.7879	.5147	-.1166	.0970	.2161	1.5309	173.3437	5.9355	-167.2078	56.8463

TH2= 1.5000 TK= .5000

PHIC	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	CELD	PSID
2.0000	1.4997	.7502	.3456	.3451	-.8270	-.8281	-.0007	1.0013	140.4079	140.3703	-.0373	45.0372
40.0000	1.3893	.8058	.4438	.2491	-.6206	-1.3110	-.3806	1.7618	148.1745	127.3357	-20.8388	60.6981
45.0000	1.3680	.8236	.4728	.2236	-.5698	-1.6875	-.5658	2.1190	150.3256	120.6511	-25.6745	64.6943
50.0000	1.3427	.8379	.5066	.1983	-.5150	-2.7060	-.9156	2.5553	152.7518	110.2820	-42.4698	68.6272
70.0000	1.2637	.8502	.6979	.2812	-.2680	.6765	1.0750	2.4817	164.5552	32.0607	-132.5305	68.0528
75.0000	1.2505	.8956	.7620	.3889	-.2019	.3638	.6106	1.9592	168.5838	19.9925	-148.5509	62.5601
80.0000	1.2408	.9066	.8339	.5372	-.1351	.2064	.3513	1.5518	172.3087	11.6625	-160.6458	57.1986

TH2= 1.5000 TK= 1.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.4998	1.5002	.5425	.5421	-.8564	-.8578	-.0008	1.0008	139.4220	139.3754	-.0466	45.0233
40.0000	1.4328	1.5704	.6314	.4525	-.6119	-1.3414	-.4007	1.3953	146.5388	126.7048	-21.8340	54.3719
45.0000	1.4191	1.5855	.6553	.4294	-.5567	-1.6135	-.5567	1.5260	150.8550	121.7855	-29.1091	56.7632
50.0000	1.4056	1.6000	.6821	.4035	-.4989	-2.1238	-.7850	1.6822	153.4856	115.2137	-38.2719	59.2701
70.0000	1.3607	1.6536	.8183	.3934	-.2531	1.8892	4.1054	2.0758	165.7959	62.1063	-103.6896	64.3206
75.0000	1.3533	1.6626	.8595	.4600	-.1900	.9732	1.4271	1.8684	169.2298	44.2206	-125.0192	61.8432
80.0000	1.3479	1.6653	.9036	.5771	-.1268	.5276	.7013	1.5658	172.1751	27.8153	-144.9599	57.4360

TH2= 1.5000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CFLSD	DFLPD	DFLD	PSID
2.0000	1.4999	2.2502	.6855	.6851	-.7123	-.7134	-.0007	1.0005	144.5379	144.4545	-.0430	45.0143
40.0000	1.4587	2.3137	.7524	.6128	-.5142	-1.0484	-.3471	1.2279	152.7891	133.6460	-19.1491	50.8403
45.0000	1.4503	2.3272	.7698	.5927	-.4689	-1.2021	-.4689	1.2990	154.8787	129.7573	-25.1214	52.4094
50.0000	1.4419	2.3406	.7891	.5703	-.4217	-1.4430	-.6356	1.3836	157.1606	124.7219	-32.4387	54.1429
70.0000	1.4142	2.3865	.8830	.5040	-.2154	7.7212	-11.9666	1.7519	167.6437	82.6206	-85.2231	60.2813
75.0000	1.4096	2.3943	.9103	.5321	-.1620	2.0328	3.2720	1.7106	170.6006	63.8062	-106.5944	59.6905
80.0000	1.4083	2.4000	.9390	.6122	-.1081	.5709	1.1429	1.5339	173.6278	42.6432	-131.1846	56.8982

TH2= 1.5000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DFLPD	DELD	PSID
2.0000	1.4999	3.0002	.7789	.7787	-.5849	-.5858	-.0006	1.0003	149.6754	149.6381	-.0372	45.0093
40.0000	1.4730	3.0550	.8279	.7229	-.4288	-.8269	-.2939	1.1452	156.1513	140.4115	-16.3797	48.8715
45.0000	1.4675	3.0665	.8404	.7063	-.3922	-.9270	-.3922	1.1899	158.5841	137.1683	-21.4159	49.9557
50.0000	1.4620	3.0780	.8542	.6870	-.3534	-1.0724	-.5216	1.2434	160.5389	132.9958	-27.5390	51.1929
70.0000	1.4438	3.1172	.9203	.5999	-.1825	-3.7498	-3.1343	1.5342	169.6575	97.3526	-72.3049	56.9034
75.0000	1.4405	3.1238	.9392	.6019	-.1374	5.2531	19.3041	1.5619	172.1751	79.2219	-92.9532	57.3639
80.0000	1.4383	3.1287	.9588	.6478	-.0919	1.4712	1.8074	1.4801	174.7509	55.7955	-118.9554	55.9563

TH2= 1.5000 TK= 2.5000

PHIC	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	1.4999	3.7501	.8359	.8393	-.4894	-.4901	-.0006	1.0002	153.9206	153.8885	-.0321	45.0064
40.0000	1.4813	3.7974	.8757	.7965	-.3630	-.6755	-.2509	1.0596	160.0452	145.9618	-14.0874	47.7119
45.0000	1.4774	3.8073	.8849	.7831	-.3328	-.7465	-.3328	1.1300	161.5919	143.1838	-18.4081	48.4931
50.0000	1.4736	3.8172	.8950	.7671	-.3005	-.8506	-.4381	1.1668	163.2734	139.6151	-23.6582	49.4029
70.0000	1.4607	3.8505	.9431	.6775	-.1564	-2.9903	-1.9310	1.3520	171.1128	108.4906	-62.6222	54.3076
75.0000	1.4586	3.8565	.9567	.6634	-.1179	-38.8893	-6.9426	1.4421	173.2764	91.4730	-81.8034	55.2614
80.0000	1.4570	3.8607	.9708	.6832	-.0789	2.3912	3.0443	1.4209	175.4858	67.3053	-108.1844	54.8623

TH2= 1.5000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	CELSD	DELPD	CELD	PSID
2.0000	1.5000	4.5001	.8756	.8795	-.4183	-.4189	-.0005	1.0002	157.2998	157.2716	-.0279	45.0046
40.0000	1.4864	4.5412	.9071	.8462	-.3128	-.5688	-.2173	1.0719	162.6320	150.3709	-12.2611	46.9881
45.0000	1.4836	4.5458	.9140	.8354	-.2872	-.6261	-.2472	1.0941	163.5745	147.9451	-16.0295	47.5718
50.0000	1.4808	4.5585	.9217	.8223	-.2598	-.7045	-.3760	1.1208	165.4375	144.8235	-20.6040	48.2607
70.0000	1.4713	4.5878	.9578	.7385	-.1359	-1.9661	-1.4317	1.2969	172.2620	117.1960	-55.0660	52.3657
75.0000	1.4697	4.5527	.9679	.7162	-.1025	-4.9782	-3.2280	1.3514	174.1457	101.3582	-72.7876	53.4986
80.0000	1.4686	4.5964	.9784	.7170	-.0686	4.4424	8.4903	1.3645	176.0729	77.3138	-98.7591	53.7625

TH2= 1.5000 TK= 4.0000

PHIC	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DFLD	PSID
2.0000	1.5000	6.0001	.9263	.9262	-.3219	-.3224	-.0004	1.0001	162.1547	162.1328	-.0219	45.0027
40.0000	1.4920	6.0323	.9433	.9050	-.2430	-.4306	-.1698	1.0423	166.3401	156.7035	-9.6366	46.1894
45.0000	1.4903	6.0391	.9476	.8979	-.2236	-.4708	-.2236	1.0553	167.3547	154.7094	-12.6053	46.5413
50.0000	1.4886	6.0459	.9523	.8890	-.2026	-.5246	-.2910	1.0712	168.5446	152.3198	-16.2268	46.9677
70.0000	1.4830	6.0650	.9744	.8228	-.1067	-1.1987	-.9682	1.1843	173.5107	129.8354	-44.0753	49.8732
75.0000	1.4820	6.0728	.9806	.7963	-.0806	-2.0346	-1.6788	1.2314	175.3528	116.1735	-59.2192	50.9206
80.0000	1.4813	6.0757	.9869	.7765	-.0540	-16.0692	-8.5750	1.2711	176.9052	93.5610	-83.3483	51.8065

TH2= 1.5000 TK= 6.0000

PHIC	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CFLSD	DELPD	CELD	PSID
2.0000	1.5000	9.0001	.9650	.9650	-.2187	-.2190	-.0003	1.0000	167.6633	167.6482	-.0151	45.0012
40.0000	1.4963	9.0223	.9731	.9546	-.1664	-.2888	-.1168	1.0194	170.5507	163.8905	-6.6601	45.5509
45.0000	1.4955	9.0270	.9752	.9510	-.1534	-.3142	-.1534	1.0254	171.2750	162.5581	-8.7210	45.7195
50.0000	1.4947	9.0317	.9776	.9464	-.1392	-.3476	-.1988	1.0328	172.0735	160.8325	-11.2411	45.9239
70.0000	1.4921	9.0476	.9880	.9074	-.0737	-.7087	-.6034	1.0888	175.7846	144.6764	-31.1083	47.4351
75.0000	1.4917	9.0503	.9909	.8866	-.0557	-1.0254	-.9172	1.1176	176.8104	134.2020	-42.5784	48.1785
80.0000	1.4913	9.0523	.9939	.8594	-.0374	-2.0956	-1.9088	1.1565	177.8601	115.5098	-62.3503	49.1513

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TN2= 1.5000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.5000	15.0000	.9869	.9869	-.1325	-.1327	-.0002	1.0000	172.4514	172.4422	-.0092	45.0004
40.0000	1.4986	15.0136	.9900	.9830	-.1013	-.1738	-.0712	1.0071	174.2156	170.1412	-4.0744	45.2032
45.0000	1.4984	15.0168	.9908	.9816	-.0935	-.1886	-.0935	1.0093	174.6610	169.3220	-5.3390	45.2660
50.0000	1.4981	15.0154	.9916	.9798	-.0849	-.2078	-.1209	1.0120	175.1469	168.2583	-6.8887	45.3427
70.0000	1.4971	15.0251	.9935	.9633	-.0451	-.4019	-.3506	1.0335	177.4183	158.1060	-15.3123	45.9434
75.0000	1.4969	15.0308	.9966	.9530	-.0341	-.5472	-.5036	1.0458	178.0464	151.3146	-26.7318	46.2875
80.0000	1.4960	15.0320	.9977	.9354	-.0229	-.8926	-.8523	1.0667	178.4853	138.2480	-40.4414	46.8478

TN2= 1.5000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.5000	30.0000	.9967	.9967	-.0665	-.0666	-.0001	1.0000	176.1935	176.1889	-.0046	45.0001
40.0000	1.4997	30.0065	.9979	.9957	-.0510	-.0870	-.0359	1.0018	177.0825	175.0281	-2.0544	45.0513
45.0000	1.4996	30.0083	.9977	.9953	-.0470	-.0943	-.0470	1.0024	177.3070	174.6140	-2.6930	45.0672
50.0000	1.4995	30.0058	.9979	.9948	-.0428	-.1038	-.0607	1.0030	177.5520	174.0757	-3.4763	45.0868
70.0000	1.4993	30.0147	.9989	.9904	-.0227	-.1964	-.1729	1.0085	178.6575	168.8890	-9.8085	45.2438
75.0000	1.4992	30.0155	.9991	.9874	-.0172	-.2614	-.2431	1.0119	179.0144	165.3507	-13.6637	45.3380
80.0000	1.4992	30.0161	.9994	.9817	-.0115	-.3978	-.3845	1.0181	179.3387	158.3072	-21.0315	45.5134

TN2= 2.0000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9997	.2000	.3394	.3390	-.1315	-.1316	-.0001	1.0012	172.5076	172.5007	-.0069	45.0346
40.0000	1.8951	.2111	.4303	.2416	-.1061	-.1754	-.0681	1.7810	173.5440	170.0520	-3.8940	60.6860
45.0000	1.8723	.2136	.4577	.2095	-.0990	-.2000	-.0990	2.1848	174.2452	168.6904	-5.6548	65.4065
50.0000	1.8493	.2163	.4900	.1700	-.0911	-.2444	-.1500	2.8830	174.7569	166.2674	-8.5294	70.8706
70.0000	1.7687	.2262	.6805	.1318	-.0505	.2797	.3350	5.1615	177.1080	15.6269	-161.4811	75.0352
75.0000	1.7547	.2280	.7467	.2595	-.0385	.1273	.1666	2.8776	177.7945	7.2539	-170.5406	70.0172
80.0000	1.7443	.2253	.8218	.4312	-.0260	.0650	.0912	1.9059	178.5117	3.7204	-174.7913	62.3141

TN2= 2.0000 TK= .7000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9997	.4001	.3961	.3957	-.2530	-.2533	-.0002	1.0012	165.8000	165.7869	-.0134	45.0336
40.0000	1.8985	.4214	.4479	.2576	-.2021	-.3412	-.1302	1.7386	168.5769	161.1583	-7.4185	60.0939
45.0000	1.8766	.4263	.4754	.2260	-.1882	-.3902	-.1882	2.1037	169.3415	158.6810	-10.6581	64.5758
50.0000	1.8545	.4314	.5075	.1877	-.1726	-.4780	-.2821	2.7043	170.2047	154.4500	-15.7547	69.7068
70.0000	1.7775	.4501	.6943	.1460	-.0949	.5705	.7035	4.7551	174.5806	25.7061	-144.8745	78.1236
75.0000	1.7643	.4534	.7583	.2668	-.0722	.2593	.3378	2.8424	175.8707	14.5376	-161.3331	70.6176
80.0000	1.7544	.4560	.8304	.4356	-.0486	.1327	.1825	1.9062	177.2154	7.5586	-169.6567	62.3186

TN2= 2.0000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9997	.6001	.3814	.3810	-.3570	-.3573	-.0003	1.0011	160.3558	160.3366	-.0192	45.0320
40.0000	1.9037	.6241	.4741	.2824	-.2821	-.4885	-.1823	1.2788	164.2553	153.4655	-10.3298	59.2189
45.0000	1.8831	.6312	.5014	.2514	-.2611	-.5603	-.2611	1.5943	165.3692	150.7385	-14.6308	63.3691
50.0000	1.8624	.6445	.5332	.2148	-.2387	-.6877	-.3857	2.4831	166.5750	145.4822	-21.0929	68.0639
70.0000	1.7906	.6702	.7140	.1674	-.1296	.8878	1.1455	4.2660	172.6177	41.5973	-131.0206	76.8073
75.0000	1.7783	.6748	.7747	.2781	-.0984	.4000	.5188	2.7861	174.3818	21.8024	-152.5792	70.2559
80.0000	1.7692	.6783	.8425	.4421	-.0662	.2046	.2745	1.9056	176.2145	11.5825	-164.6520	62.3109

TN2= 2.0000 TK= .5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9998	1.0001	.4474	.4470	-.4997	-.5003	-.0005	1.0010	153.4489	153.4210	-.0279	45.0279
40.0000	1.9171	1.0433	.5356	.3494	-.3827	-.7019	-.2516	1.5443	159.0592	144.9360	-14.1232	57.0755
45.0000	1.8996	1.0529	.5658	.3202	-.3531	-.8067	-.3531	1.7677	160.5527	141.1013	-15.4474	60.4968
50.0000	1.8821	1.0626	.5959	.2866	-.3208	-.9863	-.5075	2.0751	162.2127	135.3982	-26.8175	64.3136
70.0000	1.8224	1.0974	.7596	.2233	-.1703	1.7077	2.6480	3.4012	170.2367	59.6475	-110.6888	73.6157
75.0000	1.8124	1.1035	.8120	.3092	-.1288	.7210	.9368	2.4264	172.6818	35.7930	-136.8686	69.1559
80.0000	1.8050	1.1080	.8696	.4584	-.0864	.3625	.4634	1.8970	175.0637	19.9275	-155.1358	62.2042

TN2= 2.0000 TK= 1.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9958	2.0002	.6204	.6200	-.5710	-.5718	-.0006	1.0006	150.2726	150.2377	-.0349	45.0174
40.0000	1.9490	2.0523	.6960	.5373	-.4235	-.8085	-.2068	1.2955	157.0454	141.0436	-16.0018	52.3353
45.0000	1.9385	2.0634	.7162	.5129	-.3883	-.9144	-.3883	1.3963	158.3799	137.5551	-21.2201	54.3899
50.0000	1.9280	2.0746	.7388	.4850	-.3506	-1.0764	-.5270	1.5731	160.6018	132.6929	-27.7889	56.7126
70.0000	1.8928	2.1132	.8522	.3874	-.1823	18.4299	-7.8903	2.2243	165.6712	66.8542	-82.7769	65.8119
75.0000	1.8870	2.1198	.8862	.4107	-.1374	2.0743	3.0932	2.1575	172.1776	64.2619	-107.9157	65.1321
80.0000	1.8826	2.1247	.9222	.5070	-.0919	.8535	1.0250	1.8188	174.7487	40.4794	-134.2651	61.1976

TN2= 2.0000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9999	3.0001	.7455	.7452	-.4996	-.5004	-.0006	1.0006	153.4511	153.4188	-.0322	45.0107
40.0000	1.9687	3.0570	.8001	.6824	-.3712	-.6923	-.2956	1.1725	155.0726	145.3044	-14.3262	49.5404
45.0000	1.9622	3.0578	.8145	.6631	-.3405	-.7703	-.3405	1.2280	161.1587	147.3635	-12.8034	50.8429
50.0000	1.9558	3.0670	.8300	.6403	-.3076	-.8816	-.4516	1.2562	162.5044	138.5998	-24.3047	52.3511
70.0000	1.9341	3.1022	.9062	.5242	-.1602	-4.1354	-2.3912	1.7288	170.8595	103.5935	-67.3056	59.9534
75.0000	1.9305	3.1080	.9283	.5162	-.1208	9.6988	-97.2613	1.7987	173.1128	84.1134	-88.9995	60.9209
80.0000	1.9278	3.1123	.9513	.5618	-.0808	1.6178	1.9541	1.4934	175.3790	58.2782	-111.1008	59.4365

TN2= 2.0000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	1.9999	4.0001	.8247	.8245	-.4208	-.4213	-.0005	1.0002	157.1803	157.1524	-.0279	45.0070
40.0000	1.9798	4.0413	.8636	.7701	-.3149	-.5727	-.2184	1.1100	162.5222	150.2016	-12.1206	47.9835
45.0000	1.9753	4.0459	.8736	.7632	-.2892	-.6312	-.2892	1.1446	163.8697	147.7393	-16.1303	48.6585
50.0000	1.9711	4.0586	.8846	.7452	-.2616	-.7118	-.3796	1.1871	165.3359	144.5549	-20.7846	49.8892
70.0000	1.9565	4.0981	.9372	.6345	-.1369	-2.0943	-1.5212	1.4770	172.2040	115.5234	-56.6807	55.9007
75.0000	1.9545	4.0531	.9521	.6087	-.1033	-6.6885	-3.0941	1.5643	174.1011	58.5013	-75.5978	57.4106
80.0000	1.9528	4.0567	.9676	.6175	-.0692	3.2717	4.3182	1.5649	176.0428	73.0041	-103.0389	57.4545

TN2= 2.0000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.0000	5.0001	.8745	.8744	-.3569	-.3574	-.0004	1.0002	160.3382	160.3141	-.0241	45.0048
40.0000	1.9859	5.0356	.9029	.8357	-.2687	-.4801	-.1872	1.0752	164.5607	154.3550	-10.2057	47.0757
45.0000	1.9829	5.0430	.9101	.8283	-.2471	-.5263	-.2471	1.0988	166.1210	152.2420	-13.8790	47.6940
50.0000	1.9800	5.0505	.9180	.8142	-.2238	-.5888	-.3725	1.1275	167.3864	149.5121	-17.8743	48.4307
70.0000	1.9701	5.0759	.9557	.7167	-.1176	-1.4530	-1.1405	1.3326	172.2538	124.5374	-48.7563	53.1347
75.0000	1.9685	5.0801	.9663	.6839	-.0888	-2.8365	-2.1949	1.4130	174.5258	109.4202	-65.5057	54.7119
80.0000	1.9672	5.0833	.9773	.6698	-.0595	11.6618	38.2631	1.4551	176.5560	85.0984	-91.4971	55.9749

TN2= 2.0000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.0000	6.0001	.9068	.9067	-.3075	-.3079	-.0004	1.0001	162.9077	162.8868	-.0209	45.0035
40.0000	1.9897	6.0309	.9281	.8803	-.2325	-.4105	-.1625	1.0543	166.9122	157.6834	-9.2287	46.5144
45.0000	1.9876	6.0374	.9335	.8714	-.2140	-.4485	-.2140	1.0713	167.5218	155.4535	-12.0783	46.9703
50.0000	1.9855	6.0439	.9394	.8603	-.1940	-.4993	-.2784	1.0920	169.0228	153.4652	-15.5577	47.5176
70.0000	1.9782	6.0660	.9674	.7771	-.1022	-1.1284	-.9200	1.2449	174.1635	131.5490	-42.6159	51.2257
75.0000	1.9770	6.0657	.9752	.7432	-.0772	-1.8833	-1.9767	1.3122	175.5839	117.9682	-57.6157	52.6897
80.0000	1.9761	6.0725	.9833	.7163	-.0518	-11.2460	-7.0759	1.3729	177.0374	95.0815	-81.9559	53.9300

TN2= 2.0000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.0000	8.0001	.9436	.9436	-.2387	-.2390	-.0003	1.0001	166.5772	166.5608	-.0164	45.0020
40.0000	1.9939	8.0243	.9566	.9271	-.1814	-.3158	-.1272	1.0318	169.7192	162.4726	-7.2466	45.8976
45.0000	1.9927	8.0254	.9599	.9215	-.1671	-.3439	-.1671	1.0417	170.9117	161.0234	-9.6083	46.1713
50.0000	1.9914	8.0345	.9635	.9143	-.1517	-.3809	-.2167	1.0539	171.3762	159.1471	-12.2250	46.5027
70.0000	1.9871	8.0518	.9805	.8551	-.0802	-.7921	-.6693	1.1467	175.4135	141.6178	-33.7961	48.9082
75.0000	1.9864	8.0547	.9852	.8255	-.0606	-1.1749	-1.0402	1.1935	176.5295	130.4015	-46.1284	50.0404
80.0000	1.9855	8.0569	.9900	.7902	-.0407	-2.6917	-2.3895	1.2529	177.6720	110.3810	-67.2910	51.4049

TN2= 2.0000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.0000	12.0000	.9735	.9735	-.1632	-.1634	-.0002	1.0000	170.7331	170.7217	-.0113	45.0009
40.0000	1.9972	12.0187	.9797	.9656	-.1246	-.2144	-.0875	1.0146	172.8597	167.8975	-5.0022	45.4151
45.0000	1.9966	12.0203	.9812	.9628	-.1149	-.2328	-.1149	1.0191	173.4468	166.8931	-6.5534	45.5430
50.0000	1.9960	12.0238	.9829	.9592	-.1043	-.2569	-.1406	1.0247	174.0432	165.5900	-8.4532	45.6990
70.0000	1.9941	12.0358	.9909	.9273	-.0554	-.5047	-.4371	1.0686	176.8314	153.2156	-23.6118	46.8983
75.0000	1.9937	12.0378	.9931	.9085	-.0419	-.6993	-.6387	1.0931	177.6023	145.0365	-32.5659	47.5472
80.0000	1.9935	12.0393	.9954	.8790	-.0281	-1.2092	-1.1424	1.1323	178.3514	129.9895	-48.8015	48.5509

TN2= 2.0000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.0000	20.0000	.9902	.9902	-.0992	-.0993	-.0001	1.0000	174.3251	174.3182	-.0069	45.0003
40.0000	1.9990	20.0102	.9925	.9872	-.0759	-.1299	-.0534	1.0053	175.6585	172.6010	-3.0575	45.1526
45.0000	1.9988	20.0124	.9930	.9861	-.0701	-.1408	-.0701	1.0070	175.9927	171.9853	-4.0073	45.1999
50.0000	1.9985	20.0145	.9937	.9848	-.0637	-.1551	-.0905	1.0090	176.3573	171.1854	-5.1719	45.2578
70.0000	1.9978	20.0218	.9966	.9720	-.0338	-.2961	-.2596	1.0254	178.0620	163.5077	-14.5543	45.7182
75.0000	1.9977	20.0231	.9974	.9636	-.0256	-.3977	-.3683	1.0351	178.5335	158.3124	-20.2211	45.9875
80.0000	1.9976	20.0240	.9983	.9485	-.0172	-.6220	-.5984	1.0525	179.0161	148.1178	-30.8983	46.4663

TN2= 2.0000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.0000	40.0000	.9975	.9975	-.0499	-.0499	-.0001	1.0000	177.1447	177.1412	-.0035	45.0001
40.0000	1.9997	40.0052	.9981	.9968	-.0382	-.0652	-.0269	1.0013	177.8119	176.2704	-1.5410	45.0385
45.0000	1.9997	40.0062	.9982	.9965	-.0353	-.0706	-.0353	1.0018	177.9755	175.9557	-2.0201	45.0509
50.0000	1.9996	40.0073	.9984	.9961	-.0321	-.0777	-.0455	1.0023	178.1636	175.5557	-2.6079	45.0651
70.0000	1.9994	40.0110	.9991	.9928	-.0171	-.1466	-.1293	1.0064	179.0225	171.6572	-7.3657	45.1835
75.0000	1.9994	40.0116	.9994	.9905	-.0129	-.1946	-.1812	1.0089	179.2606	168.9855	-10.2711	45.2552
80.0000	1.9994	40.0121	.9996	.9860	-.0087	-.2934	-.2840	1.0137	179.5035	163.6495	-15.8544	45.3910

TN2= 2.5000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.4998	.2500	.4336	.4332	-.0941	-.0942	-.0001	1.0010	174.6261	174.6205	-.0059	45.0276
40.0000	2.4169	.2586	.5233	.3342	-.0745	-.1246	-.0497	1.5658	175.7418	172.8588	-2.8831	57.4354
45.0000	2.3990	.2605	.5492	.3016	-.0692	-.1391	-.0692	1.8208	176.0408	172.0815	-3.9593	61.2746
50.0000	2.3811	.2625	.5792	.2614	-.0634	-.1671	-.0977	2.2156	176.3742	170.7936	-5.5806	65.7085
70.0000	2.3189	.2655	.7460	.0572	-.0346	1.0678	1.1446	13.0349	178.0199	46.8783	-131.1416	85.6130
75.0000	2.3082	.2708	.8008	.1792	-.0263	.2292	.2571	4.4685	178.4548	12.9116	-165.5832	77.3858
80.0000	2.3003	.2717	.8614	.3599	-.0177	.0996	.1175	2.3938	178.5867	5.6885	-173.2582	67.3277

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TN2= 2.5000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANDP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.4998	.5000	.4474	.4470	-.1817	-.1819	-.0002	1.0009	165.7005	169.6898	-.0107	45.0768
40.0000	2.4195	.5166	.5368	.3485	-.1430	-.2419	-.0956	1.5405	171.8598	166.3989	-5.4608	57.0103
45.0000	2.4022	.5203	.5625	.3164	-.1328	-.2704	-.1328	1.7779	172.4357	164.8714	-7.5643	60.6440
50.0000	2.3849	.5241	.5921	.2770	-.1214	-.3151	-.1866	2.1371	173.0771	162.5085	-10.5686	64.9239
70.0000	2.3251	.5376	.7552	.0911	-.0659	2.3509	2.8601	8.2856	176.2281	66.5566	-105.7715	83.1182
75.0000	2.3149	.5400	.8084	.1902	-.0501	.4676	.5300	4.2505	177.1339	25.0594	-152.0745	76.7611
80.0000	2.3073	.5418	.8669	.3641	-.0337	.2013	.2366	2.3812	178.0712	11.3829	-166.6883	67.2195

TN2= 2.5000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.4998	.7501	.4687	.4683	-.2579	-.2582	-.0003	1.0009	165.5374	165.5220	-.0154	45.0256
40.0000	2.4234	.7737	.5573	.3707	-.2014	-.3459	-.1350	1.5035	168.6111	160.9206	-7.6905	56.3708
45.0000	2.4071	.7789	.5825	.3393	-.1867	-.3860	-.1867	1.7167	165.4259	158.8517	-10.5742	59.7785
50.0000	2.3908	.7843	.6115	.3013	-.1704	-.4509	-.2605	2.0296	170.3309	155.7308	-14.6002	63.7696
70.0000	2.3344	.8032	.7688	.1297	-.0919	4.3009	1.2643	5.5273	174.7487	76.9108	-97.8361	80.4237
75.0000	2.3249	.8065	.8194	.2072	-.0697	.7258	.8379	3.9555	176.0121	35.9709	-140.0414	75.8120
80.0000	2.3178	.8050	.8749	.3707	-.0469	.3070	.3591	2.3601	177.3175	17.0682	-160.2492	67.0372

TN2= 2.5000 TK= .5000

PHID	A	B	RS	RP	TANOS	TANDP	TANC	TAPSI	CELSD	DELPD	CELD	PSID
2.0000	2.4998	1.2501	.5256	.5252	-.3668	-.3672	-.0004	1.0008	155.8594	159.8371	-.0223	45.0273
40.0000	2.4331	1.2840	.6105	.4314	-.2816	-.4986	-.1902	1.4151	164.2706	153.4994	-10.7713	54.7527
45.0000	2.4158	1.2914	.6340	.4020	-.2601	-.5578	-.2601	1.5772	165.4231	150.8461	-14.5770	57.6236
50.0000	2.4058	1.2989	.6608	.3669	-.2365	-.6403	-.3571	1.8010	166.6562	147.0445	-19.6512	60.9586
70.0000	2.3581	1.3252	.8021	.2108	-.1259	32.9263	-10.5075	3.9056	172.6240	88.2605	-84.5635	75.2771
75.0000	2.3501	1.3258	.8463	.2536	-.0953	1.3666	1.6807	3.3372	174.5571	53.8052	-120.7519	73.3191
80.0000	2.3441	1.3331	.8941	.3857	-.0639	.5372	.6225	2.2944	176.3420	28.2444	-148.0975	66.4499

TN2= 2.5000 TK= 1.0000

PHIC	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.4995	2.5001	.6780	.6777	-.4345	-.4351	-.0005	1.0005	156.5154	156.4875	-.0279	45.0139
40.0000	2.4590	2.5417	.7437	.6027	-.3267	-.5947	-.2244	1.2341	161.9088	149.2589	-12.6499	50.9813
45.0000	2.4505	2.5505	.7611	.5793	-.3003	-.6602	-.3003	1.3130	163.2835	146.5670	-16.7165	52.7243
50.0000	2.4420	2.5554	.7805	.5515	-.2719	-.7540	-.4001	1.4154	164.7886	142.9833	-21.8054	54.7578
70.0000	2.4133	2.5858	.8770	.4045	-.1427	-3.5908	-2.2799	2.1680	171.8786	105.5619	-66.3167	65.2382
75.0000	2.4085	2.5550	.9055	.3951	-.1077	7.5157	40.6297	2.2520	173.8508	82.4408	-91.4099	66.4725
80.0000	2.4050	2.5988	.9356	.4573	-.0722	1.3341	1.5560	2.0458	175.8726	53.1449	-122.7277	63.9505

TN2= 2.5000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.4999	3.7501	.7875	.7873	-.3881	-.3886	-.0004	1.0003	158.7892	158.7635	-.0258	45.0086
40.0000	2.4748	3.7692	.8336	.7325	-.2918	-.5253	-.2025	1.1380	163.7315	152.2863	-11.4453	48.6931
45.0000	2.4656	3.7562	.8455	.7149	-.2683	-.5782	-.2683	1.1627	164.5813	149.9626	-15.0187	49.7843
50.0000	2.4443	3.8043	.8587	.6935	-.2479	-.6510	-.3524	1.2382	166.2458	146.9343	-19.4115	51.0749
70.0000	2.4467	3.8217	.9225	.5594	-.1275	-1.8791	-1.4130	1.6489	172.7315	118.0201	-54.7119	58.7646
75.0000	2.4437	3.8363	.9408	.5265	-.0963	-5.6454	-3.5949	1.7876	174.4557	100.0449	-74.4548	60.7687
80.0000	2.4416	3.8357	.9559	.5354	-.0645	3.1847	4.0892	1.7930	176.3095	72.5676	-103.7419	60.8511

TN2= 2.5000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.5000	5.0001	.8554	.8552	-.3304	-.3308	-.0004	1.0002	161.7184	161.6961	-.0223	45.0056
40.0000	2.4836	5.0330	.8877	.8158	-.2494	-.4426	-.1740	1.0891	164.9537	156.1245	-9.0688	47.4171
45.0000	2.4802	5.0400	.8960	.8027	-.2295	-.4846	-.2295	1.1161	167.0328	154.1453	-12.9274	48.1412
50.0000	2.4768	5.0469	.9050	.7866	-.2080	-.5412	-.2995	1.1506	168.2498	151.5789	-16.6708	49.0868
70.0000	2.4652	5.0705	.9485	.6724	-.1095	-1.3001	-1.0422	1.4106	173.7301	127.5664	-46.1837	54.6658
75.0000	2.4633	5.0745	.9608	.6317	-.0827	-2.4147	-1.9437	1.5208	175.2708	112.4962	-62.7745	56.6735
80.0000	2.4614	5.0775	.9735	.6099	-.0554	22.7337	-87.5871	1.5962	176.8272	87.4814	-89.3458	57.9377

TN2= 2.5000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.5000	6.2501	.8573	.8972	-.2819	-.2823	-.0003	1.0001	164.2565	164.2373	-.0193	45.0038
40.0000	2.4887	6.2789	.9206	.8683	-.2136	-.3750	-.1494	1.0603	167.5468	159.4414	-8.4592	46.6764
45.0000	2.4863	6.2844	.9265	.8585	-.1967	-.4093	-.1967	1.0793	168.8722	157.7464	-11.1768	47.1835
50.0000	2.4839	6.2904	.9330	.8462	-.1784	-.4549	-.2558	1.1026	165.8841	155.5372	-14.3469	47.7942
70.0000	2.4759	6.3108	.9639	.7522	-.0942	-1.0018	-.8796	1.2813	174.2201	134.9485	-39.2712	52.0305
75.0000	2.4746	6.3142	.9726	.7117	-.0712	-1.6987	-1.3796	1.3695	175.9292	121.8651	-54.0641	53.8026
80.0000	2.4736	6.3167	.9815	.6750	-.0477	-6.2187	-4.7592	1.4541	171.2650	94.1353	-78.1337	55.4860

TN2= 2.5000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DFLPD	DELD	PSID
2.0000	2.5000	7.5001	.9242	.9241	-.2437	-.2441	-.0003	1.0001	168.3014	166.2847	-.0168	45.0028
40.0000	2.4518	7.5248	.9415	.9022	-.1852	-.3228	-.1298	1.0435	169.5068	162.1117	-7.3952	46.2203
45.0000	2.4501	7.5300	.9459	.8948	-.1707	-.3535	-.1707	1.0572	170.3155	160.6316	-9.6845	46.5920
50.0000	2.4883	7.5352	.9507	.8853	-.1549	-.3896	-.2216	1.0739	171.1576	158.7128	-12.4849	47.0417
70.0000	2.4825	7.5529	.9735	.8087	-.0815	-.8178	-.6857	1.2039	175.3186	140.7231	-34.9555	50.2856
75.0000	2.4815	7.5559	.9759	.7715	-.0619	-1.2284	-1.0840	1.2701	176.4577	129.1485	-47.3048	51.7457
80.0000	2.4808	7.5581	.9865	.7292	-.0415	-3.0005	-2.6313	1.3528	177.6235	108.4321	-65.1514	53.5296

TN2= 2.5000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.5000	10.0001	.9544	.9544	-.1899	-.1901	-.0002	1.0001	165.2473	169.2342	-.0131	45.0016
40.0000	2.4952	10.0154	.9650	.9410	-.1448	-.2501	-.1017	1.0255	171.7620	165.9576	-5.8044	45.7213
45.0000	2.4941	10.0235	.9676	.9363	-.1335	-.2718	-.1335	1.0335	172.3566	164.7932	-7.6034	45.9428
50.0000	2.4931	10.0276	.9705	.9303	-.1212	-.3003	-.1728	1.0432	173.0885	163.2832	-9.8058	46.2123
70.0000	2.4857	10.0415	.9842	.8786	-.0642	-.6008	-.5166	1.1203	176.3240	149.0023	-27.3717	48.7462
75.0000	2.4891	10.0438	.9880	.8459	-.0486	-.8501	-.7697	1.1625	177.2184	139.6324	-37.5860	49.2979
80.0000	2.4887	10.0456	.9920	.8051	-.0326	-1.5877	-1.4782	1.2260	178.1338	122.2128	-55.5211	50.7978

TN2= 2.5000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.5000	15.0000	.9787	.9787	-.1302	-.1304	-.0002	1.0000	172.5811	172.5720	-.0091	45.0007
40.0000	2.4578	15.0134	.9837	.9723	-.0996	-.1707	-.0700	1.0117	174.3148	170.3105	-4.0044	45.3328
45.0000	2.4573	15.0162	.9849	.9700	-.0918	-.1852	-.0918	1.0153	174.7525	169.5051	-5.2475	45.4357
50.0000	2.4568	15.0150	.9863	.9671	-.0834	-.2042	-.1187	1.0158	175.2301	168.4592	-6.7709	45.5614
70.0000	2.4952	15.0266	.9927	.9405	-.0443	-.3946	-.3443	1.0555	177.4625	158.4663	-18.9562	46.5467
75.0000	2.4950	15.0302	.9945	.9240	-.0335	-.5365	-.4945	1.0763	178.0798	151.7672	-26.3126	47.1041
80.0000	2.4948	15.0314	.9963	.8959	-.0225	-.8744	-.8355	1.1121	178.7117	138.8344	-35.8773	48.0370

TN2= 2.5000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.5000	25.0000	.9921	.9921	-.0793	-.0794	-.0001	1.0000	175.4668	175.4613	-.0055	45.0003
40.0000	2.4992	25.0082	.9940	.9857	-.0607	-.1037	-.0427	1.0043	176.5256	174.0790	-2.4467	45.1222
45.0000	2.4990	25.0095	.9944	.9889	-.0560	-.1124	-.0560	1.0056	176.7530	173.5860	-3.2070	45.1601
50.0000	2.4588	25.0116	.9949	.9878	-.0509	-.1238	-.0724	1.0072	177.0848	172.9452	-4.1396	45.2066
70.0000	2.4983	25.0175	.9973	.9774	-.0271	-.2349	-.2065	1.0204	178.4490	166.7792	-11.6697	45.5786
75.0000	2.4982	25.0185	.9980	.9705	-.0205	-.3137	-.2913	1.0283	178.8263	162.5843	-16.2420	45.7999
80.0000	2.4981	25.0192	.9986	.9575	-.0137	-.4818	-.4650	1.0430	175.2125	154.2738	-24.5387	46.2053

TN2= 2.5000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.5000	50.0000	.9980	.9980	-.0399	-.0199	-.0000	1.0000	177.7156	177.7128	-.0028	45.0001
40.0000	2.4998	50.0041	.9985	.9974	-.0306	-.0521	-.0215	1.0011	178.2490	177.0161	-1.2329	45.0308
45.0000	2.4598	50.0050	.9986	.9972	-.0282	-.0565	-.0282	1.0014	178.3837	176.7675	-1.6163	45.0404
50.0000	2.4997	50.0059	.9987	.9969	-.0256	-.0621	-.0364	1.0018	178.5308	176.4442	-2.0866	45.0521
70.0000	2.4556	50.0088	.9993	.9942	-.0136	-.1171	-.1033	1.0051	179.2183	173.3222	-5.8561	45.1471
75.0000	2.4995	50.0053	.9995	.9924	-.0103	-.1551	-.1446	1.0072	175.4084	171.1828	-8.2256	45.2048
80.0000	2.4595	50.0057	.9997	.9887	-.0069	-.2329	-.2256	1.0111	175.6031	166.8853	-12.7138	45.3151

TN2= 3.0000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANDP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.9598	.3000	.5044	.5040	-.0741	-.0742	-.0001	1.0008	175.7607	175.7561	-.0046	45.0230
40.0000	2.9311	.3071	.5894	.4080	-.0581	-.0978	-.0355	1.4448	176.6755	174.4159	-2.2596	55.3122
45.0000	2.9164	.3086	.6134	.3763	-.0539	-.1081	-.0539	1.6302	176.9161	173.8321	-3.0840	58.4747
50.0000	2.9016	.3102	.6408	.3370	-.0492	-.1234	-.0737	1.9015	177.1825	172.9663	-4.2163	62.2598
70.0000	2.8507	.3157	.7881	.0601	-.0266	-1.1018	-1.0445	13.1211	178.4745	132.2268	-46.2477	85.6417
75.0000	2.8421	.3167	.8350	.1068	-.0202	.4494	.4739	7.8148	178.8422	24.1587	-154.6436	82.7079
80.0000	2.8356	.3174	.8859	.2910	-.0136	.1399	.1538	3.0446	175.2215	7.9648	-171.2567	71.8173

TN2= 3.0000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	CELSD	DELPD	DELD	PSID
2.0000	2.9958	.6000	.5164	.5160	-.1435	-.1436	-.0002	1.0008	171.8760	171.8770	-.0090	45.0274
40.0000	2.9332	.6137	.6007	.4209	-.1120	-.1898	-.0762	1.4270	173.6084	169.2517	-4.3567	54.9777
45.0000	2.9190	.6167	.6243	.3897	-.1038	-.2099	-.1038	1.6018	174.0732	168.1467	-5.5268	58.0240
50.0000	2.9047	.6157	.6512	.3512	-.0947	-.2396	-.1417	1.8541	174.5874	166.5250	-8.0624	61.6605
70.0000	2.8556	.6303	.7951	.0958	-.0511	-1.9488	-1.7258	7.9649	177.0736	117.1637	-55.9099	82.8439
75.0000	2.8472	.6322	.8406	.1279	-.0388	.9396	1.0154	6.5658	177.7754	43.2168	-134.5626	81.3454
80.0000	2.8410	.6336	.8900	.2966	-.0261	.2831	.3115	3.0004	178.5071	15.8080	-167.6991	71.5673

TN2= 3.0000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	CFLSD	DELPD	DELD	PSID
2.0000	2.9998	.9001	.5351	.5347	-.2042	-.2044	-.0002	1.0007	168.4590	168.4462	-.0128	45.0213
40.0000	2.9364	.9155	.6179	.4412	-.1586	-.2714	-.1081	1.4004	170.9869	164.8176	-6.1689	54.4703
45.0000	2.9229	.9237	.6409	.4108	-.1468	-.3002	-.1468	1.5603	171.6464	163.2925	-8.3536	57.3440
50.0000	2.9094	.9280	.6671	.3734	-.1339	-.3425	-.1955	1.7866	172.3755	161.0913	-11.2842	60.7632
70.0000	2.8629	.9431	.8057	.1435	-.0719	-2.4367	-2.0121	5.6151	175.8859	112.3126	-63.5733	79.9019
75.0000	2.8551	.9457	.8451	.1570	-.0545	1.5280	1.7263	5.4096	176.8791	56.7968	-120.0824	79.5267
80.0000	2.8452	.9476	.8960	.3057	-.0366	.4331	.4773	2.9314	177.5025	23.4172	-154.4853	71.1636

TN2= 3.0000 TK= .5000

PHID	A	B	RS	RP	TANCS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.9998	1.5001	.5854	.5850	-.2925	-.2929	-.0001	1.0007	163.6555	163.6768	-.0186	45.0186
40.0000	2.9448	1.5281	.6631	.4967	-.2247	-.3921	-.1538	1.3350	167.3372	158.5922	-8.7450	53.1650
45.0000	2.9332	1.5342	.6844	.4684	-.2075	-.4336	-.2075	1.4612	168.2788	156.5577	-11.7212	55.6132
50.0000	2.9216	1.5403	.7084	.4339	-.1887	-.4938	-.2792	1.6325	165.3153	153.7181	-15.5972	58.5107
70.0000	2.8815	1.5615	.8323	.2329	-.1005	-2.5931	-1.9773	3.5737	174.2602	111.0984	-63.1718	74.3673
75.0000	2.8752	1.5651	.8703	.2254	-.0761	3.5413	4.9513	3.8604	175.6495	74.2312	-101.4183	75.4772
80.0000	2.8702	1.5678	.9110	.3321	-.0510	.7698	.8544	2.7430	171.0776	37.5880	-135.4896	65.9658

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TN2= 3.0000 TK= 1.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.9999	3.0001	.7213	.7210	-.3527	-.3532	-.0004	1.0004	160.5716	160.5483	-.0233	45.0116
40.0000	2.9658	3.0344	.7792	.6530	-.2669	-.4752	-.1848	1.1932	165.0547	154.5845	-10.4702	50.0356
45.0000	2.9586	3.0420	.7945	.6312	-.2457	-.5230	-.2457	1.2587	166.1543	152.3866	-13.8057	51.5333
50.0000	2.9515	3.0493	.8114	.6046	-.2228	-.5895	-.3241	1.3621	167.4408	149.4808	-17.9601	53.3092
70.0000	2.9273	3.0745	.8951	.4389	-.1175	-1.8131	-1.3980	2.0352	173.3008	118.8781	-54.4278	63.8773
75.0000	2.9233	3.0787	.9196	.4017	-.0987	-7.4023	-4.4139	2.2890	174.5784	97.6538	-77.2346	66.4006
80.0000	2.9203	3.0819	.9453	.4257	-.0595	2.2111	2.6144	2.2204	176.5963	65.6645	-110.5318	65.7550

TN2= 3.0000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	2.9999	4.5001	.8180	.8178	-.3184	-.3188	-.0004	1.0003	162.3397	162.3182	-.0215	45.0071
40.0000	2.9789	4.5318	.8578	.7696	-.2409	-.4260	-.1679	1.1147	166.4569	156.5272	-9.5296	48.1054
45.0000	2.9746	4.5385	.8681	.7537	-.2217	-.4664	-.2217	1.1519	167.4577	154.9953	-12.5024	49.0376
50.0000	2.9702	4.5452	.8795	.7340	-.2010	-.5211	-.2897	1.1982	168.6338	152.4778	-16.1560	50.1528
70.0000	2.9553	4.5680	.9341	.5964	-.1060	-1.2732	-1.0284	1.5662	173.5504	128.1412	-45.8031	57.4417
75.0000	2.9528	4.5715	.9458	.5487	-.0801	-2.4519	-1.9826	1.7310	175.4218	112.1891	-63.2337	59.9852
80.0000	2.9510	4.5747	.9660	.5266	-.0537	11.8658	32.8145	1.8346	176.9283	85.1827	-91.7456	61.4062

TN2= 3.0000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	6.0001	.8771	.8770	-.2726	-.2729	-.0003	1.0002	164.7542	164.7356	-.0186	45.0046
40.0000	2.9863	6.0275	.9047	.8428	-.2069	-.3622	-.1446	1.0734	166.3177	160.0884	-8.2293	47.0282
45.0000	2.9834	6.0333	.9118	.8313	-.1904	-.3952	-.1904	1.0968	169.2173	158.4346	-10.7827	47.6427
50.0000	2.9806	6.0391	.9195	.8169	-.1728	-.4392	-.2477	1.1257	170.1588	156.2881	-13.9106	48.3833
70.0000	2.9709	6.0588	.9564	.7066	-.0913	-.9672	-.8049	1.3536	174.7861	135.9565	-38.8296	53.5449
75.0000	2.9693	6.0621	.9669	.6590	-.0690	-1.5548	-1.3419	1.4671	176.0547	122.7485	-53.3061	55.7210
80.0000	2.9681	6.0646	.9777	.6159	-.0462	-6.0738	-4.7061	1.5874	177.3531	99.3494	-78.0037	57.7906

TN2= 3.0000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	7.5001	.9132	.9131	-.2333	-.2336	-.0003	1.0001	166.8670	166.8509	-.0161	45.0032
40.0000	2.9905	7.5237	.9330	.8883	-.1774	-.3086	-.1244	1.0503	169.9382	162.8485	-7.0893	46.4042
45.0000	2.9886	7.5287	.9380	.8798	-.1635	-.3360	-.1635	1.0661	170.7133	161.4265	-9.2868	46.8326
50.0000	2.9866	7.5337	.9435	.8691	-.1484	-.3723	-.2121	1.0856	171.5568	159.5819	-11.9770	47.3515
70.0000	2.9799	7.5507	.9696	.7818	-.0785	-.7770	-.6583	1.2403	175.5101	142.1535	-33.3566	51.1216
75.0000	2.9787	7.5535	.9769	.7390	-.0594	-1.1590	-1.0288	1.3220	176.6025	130.7885	-45.8140	52.8949
80.0000	2.9779	7.5556	.9844	.6890	-.0398	-2.7317	-2.4279	1.4288	177.1207	110.1063	-67.6143	55.0116

TN2= 3.0000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	9.0001	.9361	.9361	-.2021	-.2024	-.0002	1.0001	168.5733	168.5593	-.0140	45.0023
40.0000	2.9931	9.0206	.9508	.9175	-.1540	-.2665	-.1081	1.0363	171.2453	165.0772	-6.1681	46.0209
45.0000	2.9917	9.0250	.9545	.9111	-.1420	-.2898	-.1420	1.0477	171.9197	163.8353	-8.0803	46.3339
50.0000	2.9903	9.0293	.9586	.9029	-.1289	-.3204	-.1839	1.0617	172.6554	162.2338	-10.4216	46.7141
70.0000	2.9854	9.0441	.9778	.8335	-.0683	-.6486	-.5557	1.1731	176.0533	147.0337	-25.0596	49.5544
75.0000	2.9846	9.0466	.9831	.7965	-.0516	-.9308	-.8389	1.2343	177.0438	137.0515	-39.9920	50.9854
80.0000	2.9839	9.0484	.9887	.7469	-.0346	-1.8390	-1.6963	1.3237	178.0167	118.5366	-55.4801	52.9295

TN2= 3.0000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	12.0000	.9618	.9617	-.1578	-.1580	-.0002	1.0000	171.0329	171.0219	-.0110	45.0013
40.0000	2.9960	12.0162	.9706	.9504	-.1205	-.2073	-.0847	1.0213	173.1289	168.2887	-4.8402	45.6026
45.0000	2.9951	12.0196	.9729	.9464	-.1111	-.2251	-.1111	1.0279	173.6580	167.3161	-6.3420	45.7883
50.0000	2.9943	12.0230	.9753	.9413	-.1010	-.2483	-.1438	1.0361	174.2353	166.0536	-8.1817	46.0149
70.0000	2.9914	12.0346	.9868	.8960	-.0536	-.4870	-.4224	1.1014	176.9334	154.0341	-22.8994	47.7622
75.0000	2.9909	12.0365	.9900	.8693	-.0405	-.6736	-.6162	1.1388	177.6795	146.0375	-31.6420	48.7135
80.0000	2.9905	12.0380	.9933	.8276	-.0272	-1.1579	-1.0962	1.2002	178.4432	130.8145	-47.6286	50.2000

TN2= 3.0000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	18.0000	.9822	.9822	-.1084	-.1085	-.0001	1.0000	173.8152	173.8076	-.0075	45.0006
40.0000	2.9981	18.0112	.9863	.9768	-.0829	-.1419	-.0583	1.0097	175.2601	171.9219	-3.3382	45.2777
45.0000	2.9978	18.0135	.9874	.9749	-.0765	-.1535	-.0765	1.0128	175.6250	171.2495	-4.3750	45.3636
50.0000	2.9974	18.0159	.9885	.9725	-.0695	-.1696	-.0989	1.0165	176.0231	170.3765	-5.6462	45.4689
70.0000	2.9960	18.0239	.9939	.9497	-.0369	-.3248	-.2845	1.0465	177.8842	162.0051	-15.8791	46.3020
75.0000	2.9958	18.0252	.9954	.9352	-.0280	-.4379	-.4050	1.0643	178.3589	156.3512	-22.0477	46.7850
80.0000	2.9956	18.0262	.9969	.9094	-.0188	-.6925	-.6652	1.0963	178.9258	145.2958	-33.6300	47.6292

TN2= 3.0000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	30.0000	.9934	.9934	-.0660	-.0661	-.0001	1.0000	176.2217	176.2171	-.0046	45.0002
40.0000	2.9993	30.0048	.9950	.9914	-.0506	-.0863	-.0356	1.0036	177.1041	175.0650	-2.0392	45.1019
45.0000	2.9992	30.0082	.9953	.9907	-.0467	-.0936	-.0467	1.0047	177.3270	174.6535	-2.6730	45.1335
50.0000	2.9990	30.0057	.9958	.9898	-.0424	-.1030	-.0603	1.0060	177.5702	174.1196	-3.4506	45.1723
70.0000	2.9985	30.0146	.9977	.9810	-.0226	-.1949	-.1716	1.0170	178.7072	168.9705	-9.7367	45.4840
75.0000	2.9985	30.0154	.9983	.9752	-.0171	-.2594	-.2413	1.0237	179.0217	165.4569	-13.5648	45.6711
80.0000	2.9984	30.0160	.9989	.9639	-.0115	-.3947	-.3815	1.0362	179.3436	158.4594	-20.8842	46.0197

TN2= 3.0000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.0000	60.0000	.9989	.9983	-.0332	-.0333	-.0000	1.0000	178.0562	178.0939	-.0023	45.0000
40.0000	2.9998	60.0036	.5987	.9978	-.0255	-.0434	-.0119	1.0009	178.5408	177.5139	-1.0275	45.0297
45.0000	2.9990	60.0042	.5988	.9977	-.0239	-.0471	-.0239	1.0012	178.6530	177.3081	-1.3470	45.0376
50.0000	2.9998	60.0049	.9989	.9974	-.0214	-.0518	-.0306	1.0015	178.7756	177.0366	-1.7390	45.0436
70.0000	2.9997	60.0073	.5994	.9952	-.0114	-.0975	-.0860	1.0043	175.3485	174.4335	-4.9150	45.1227
75.0000	2.9996	60.0078	.9956	.9936	-.0086	-.1290	-.1203	1.0060	175.5030	172.6481	-6.8556	45.1710
80.0000	2.9996	60.0081	.5547	.9906	-.0058	-.1933	-.1873	1.0092	175.8892	169.0806	-10.6086	45.2636

TN2= 4.0000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.9998	.4000	.6036	.6032	-.0527	-.0528	-.0001	1.0006	176.9810	176.9774	-.0035	45.0173
40.0000	3.9485	.4052	.6780	.5165	-.0409	-.0693	-.0283	1.3175	177.6567	176.0372	-1.6191	52.6967
45.0000	3.9377	.4063	.6583	.4877	-.0379	-.0759	-.0379	1.4320	177.8307	175.6614	-2.1693	55.0719
50.0000	3.9267	.4075	.7213	.4517	-.0345	-.0851	-.0506	1.5970	178.0226	175.1355	-2.8872	57.9461
70.0000	3.8892	.4114	.8400	.1776	-.0185	-.2659	-.2462	4.7107	178.5375	165.1053	-13.4785	78.0641
75.0000	3.8829	.4121	.8763	.0581	-.0141	-1.3589	-1.3196	15.0867	175.1549	126.7496	-52.0454	86.2077
80.0000	3.8782	.4126	.9152	.1697	-.0094	.2781	.2865	5.3939	175.6592	15.2431	-161.9161	79.4970

TN2= 4.0000 TK= .2000

PHIC	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.9999	.8000	.6133	.6130	-.1022	-.1024	-.0001	1.0006	174.1622	174.1555	-.0067	45.0168
40.0000	3.9501	.8101	.6866	.5276	-.0792	-.1345	-.0547	1.3013	175.4720	172.3398	-3.1324	52.4557
45.0000	3.9395	.8123	.7066	.4992	-.0733	-.1473	-.0733	1.4153	175.8098	171.6156	-4.1902	54.7565
50.0000	3.9289	.8145	.7291	.4639	-.0667	-.1652	-.0974	1.5717	176.1813	170.6176	-5.5637	57.5325
70.0000	3.8527	.8221	.8445	.2003	-.0358	-.5075	-.4631	4.2179	177.5502	153.0940	-24.4562	76.4674
75.0000	3.8865	.8234	.8862	.1016	-.0271	-2.2888	-2.1295	8.6608	178.4466	113.6007	-64.8459	83.4136
80.0000	3.8820	.8243	.9179	.1428	-.0182	.5718	.5962	5.0222	178.5564	29.7594	-149.1970	78.7388

TN2= 4.0000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	3.9999	1.2000	.6286	.6282	-.1459	-.1461	-.0002	1.0006	171.6593	171.6895	-.0096	45.0160
40.0000	3.9524	1.2144	.6999	.5449	-.1127	-.1923	-.0780	1.2844	173.5655	169.1126	-4.4574	52.0971
45.0000	3.9424	1.2175	.7192	.5173	-.1042	-.2107	-.1042	1.3504	174.0513	168.1727	-5.9487	54.2753
50.0000	3.9323	1.2207	.7410	.4830	-.0949	-.2367	-.1381	1.5342	174.5903	166.7083	-7.8720	56.9039
70.0000	3.8579	1.2314	.8523	.2329	-.0508	-.7065	-.6231	3.6554	177.0538	144.7574	-32.3369	74.7171
75.0000	3.8520	1.2333	.8861	.1477	-.0385	-2.7111	-2.4204	6.0000	177.7575	110.2465	-67.5514	80.5377
80.0000	3.8877	1.2347	.9220	.2026	-.0258	.8997	.9415	4.5514	178.5211	41.5782	-136.5430	77.6081

TN2= 4.0000 TK= .5000

PHIC	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	CELD	PSID
2.0000	3.9559	2.0001	.6657	.6694	-.2104	-.2107	-.0002	1.0005	168.1183	168.1044	-.0140	45.0139
40.0000	3.9586	2.0209	.7353	.5922	-.1615	-.2786	-.1120	1.2415	170.8243	164.4338	-6.3906	51.1499
45.0000	3.9499	2.0253	.7529	.5668	-.1491	-.3051	-.1491	1.3283	171.5165	163.0338	-8.4831	53.0252
50.0000	3.9412	2.0298	.7725	.5353	-.1356	-.3417	-.1969	1.4432	172.2763	161.1358	-11.1406	55.2821
70.0000	3.9115	2.0452	.8716	.3123	-.0722	-.9529	-.8239	2.7906	175.8821	136.1815	-35.4965	70.2953
75.0000	3.9065	2.0475	.9013	.2396	-.0547	-2.6748	-2.2858	3.7612	176.8704	110.4588	-66.3715	75.1111
80.0000	3.9028	2.0498	.9326	.2548	-.0367	1.7829	1.9470	3.6605	177.8988	60.7131	-117.1858	74.7203

TN2= 4.0000 TK= 1.0000

PHIC	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	CELD	PSID
2.0000	3.5599	4.0001	.7810	.7907	-.2579	-.2582	-.0003	1.0003	165.5384	165.5210	-.0175	45.0087
40.0000	3.9743	4.0255	.8277	.7243	-.1963	-.3425	-.1369	1.1429	168.8521	161.0541	-7.7980	48.8144
45.0000	3.9689	4.0314	.8399	.7055	-.1810	-.3742	-.1810	1.1906	165.7423	159.4848	-10.2577	49.9719
50.0000	3.9635	4.0368	.8534	.6821	-.1643	-.4169	-.2369	1.2511	170.6713	157.3678	-13.3035	51.3655
70.0000	3.9452	4.0556	.9193	.5118	-.0870	-.9839	-.8262	1.7960	175.0291	135.4657	-39.5634	60.8911
75.0000	3.9421	4.0587	.9383	.4459	-.0658	-1.7850	-1.5387	2.1040	176.2374	119.2581	-56.9793	64.5754
80.0000	3.9399	4.0611	.9582	.4055	-.0441	38.4917	-55.2619	2.3631	177.4751	88.5115	-88.9633	67.0636

TN2= 4.0000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	CELD	PSID
2.0000	4.0000	6.0001	.8950	.8588	-.2351	-.2354	-.0003	1.0002	166.7675	166.7514	-.0161	45.0054
40.0000	3.9842	6.0238	.8903	.8201	-.1789	-.3112	-.1253	1.0858	169.8543	162.7136	-7.1407	47.3500
45.0000	3.9809	6.0289	.8983	.8069	-.1649	-.3391	-.1649	1.1132	170.6344	161.2687	-9.3656	48.0665
50.0000	3.9775	6.0335	.9072	.7904	-.1497	-.3761	-.2144	1.1477	171.4858	159.3869	-12.0989	48.9333
70.0000	3.9663	6.0510	.9496	.6611	-.0792	-.8070	-.6840	1.4363	175.4688	141.0572	-34.3716	55.1536
75.0000	3.9644	6.0539	.9616	.6017	-.0599	-1.2517	-1.1086	1.5982	176.5710	128.6721	-47.5489	57.9659
80.0000	3.9630	6.0560	.9741	.5401	-.0402	-3.7088	-3.1929	1.8035	177.6553	105.0897	-72.6096	60.9920

TN2= 4.0000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DFLPD	DFLD	PSID
2.0000	4.0000	8.0001	.9057	.9056	-.2026	-.2027	-.0002	1.0001	168.5576	168.5437	-.0140	45.0035
40.0000	3.9897	8.0207	.9270	.8788	-.1543	-.2669	-.1082	1.0549	171.2305	165.0550	-6.1759	46.5316
45.0000	3.9875	8.0250	.9325	.8695	-.1422	-.2903	-.1422	1.0724	171.9059	163.8117	-8.0942	47.0010
50.0000	3.9854	8.0253	.9385	.8578	-.1291	-.3211	-.1846	1.0940	172.6424	162.1965	-10.4459	47.5712
70.0000	3.9781	8.0441	.9668	.7605	-.0684	-.6560	-.5623	1.2713	176.0856	146.7360	-29.3456	51.8125
75.0000	3.9768	8.0466	.9748	.7102	-.0517	-.9527	-.8586	1.3725	177.0375	136.3883	-40.6496	53.9730
80.0000	3.9759	8.0485	.9830	.6456	-.0347	-1.9800	-1.8202	1.5227	178.0127	116.7965	-61.2162	56.7053

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TN2= 4.0000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.0000	10.0001	.9338	.9338	-.1738	-.1740	-.0002	1.0001	170.1402	170.1282	-.0120	45.0024
40.0000	3.9929	10.0178	.9490	.9149	-.1326	-.2286	-.0932	1.0377	172.4444	167.1229	-5.3219	46.0586
45.0000	3.9914	10.0215	.9528	.9078	-.1223	-.2404	-.1228	1.0499	173.0261	166.0922	-6.9739	46.3843
50.0000	3.9895	10.0253	.9570	.8993	-.1111	-.2743	-.1586	1.0642	173.6608	164.6623	-8.9989	46.7810
70.0000	3.9848	10.0380	.9769	.8259	-.0589	-.5454	-.4713	1.1835	176.6276	151.3528	-25.2748	49.8029
75.0000	3.9840	10.0402	.9825	.7843	-.0446	-.7666	-.6987	1.2526	177.4483	142.5266	-34.9215	51.3988
80.0000	3.9834	10.0418	.9882	.7245	-.0299	-1.3964	-1.3118	1.3640	178.2879	125.6074	-52.6809	53.7543

TN2= 4.0000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.0000	12.0000	.9519	.9519	-.1508	-.1510	-.0002	1.0001	171.4216	171.4111	-.0105	45.0017
40.0000	3.9948	12.0155	.9627	.9372	-.1152	-.1981	-.0810	1.0272	173.4263	168.7561	-4.6702	45.7687
45.0000	3.9938	12.0187	.9655	.9322	-.1063	-.2150	-.1063	1.0357	173.9324	167.8647	-6.0676	46.0058
50.0000	3.9927	12.0220	.9686	.9258	-.0966	-.2372	-.1375	1.0463	174.4846	166.6593	-7.8253	46.2952
70.0000	3.9890	12.0331	.9832	.8688	-.0513	-.4642	-.4034	1.1317	177.0659	155.0986	-21.9670	48.5345
75.0000	3.9884	12.0350	.9872	.8354	-.0388	-.6406	-.5873	1.1818	177.7797	147.3555	-30.4242	49.7633
80.0000	3.9879	12.0363	.9914	.7827	-.0260	-1.0930	-1.0376	1.2866	178.5104	132.4545	-46.0558	51.7088

TN2= 4.0000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.0000	16.0000	.9711	.9711	-.1180	-.1182	-.0001	1.0000	173.2697	173.2615	-.0082	45.0010
40.0000	3.9970	16.0121	.9778	.9625	-.0903	-.1546	-.0635	1.0159	174.8422	171.2096	-3.6326	45.4530
45.0000	3.9963	16.0147	.9795	.9594	-.0833	-.1677	-.0833	1.0209	175.2392	170.4784	-4.7608	45.5932
50.0000	3.9957	16.0173	.9814	.9555	-.0757	-.1848	-.1076	1.0271	175.6724	169.5289	-6.1439	45.7647
70.0000	3.9935	16.0260	.9900	.9195	-.0402	-.3556	-.3110	1.0767	177.6577	160.4240	-17.2737	47.1159
75.0000	3.9932	16.0274	.9925	.8970	-.0304	-.4817	-.4447	1.1064	178.2578	154.2815	-23.9763	47.8905
80.0000	3.9929	16.0285	.9949	.8583	-.0204	-.7730	-.7409	1.1592	178.8311	142.2971	-36.5340	49.2176

TN2= 4.0000 TK= 6.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.0000	24.0000	.9866	.9866	-.0812	-.0813	-.0001	1.0000	175.3598	175.3535	-.0057	45.0005
40.0000	3.9986	24.0084	.9897	.9825	-.0622	-.1062	-.0437	1.0073	176.4434	173.9389	-2.5045	45.2085
45.0000	3.9983	24.0101	.9905	.9811	-.0574	-.1151	-.0574	1.0096	176.7171	173.4342	-3.2829	45.2732
50.0000	3.9980	24.0119	.9914	.9792	-.0521	-.1267	-.0741	1.0124	177.0158	172.7783	-4.2375	45.3524
70.0000	3.9970	24.0179	.9954	.9617	-.0277	-.2407	-.2116	1.0350	178.4122	166.4661	-11.9461	45.9864
75.0000	3.9969	24.0189	.9965	.9502	-.0210	-.3216	-.2986	1.0487	178.7989	162.1714	-16.6271	46.3630
80.0000	3.9967	24.0197	.9977	.9287	-.0141	-.4950	-.4776	1.0743	179.1935	153.6625	-25.5314	47.0510

TN2= 4.0000 TK=10.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.0000	40.0000	.9951	.9951	-.0495	-.0496	-.0001	1.0000	177.1659	177.1624	-.0035	45.0002
40.0000	3.9995	40.0051	.9962	.9936	-.0379	-.0647	-.0267	1.0027	177.8277	176.2981	-1.5296	45.0764
45.0000	3.9994	40.0062	.9965	.9930	-.0350	-.0701	-.0350	1.0035	177.9948	175.9897	-2.0052	45.1002
50.0000	3.9993	40.0073	.9968	.9923	-.0318	-.0771	-.0452	1.0045	178.1772	175.5887	-2.5886	45.1293
70.0000	3.9989	40.0109	.9983	.9857	-.0169	-.1456	-.1283	1.0128	179.0302	171.7187	-7.3115	45.3643
75.0000	3.9988	40.0115	.9987	.9812	-.0128	-.1931	-.1799	1.0178	179.2661	169.0701	-10.1960	45.5067
80.0000	3.9988	40.0120	.9991	.9724	-.0086	-.2911	-.2818	1.0275	179.5076	163.7671	-15.7405	45.7765

TN2= 4.0000 TK=20.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.0000	80.0000	.9988	.9988	-.0249	-.0250	-.0000	1.0000	178.5721	178.5704	-.0017	45.0000
40.0000	3.9999	80.0026	.9990	.9984	-.0191	-.0326	-.0135	1.0007	178.9059	178.1349	-.7706	45.0192
45.0000	3.9998	80.0031	.9991	.9982	-.0176	-.0353	-.0176	1.0009	178.9897	177.9755	-1.0103	45.0252
50.0000	3.9998	80.0037	.9992	.9981	-.0160	-.0388	-.0228	1.0011	179.0816	177.7773	-1.3043	45.0326
70.0000	3.9997	80.0055	.9996	.9964	-.0085	-.0730	-.0644	1.0032	179.5114	175.8235	-3.6874	45.0921
75.0000	3.9997	80.0058	.9997	.9952	-.0065	-.0966	-.0901	1.0045	179.6302	174.4833	-5.1469	45.1285
80.0000	3.9997	80.0060	.9998	.9929	-.0043	-.1444	-.1400	1.0070	179.7519	171.7851	-7.9668	45.1985

TN2= 5.0000 TK= .1000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.9998	.5000	.6697	.6694	-.0412	-.0413	-.0000	1.0005	177.6400	177.6372	-.0028	45.0138
40.0000	4.9589	.5041	.7348	.5920	-.0318	-.0540	-.0221	1.2412	178.1763	176.9075	-1.2688	51.1437
45.0000	4.9503	.5050	.7523	.5660	-.0294	-.0589	-.0294	1.3292	178.3137	176.6274	-1.6863	53.0449
50.0000	4.9416	.5059	.7719	.5334	-.0268	-.0656	-.0387	1.4473	178.4644	176.2457	-2.2188	55.3573
70.0000	4.9118	.5090	.8711	.2766	-.0143	-.1630	-.1483	3.1492	179.1781	170.7419	-8.4366	72.3834
75.0000	4.9068	.5095	.9009	.1477	-.0109	-.3360	-.3239	6.0992	179.277	161.4300	-17.8474	80.6888
80.0000	4.9031	.5099	.9323	.0756	-.0073	.0140	.0262	12.3306	179.5820	39.1494	-140.4366	85.3635

TN2= 5.0000 TK= .2000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.9999	1.0000	.6780	.6777	-.0800	-.0800	-.0001	1.0009	175.4288	175.4234	-.0054	45.0194
40.0000	4.9601	1.0080	.7419	.6017	-.0617	-.1049	-.0429	1.2431	176.4695	174.0112	-2.4583	50.9589
45.0000	4.9517	1.0097	.7590	.5761	-.0570	-.1144	-.0570	1.3175	176.7359	173.4718	-3.2641	52.8004
50.0000	4.9431	1.0115	.7782	.5441	-.0519	-.1274	-.0750	1.4302	177.0280	172.7392	-4.2889	55.0385
70.0000	4.9149	1.0174	.8749	.2943	-.0278	-.3139	-.2836	2.9726	178.4099	162.5745	-15.8354	71.4067
75.0000	4.9096	1.0184	.9038	.1744	-.0210	-.6336	-.6045	5.1810	178.7558	147.6418	-31.1538	79.0755
80.0000	4.9060	1.0192	.9344	.1086	-.0141	1.8086	1.8705	8.6025	179.1514	61.0619	-118.1299	83.3724

TN2= 5.0000 TK= .3000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.9999	1.5000	.6909	.6906	-.1142	-.1144	-.0001	1.0004	173.4840	173.4764	-.0077	45.0120
40.0000	4.9620	1.5115	.7520	.6167	-.0880	-.1501	-.0613	1.2207	174.9717	171.4661	-3.5056	50.6752
45.0000	4.9540	1.5139	.7694	.5920	-.0813	-.1637	-.0813	1.2997	175.3515	170.7038	-4.6481	52.4256
50.0000	4.9460	1.5164	.7879	.5609	-.0740	-.1822	-.1068	1.4046	175.7687	169.6735	-6.0951	54.5511
70.0000	4.9185	1.5248	.8807	.3211	-.0395	-.4431	-.3966	2.7430	177.7375	156.1030	-21.6345	69.9701
75.0000	4.9139	1.5263	.9084	.2110	-.0299	-.8674	-.8163	4.3041	178.2864	139.0623	-39.2242	76.9202
80.0000	4.9105	1.5273	.9375	.1476	-.0201	3.3326	3.5932	6.3521	178.8456	73.2975	-105.5522	81.0534

TN2= 5.0000 TK= .5000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.9999	2.5000	.7256	.7255	-.1652	-.1654	-.0002	1.0004	170.6701	170.6089	-.0112	45.0112
40.0000	4.9669	2.5166	.7821	.6579	-.1268	-.2176	-.0884	1.1888	172.7756	167.7242	-5.0514	49.9790
45.0000	4.9600	2.5202	.7971	.6353	-.1170	-.2373	-.1170	1.2546	173.3247	166.6453	-6.6753	51.4431
50.0000	4.9530	2.5237	.8137	.6070	-.1064	-.2640	-.1533	1.3406	173.9257	165.2128	-8.7129	53.2786
70.0000	4.9293	2.5359	.8561	.3906	-.0567	-.6200	-.5442	2.2941	176.7567	148.2030	-28.5537	66.4477
75.0000	4.9253	2.5379	.9203	.2958	-.0429	-1.1264	-1.0336	3.1109	177.5443	131.5990	-45.9452	72.1797
80.0000	4.9223	2.5395	.9458	.2296	-.0288	21.2817	54.9834	4.1188	178.3517	87.3097	-91.0420	76.3532

TN2= 5.0000 TK= 1.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	4.9999	5.0001	.8199	.8197	-.2040	-.2042	-.0002	1.0002	168.4724	168.4584	-.0140	45.0070
40.0000	4.9794	5.0207	.8590	.7717	-.1557	-.2692	-.1089	1.1132	171.1521	164.9343	-6.2178	48.0655
45.0000	4.9751	5.0251	.8692	.7554	-.1436	-.2932	-.1436	1.1505	171.8305	163.6610	-8.1695	49.0041
50.0000	4.9707	5.0294	.8804	.7350	-.1304	-.3251	-.1869	1.1978	172.5715	161.9527	-10.5748	50.1471
70.0000	4.9580	5.0443	.9345	.5744	-.0692	-.6992	-.6010	1.6769	176.0436	145.0395	-31.0041	58.4216
75.0000	4.9536	5.0469	.9500	.4995	-.0523	-1.0915	-.9831	1.9019	177.0056	132.4547	-44.5109	62.2656
80.0000	4.9517	5.0487	.9662	.4208	-.0351	-3.3887	-2.9973	2.2962	177.5507	106.4413	-71.5495	66.4677

TN2= 5.0000 TK= 1.5000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	7.5001	.8851	.8849	-.1868	-.1870	-.0002	1.0002	169.4191	169.4062	-.0129	45.0043
40.0000	4.9873	7.5151	.9108	.8527	-.1425	-.2460	-.1000	1.0682	171.8881	166.1782	-5.7100	46.8878
45.0000	4.9847	7.5231	.9174	.8416	-.1314	-.2675	-.1314	1.0901	172.5120	165.0235	-7.4881	47.4675
50.0000	4.9820	7.5271	.9246	.8275	-.1194	-.2958	-.1704	1.1174	173.1928	163.5213	-9.6715	48.1725
70.0000	4.9730	7.5408	.9592	.7109	-.0633	-.6028	-.5157	1.3493	176.3775	148.9183	-27.4593	53.4571
75.0000	4.9714	7.5431	.9690	.6504	-.0479	-.8736	-.7926	1.4899	177.2587	138.8551	-38.3990	56.1314
80.0000	4.9703	7.5448	.9791	.5712	-.0321	-1.7997	-1.6719	1.7140	178.1607	119.0583	-59.1024	55.7394

TN2= 5.0000 TK= 2.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	10.0000	.9236	.9235	-.1612	-.1614	-.0002	1.0001	170.8432	170.8321	-.0112	45.0028
40.0000	4.9918	10.0165	.9410	.9014	-.1231	-.2118	-.0865	1.0439	172.9820	168.0400	-4.9421	46.2291
45.0000	4.9900	10.0200	.9454	.8938	-.1135	-.2301	-.1135	1.0578	173.5221	167.0443	-6.4779	46.6079
50.0000	4.9883	10.0235	.9502	.8840	-.1031	-.2540	-.1470	1.0750	174.1119	165.7502	-8.3613	47.0696
70.0000	4.9824	10.0353	.9732	.7991	-.0547	-.5027	-.4359	1.2179	176.8671	153.3129	-23.5541	50.6110
75.0000	4.9814	10.0373	.9797	.7514	-.0414	-.7030	-.6429	1.3038	177.6252	144.8931	-32.7361	52.5115
80.0000	4.9807	10.0388	.9863	.6806	-.0278	-1.2572	-1.1880	1.4452	178.4054	128.4984	-45.9110	55.3927

TN2= 5.0000 TK= 2.5000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	12.5000	.9466	.9465	-.1386	-.1388	-.0002	1.0001	172.1085	172.0985	-.0096	45.0019
40.0000	4.9943	12.5142	.9588	.9308	-.1059	-.1819	-.0745	1.0301	173.9521	169.6528	-4.2593	45.8489
45.0000	4.9931	12.5172	.9619	.9253	-.0977	-.1974	-.0977	1.0396	174.4176	168.8352	-5.5824	46.1111
50.0000	4.9919	12.5202	.9654	.9183	-.0888	-.2177	-.1264	1.0513	174.9256	167.7210	-7.2046	46.4313
70.0000	4.9879	12.5304	.9814	.8554	-.0472	-.4228	-.3693	1.1473	177.3003	157.0336	-20.2667	48.9253
75.0000	4.9872	12.5322	.9859	.8181	-.0357	-.5816	-.5349	1.2051	177.9571	149.8167	-28.1404	50.3150
80.0000	4.9867	12.5334	.9905	.7580	-.0239	-.9742	-.9286	1.3067	178.6254	135.7483	-42.8811	52.5746

TN2= 5.0000 TK= 3.0000

PHID	A	B	RS	RP	TANCS	TANCP	TANC	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	15.0000	.9609	.9609	-.1204	-.1206	-.0001	1.0000	173.1342	173.1258	-.0084	45.0014
40.0000	4.9959	15.0124	.9699	.9493	-.0921	-.1578	-.0648	1.0217	174.7382	171.0325	-3.7057	45.6161
45.0000	4.9950	15.0150	.9722	.9452	-.0850	-.1712	-.0850	1.0286	175.1432	170.2863	-4.8568	45.8067
50.0000	4.9941	15.0176	.9747	.9400	-.0772	-.1888	-.1058	1.0370	175.5851	169.3168	-6.2683	46.0397
70.0000	4.9912	15.0265	.9865	.8922	-.0410	-.3637	-.3179	1.1057	177.6512	160.0137	-17.6375	47.8735
75.0000	4.9907	15.0280	.9898	.8628	-.0310	-.4937	-.4557	1.1472	178.2228	153.7228	-24.4597	48.9206
80.0000	4.9903	15.0291	.9931	.8128	-.0208	-.7981	-.7645	1.2218	178.8075	141.4083	-37.3992	50.7010

TN2= 5.0000 TK= 4.0000

PHID	A	B	RS	RP	TANCS	TANCP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	20.0000	.9768	.9768	-.0943	-.0944	-.0001	1.0000	174.6140	174.6074	-.0066	45.0008
40.0000	4.9976	20.0057	.9822	.9698	-.0722	-.1234	-.0508	1.0127	175.8721	172.9651	-2.9070	45.3628
45.0000	4.9971	20.0118	.9839	.9674	-.0666	-.1338	-.0666	1.0167	176.1898	172.3755	-3.8102	45.4753
50.0000	4.9964	20.0138	.9850	.9642	-.0605	-.1473	-.0869	1.0216	176.5364	171.6184	-4.9180	45.6130
70.0000	4.9948	20.0208	.9920	.9345	-.0322	-.2811	-.2467	1.0615	178.1572	164.3017	-13.8560	46.7096
75.0000	4.9945	20.0219	.9939	.9155	-.0243	-.3772	-.3457	1.0857	178.6055	159.3323	-19.2732	47.3535
80.0000	4.9943	20.0228	.9959	.8810	-.0163	-.5885	-.5667	1.1305	179.0644	149.5236	-29.5408	48.5055

MUB-12611

TA2= 5.0000 TK= 6.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	30.0000	.9893	.9893	-.0649	-.0650	-.0001	1.0000	176.2870	176.2824	-.0045	45.0004
40.0000	4.9989	30.0067	.9918	.9860	-.0497	-.0848	-.0350	1.0058	177.1541	175.1502	-2.0039	45.1649
45.0000	4.9986	30.0081	.9924	.9848	-.0459	-.0920	-.0459	1.0077	177.3731	174.7462	-2.6269	45.2187
50.0000	4.9984	30.0095	.9931	.9833	-.0417	-.1012	-.0593	1.0099	177.6121	174.2210	-3.3910	45.2822
70.0000	4.9976	30.0143	.9963	.9691	-.0222	-.1915	-.1686	1.0281	178.7295	169.1595	-9.5706	45.7929
75.0000	4.9975	30.0151	.9972	.9596	-.0168	-.2548	-.2371	1.0351	179.0386	165.7026	-13.3360	46.0997
80.0000	4.9974	30.0157	.9981	.9415	-.0113	-.3876	-.3747	1.0601	179.3545	158.8122	-20.5427	46.6718

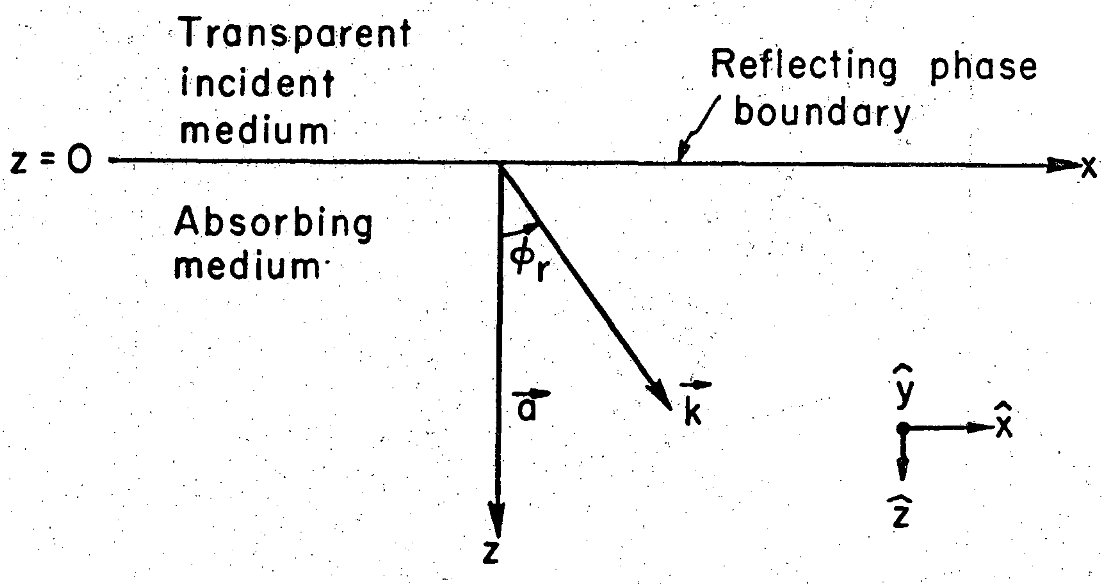
TA2= 5.0000 TK=10.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	50.0000	.9961	.9960	-.0396	-.0396	-.0000	1.0000	177.7325	177.7298	-.0028	45.0001
40.0000	4.9996	50.0041	.9970	.9948	-.0303	-.0517	-.0214	1.0021	178.2620	177.0383	-1.2237	45.0612
45.0000	4.9995	50.0050	.9972	.9944	-.0280	-.0561	-.0280	1.0028	178.3557	176.7515	-1.6043	45.0802
50.0000	4.9994	50.0058	.9975	.9939	-.0255	-.0617	-.0362	1.0036	178.5417	176.4705	-2.0711	45.1035
70.0000	4.9991	50.0087	.9986	.9885	-.0135	-.1162	-.1025	1.0102	179.2241	173.3719	-5.8525	45.2920
75.0000	4.9991	50.0092	.9990	.9849	-.0102	-.1540	-.1435	1.0143	179.4128	171.2477	-8.1651	45.4067
80.0000	4.9990	50.0096	.9993	.9777	-.0069	-.2312	-.2239	1.0221	179.6060	166.9847	-12.6214	45.6256

TA2= 5.0000 TK=20.0000

PHID	A	B	RS	RP	TANDS	TANDP	TAND	TAPSI	DELSD	DELPD	DELD	PSID
2.0000	5.0000	100.0000	.9990	.9990	-.0199	-.0200	-.0000	1.0000	178.9577	178.9563	-.0014	45.0000
40.0000	4.9999	100.0021	.9992	.9987	-.0153	-.0260	-.0108	1.0005	179.1244	178.5079	-.6165	45.0154
45.0000	4.9999	100.0025	.9993	.9986	-.0141	-.0282	-.0141	1.0007	179.1918	178.3836	-.8082	45.0202
50.0000	4.9999	100.0029	.9994	.9984	-.0128	-.0310	-.0182	1.0009	179.2653	178.2218	-1.0435	45.0261
70.0000	4.9998	100.0044	.9997	.9971	-.0068	-.0584	-.0515	1.0026	179.6051	176.6547	-2.9504	45.0737
75.0000	4.9998	100.0047	.9997	.9962	-.0052	-.0772	-.0720	1.0036	179.7042	175.5855	-4.1186	45.1028
80.0000	4.9998	100.0048	.9998	.9943	-.0035	-.1153	-.1118	1.0058	179.8015	173.4242	-6.3773	45.1591

MUB-12609



MUB 12898

Fig. 1 When light propagates in an absorbing medium, the propagation vector $\vec{k}$ forms an angle ϕ_r with the normal to the surface of the medium while the attenuation vector $\vec{a}$ lies along the normal. Planes of equal phase are normal to $\vec{k}$ while planes of equal amplitude are normal to $\vec{a}$. The angle ϕ_r is the real angle of refraction in the medium while the plane z = 0 is its surface.

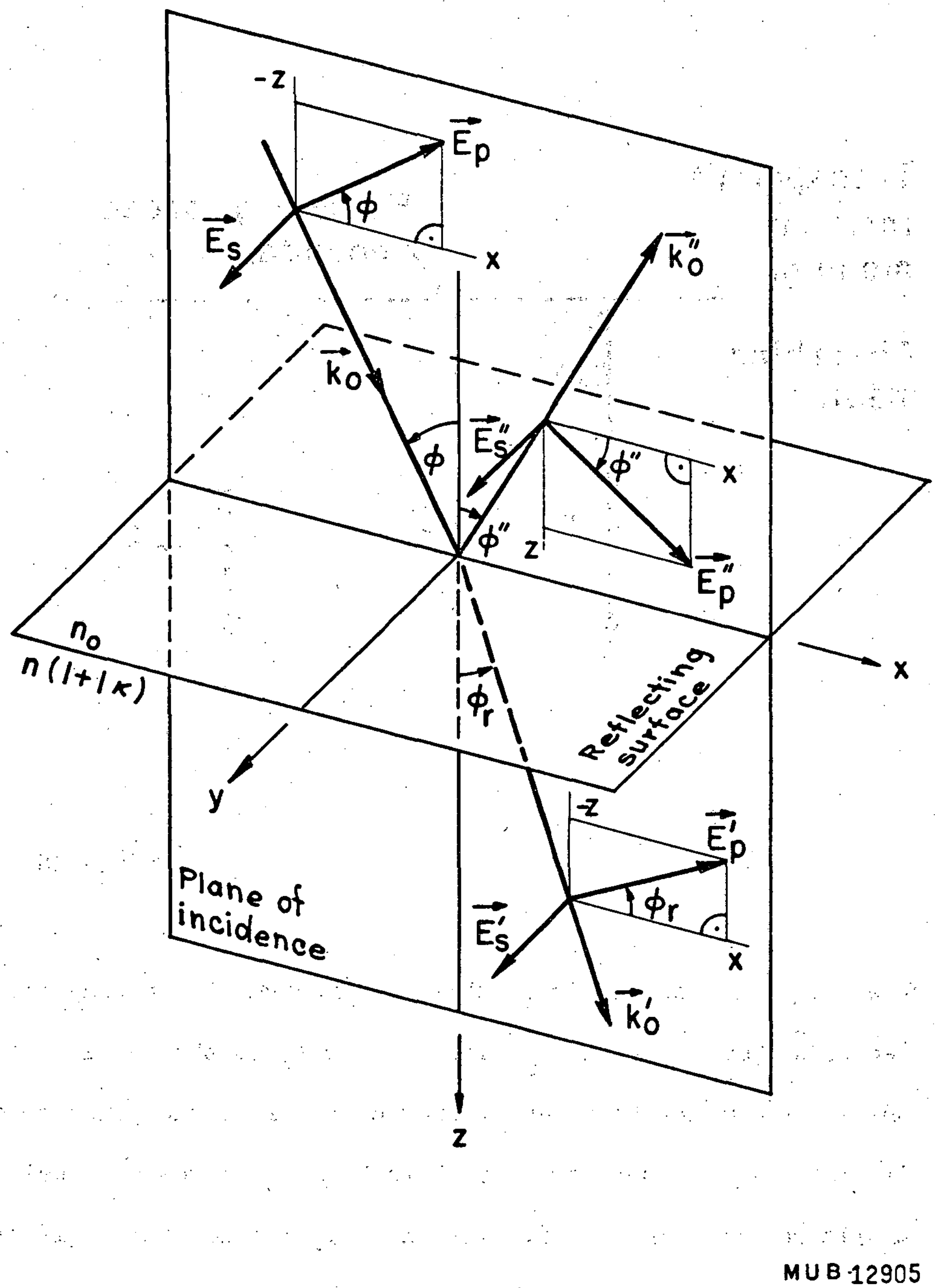


Fig. 2 Sign conventions for the electric field (positive direction of $\vec{E}_s$ and $\vec{E}_p$ in incident, reflected and refracted waves indicated by arrows). The complex index of refraction of the absorbing medium is designated $n(1 + i\kappa)$. The subscript p stands for polarization parallel and the subscript s for polarization normal to the plane of incidence.

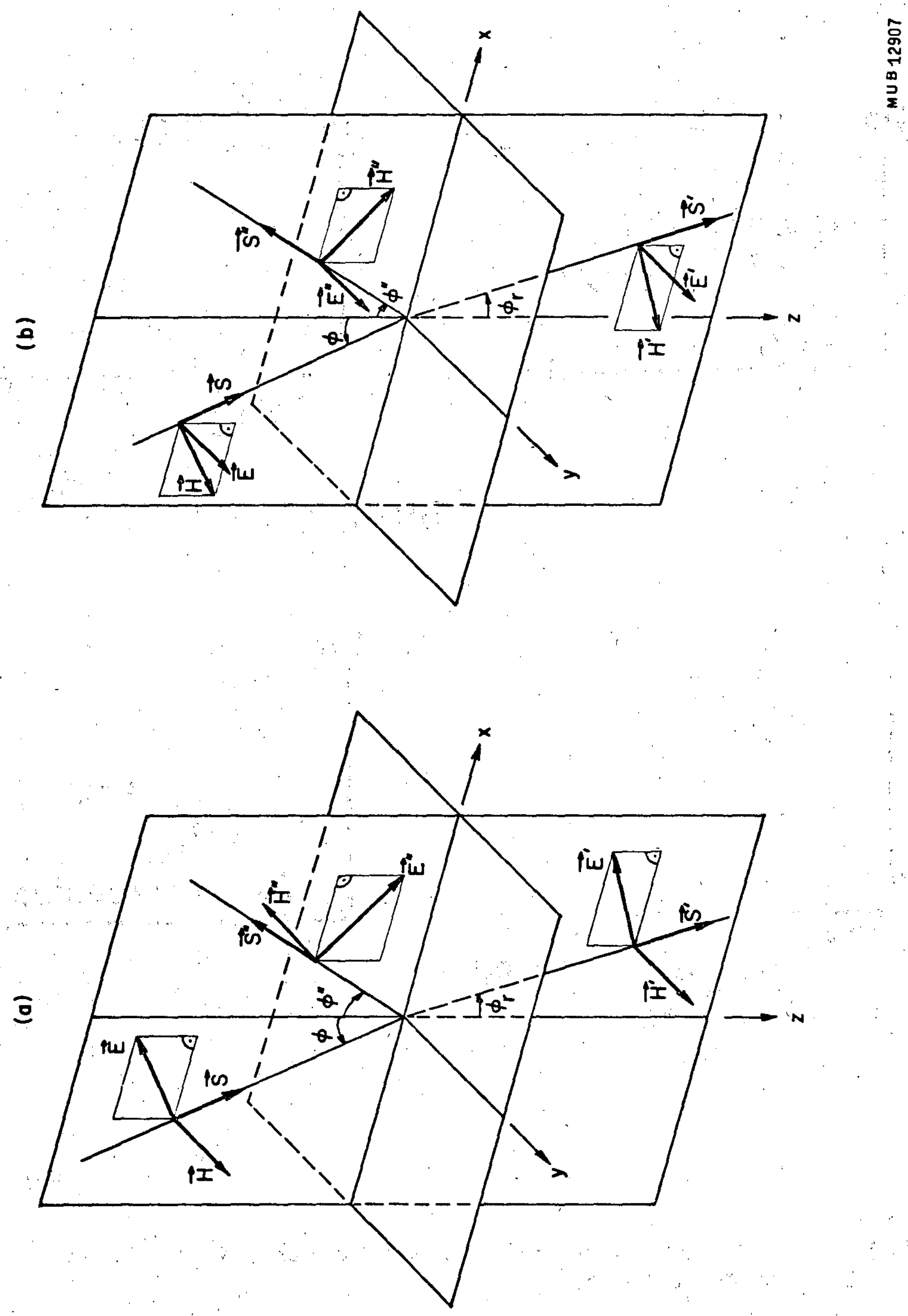
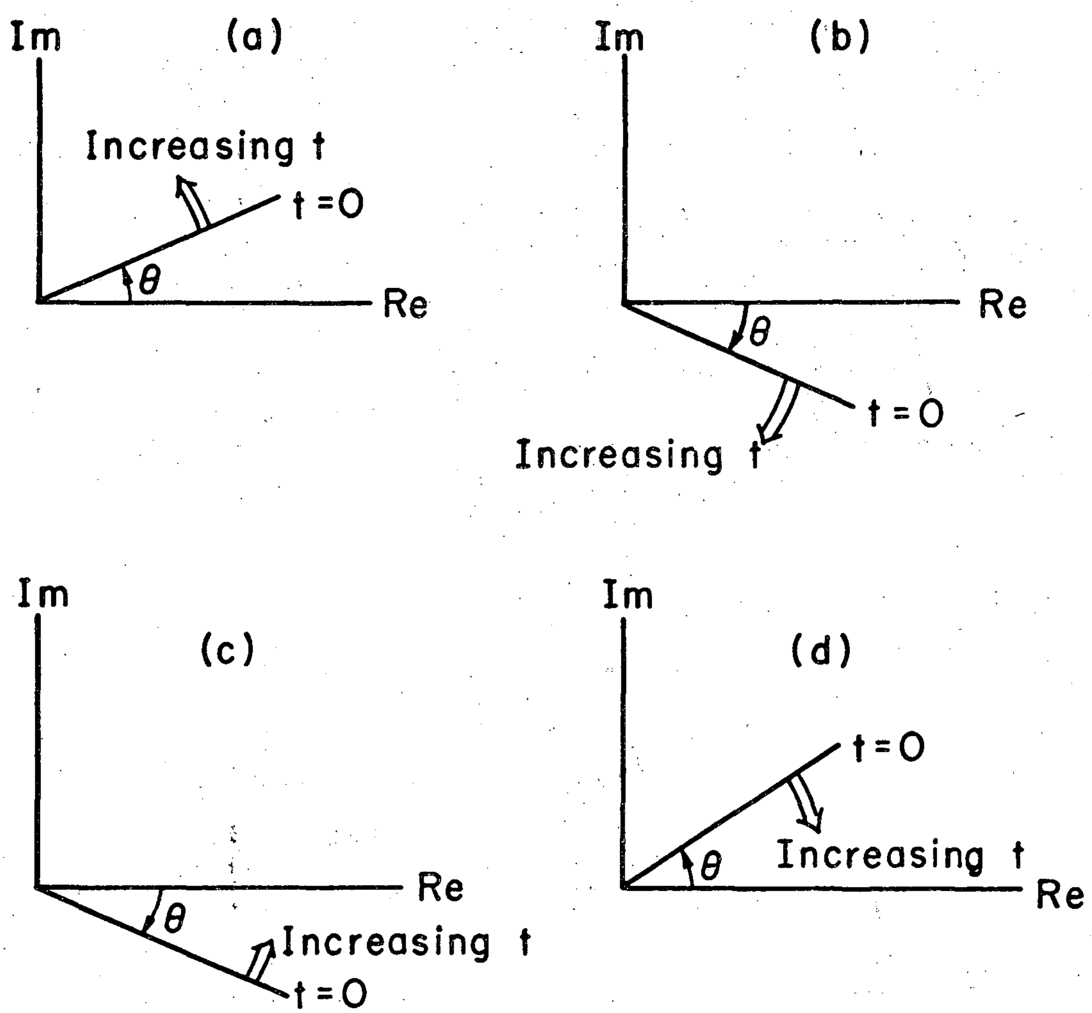


Fig. 3 Reflection and refraction of electromagnetic waves, electric and magnetic fields indicated. (a) Electric vector parallel to plane of incidence. (b) Electric vector normal to plane of incidence.



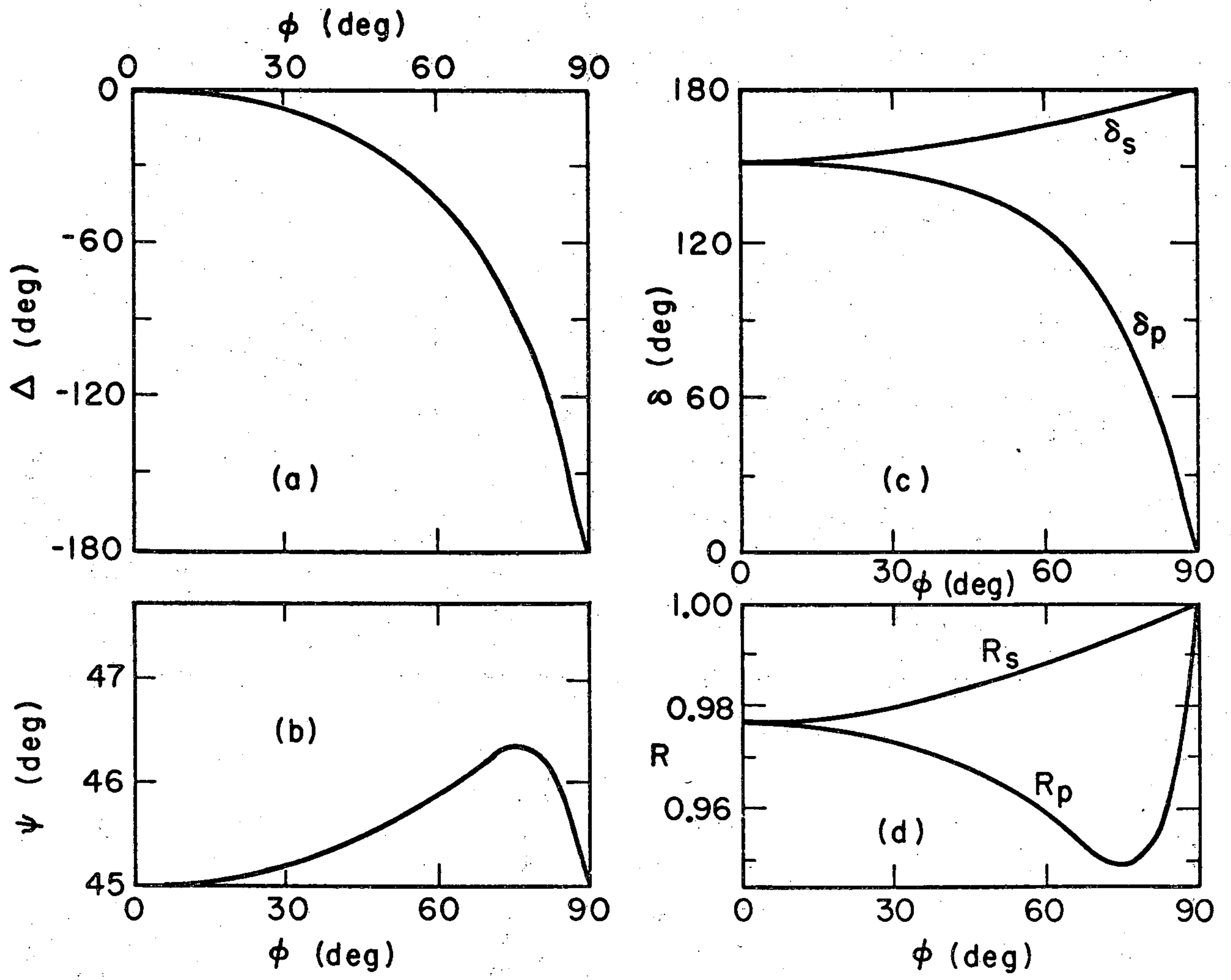
MUB 12899

Fig. 4 Alternate representations of a harmonic oscillation in the complex plane.

(a) alternate I, $e^{i(\omega t + \theta)}$ (c) alternate III, $e^{i(\omega t - \theta)}$

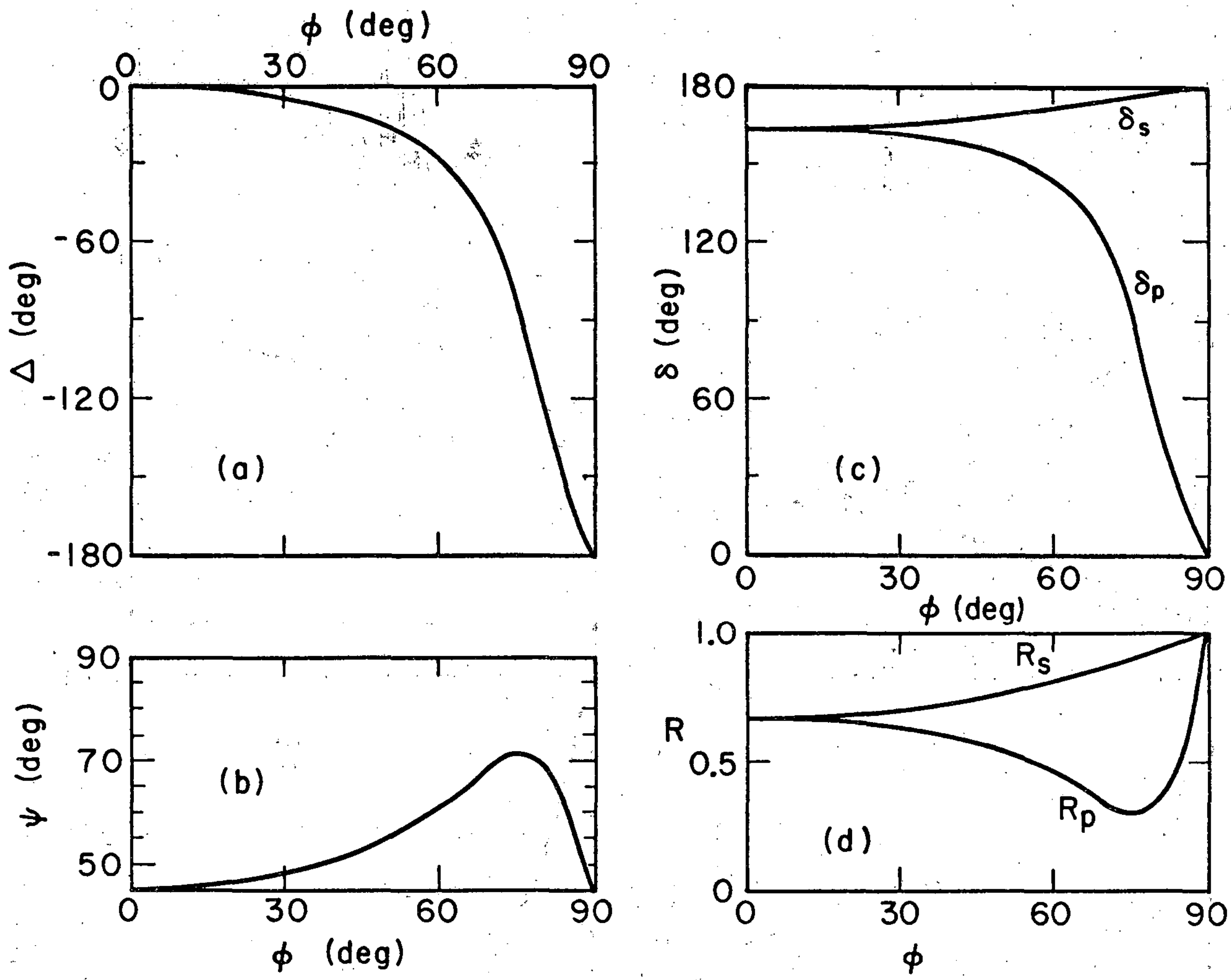
(b) alternate II, $e^{-i(\omega t + \theta)}$ (d) alternate IV, $e^{-i(\omega t - \theta)}$

Alternate II has been chosen in this treatment.



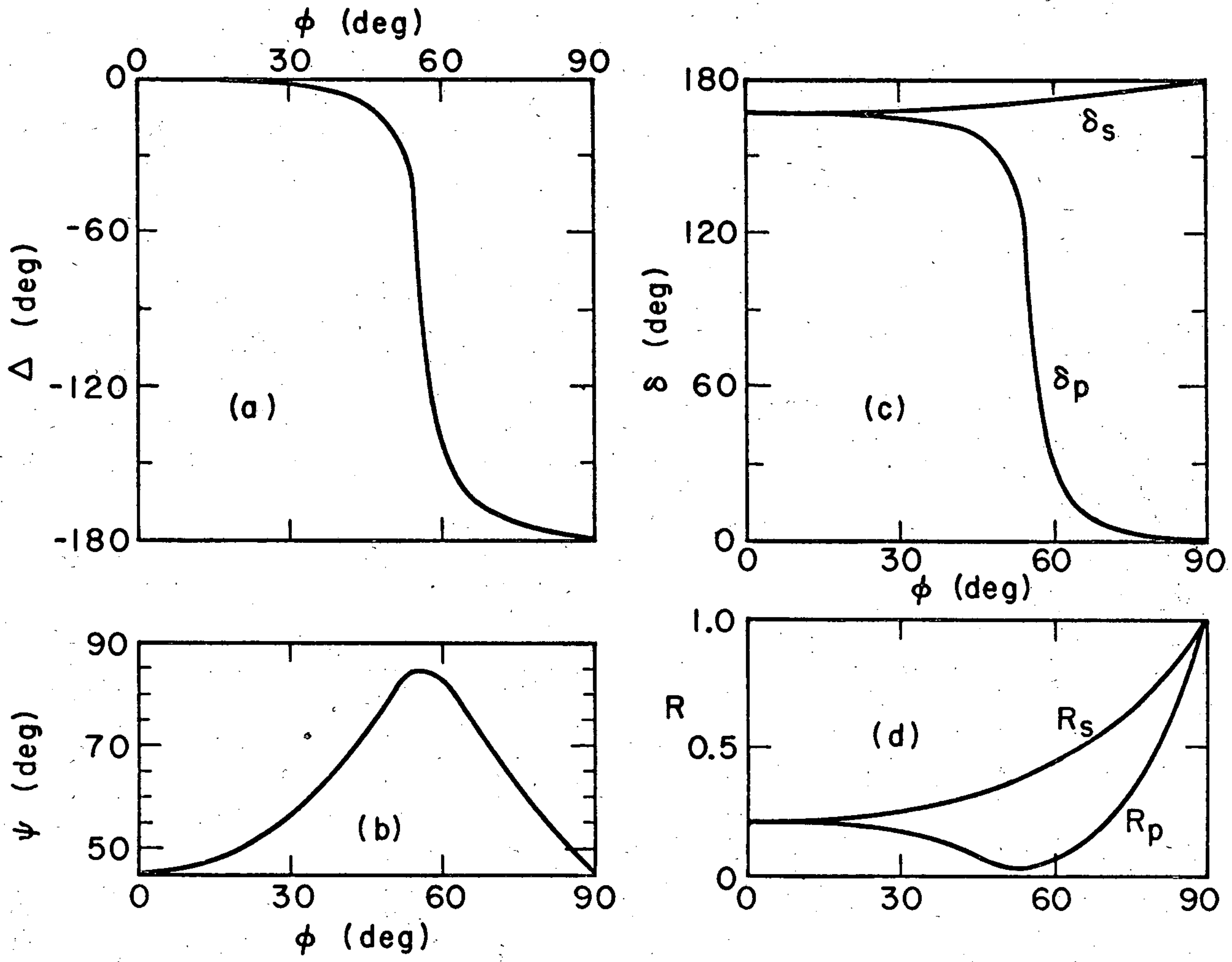
MUB-12913

Fig. 5 Relative phase change Δ, relative amplitude change ψ, absolute phase change δ, and modulus of reflection coefficient R as functions of angle of incidence ϕ for a good reflector (silver), n = 0.2, κ = 20.



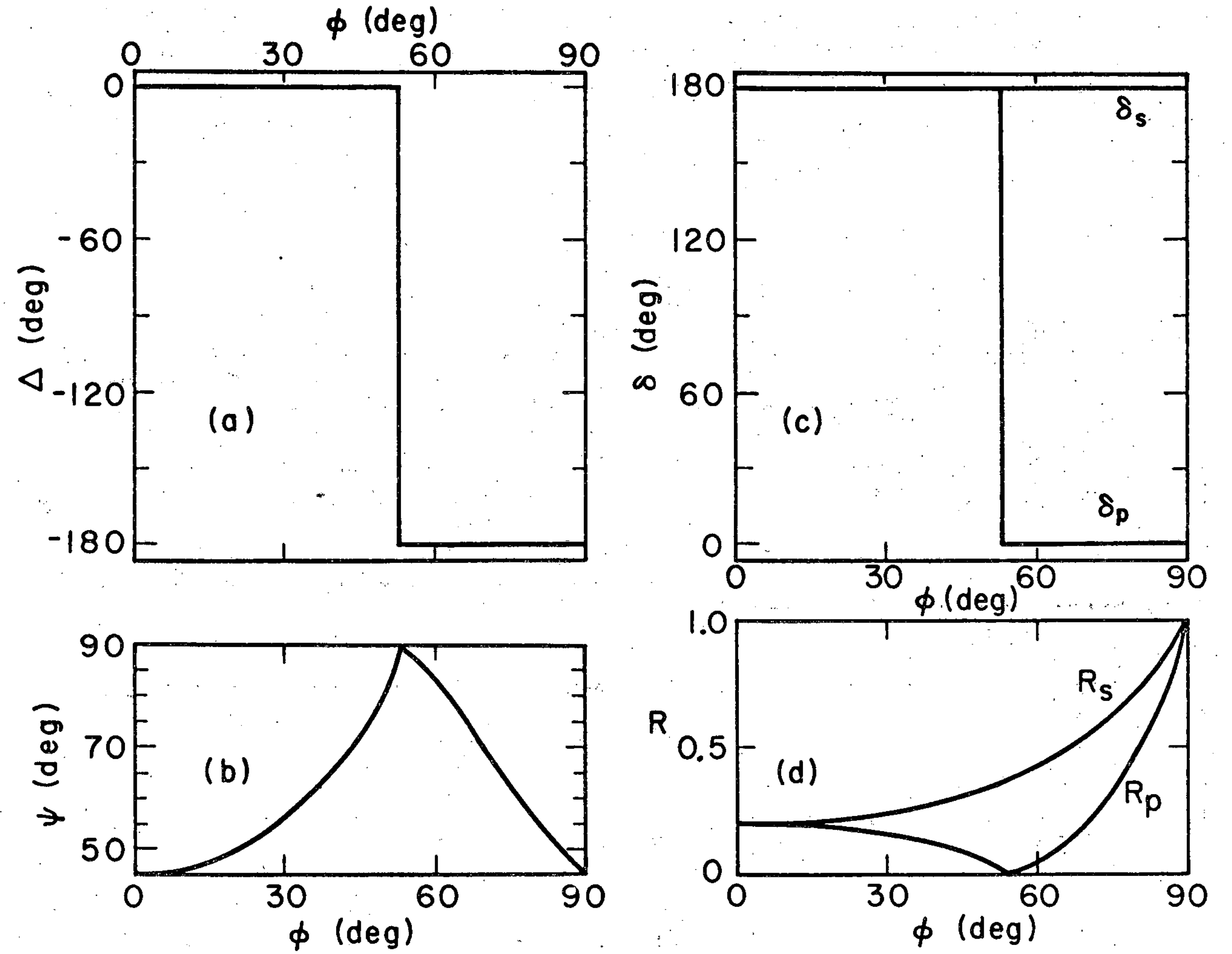
MUB-12912

Fig. 6 Relative phase change Δ, relative amplitude change ψ, absolute phase change δ, and modulus of reflection coefficient R as functions of angle of incidence ø for a poor reflector (tantalum), $n = 3.3$, $\kappa = 0.7$.



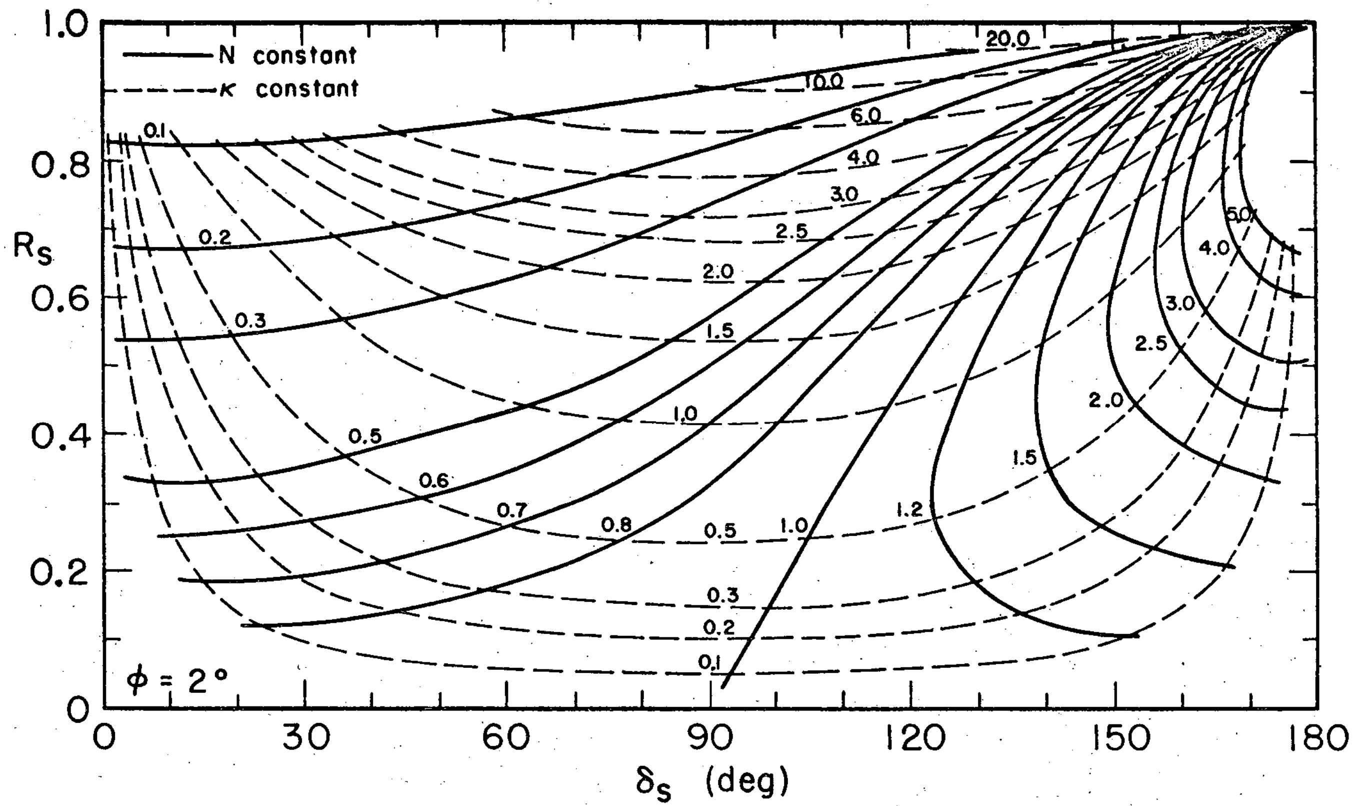
MUB 12911

Fig. 7 Relative phase change Δ, relative amplitude change ψ, absolute phase change δ, and modulus of reflection coefficient R as functions of angle of incidence ϕ. Transition between absorbing and dielectric material ("smoked glass") $n = 1.5$, $\kappa = 0.1$.



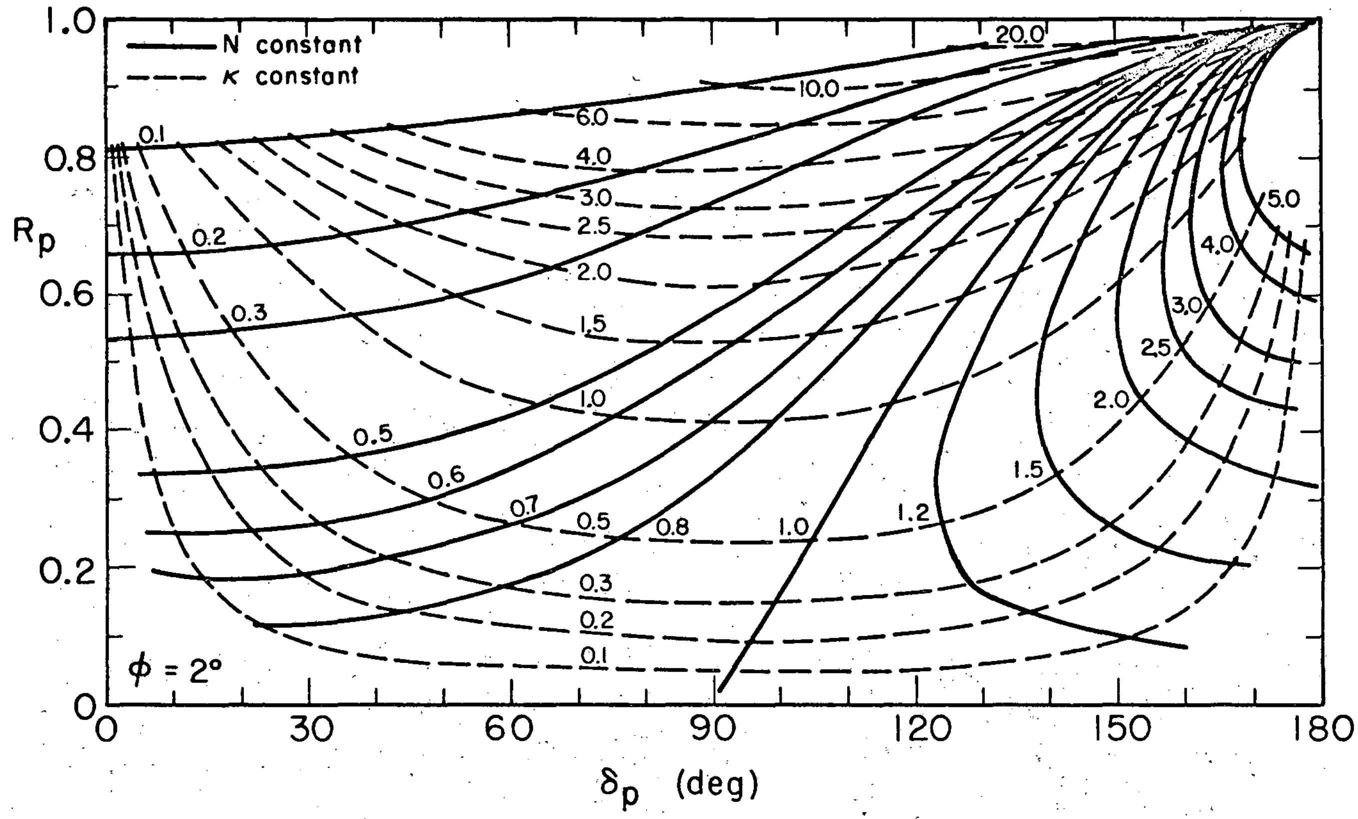
MUB 12906

Fig. 8 Relative phase change Δ, relative amplitude change ψ, absolute phase change δ, and modulus of reflection coefficient R as functions of angle of incidence ø for a transparent dielectric (glass) $n = 1.5$, $\kappa = 0$.



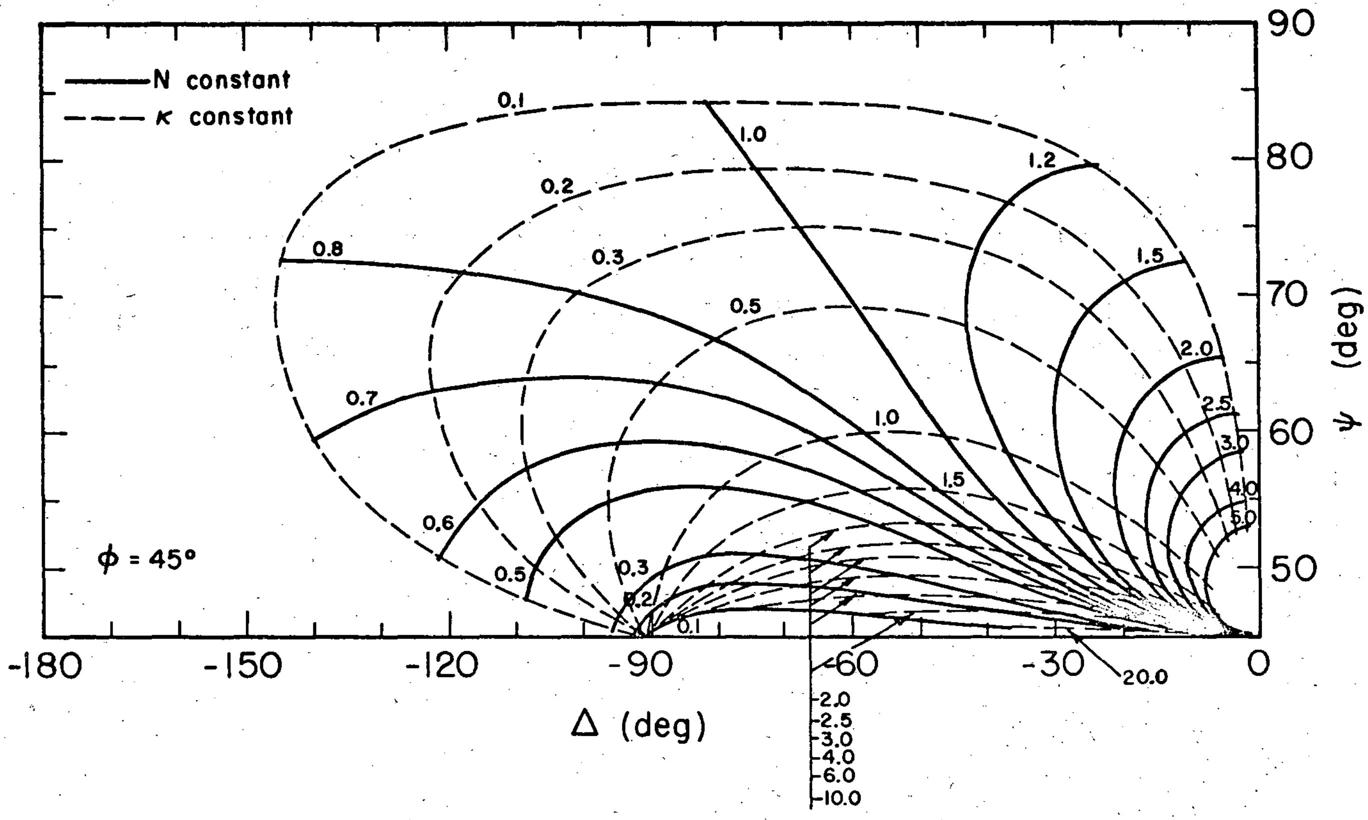
MUB 12900

Fig. 9 Absolute phase change δ_s upon reflection vs. reflected amplitude R_s, with the optical constants n and κ of the reflecting material as parameters. 2° angle of incidence; solid lines: constant $N = n/n_o$; broken lines: constant κ.



MUB 12901

Fig. 10 Absolute phase change δ_p upon reflection vs. reflected amplitude R_p, with the optical constants n and κ of the reflecting material as parameters. 2° angle of incidence; solid lines: constant $N = n/n_o$; broken lines: constant κ.



MUB 12902

Fig. 11 Relative phase change Δ and amplitude change ψ between s and p polarization with the optical constants n and κ of the reflecting material as parameters. 45° angle of incidence.

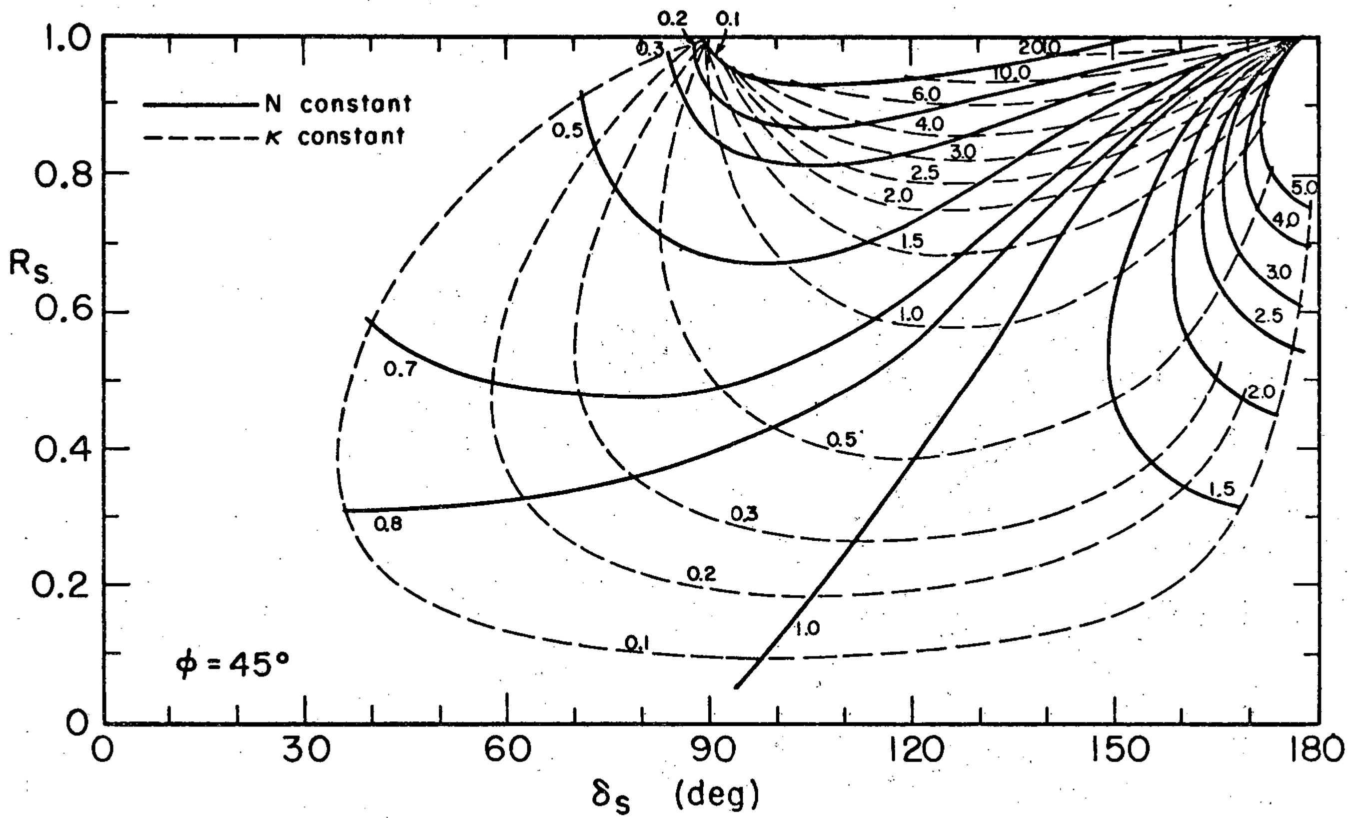
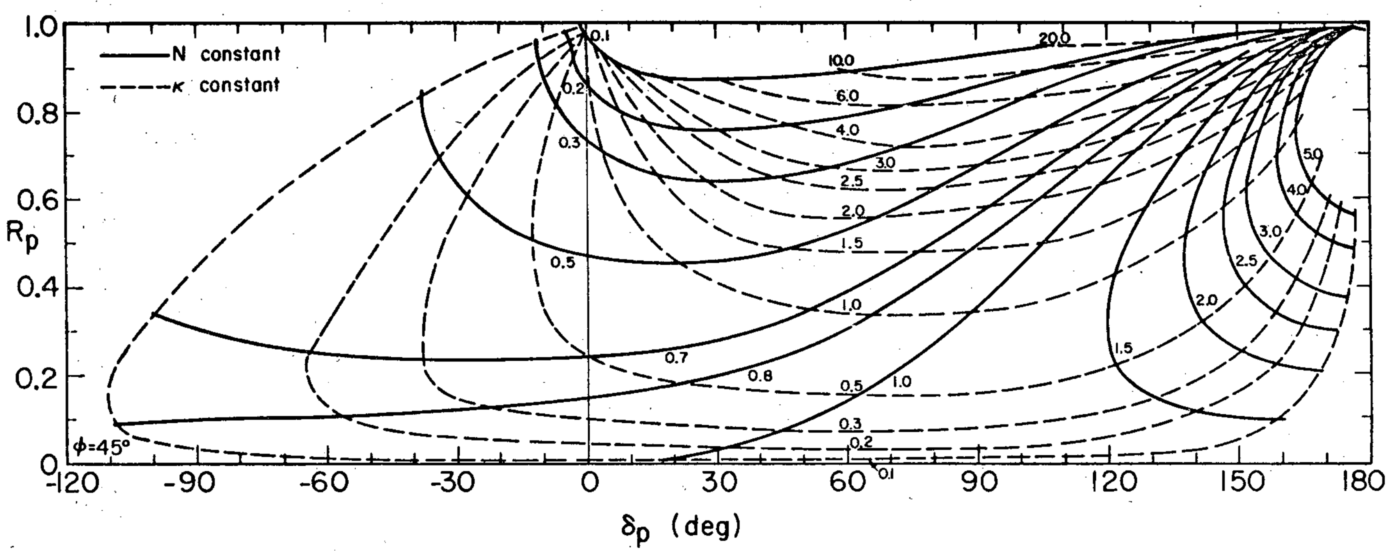
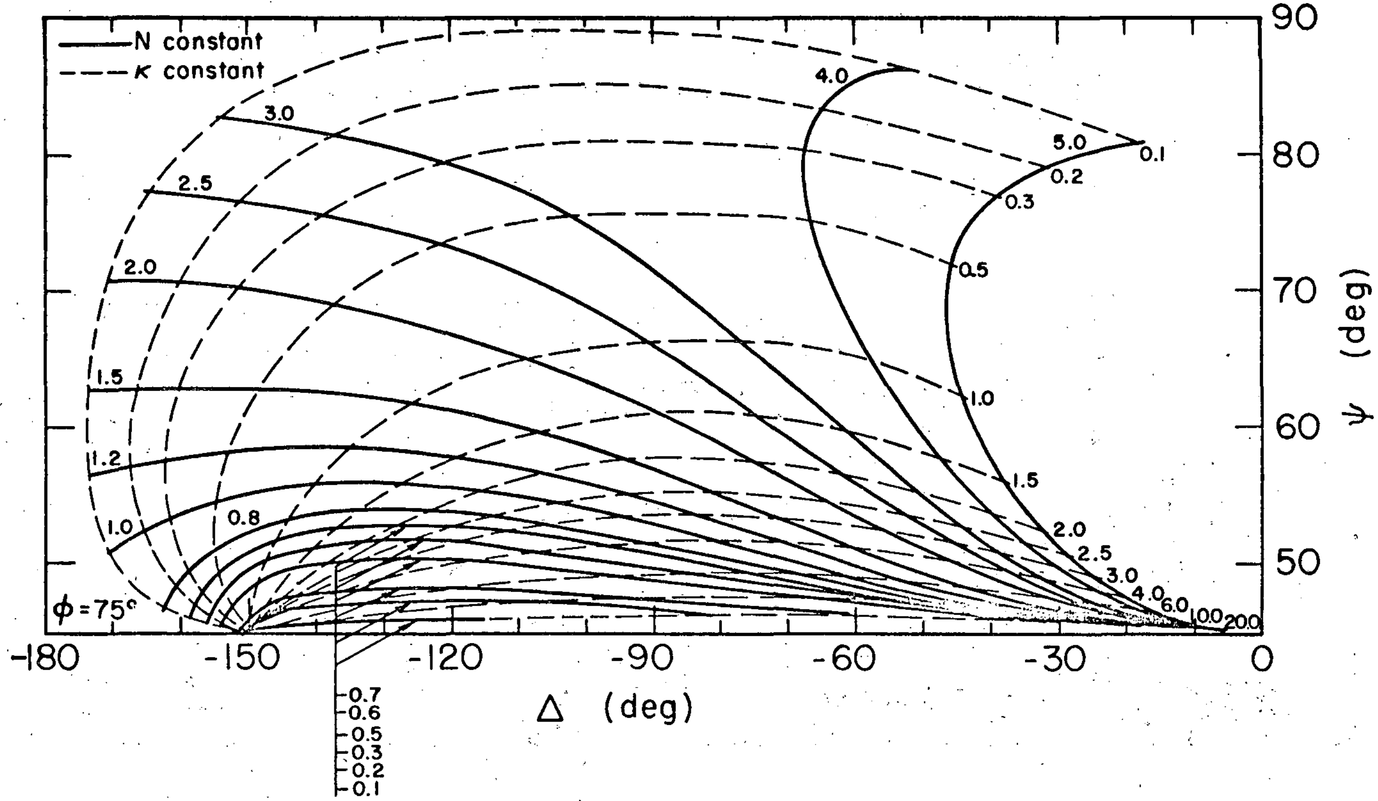


Fig. 12 Absolute phase change δ_s upon reflection vs. reflected amplitude R_s, with the optical constants n and κ of the reflecting material as parameters. 45° angle of incidence; solid lines: constant $N = n/n_o$; broken lines: constant κ.



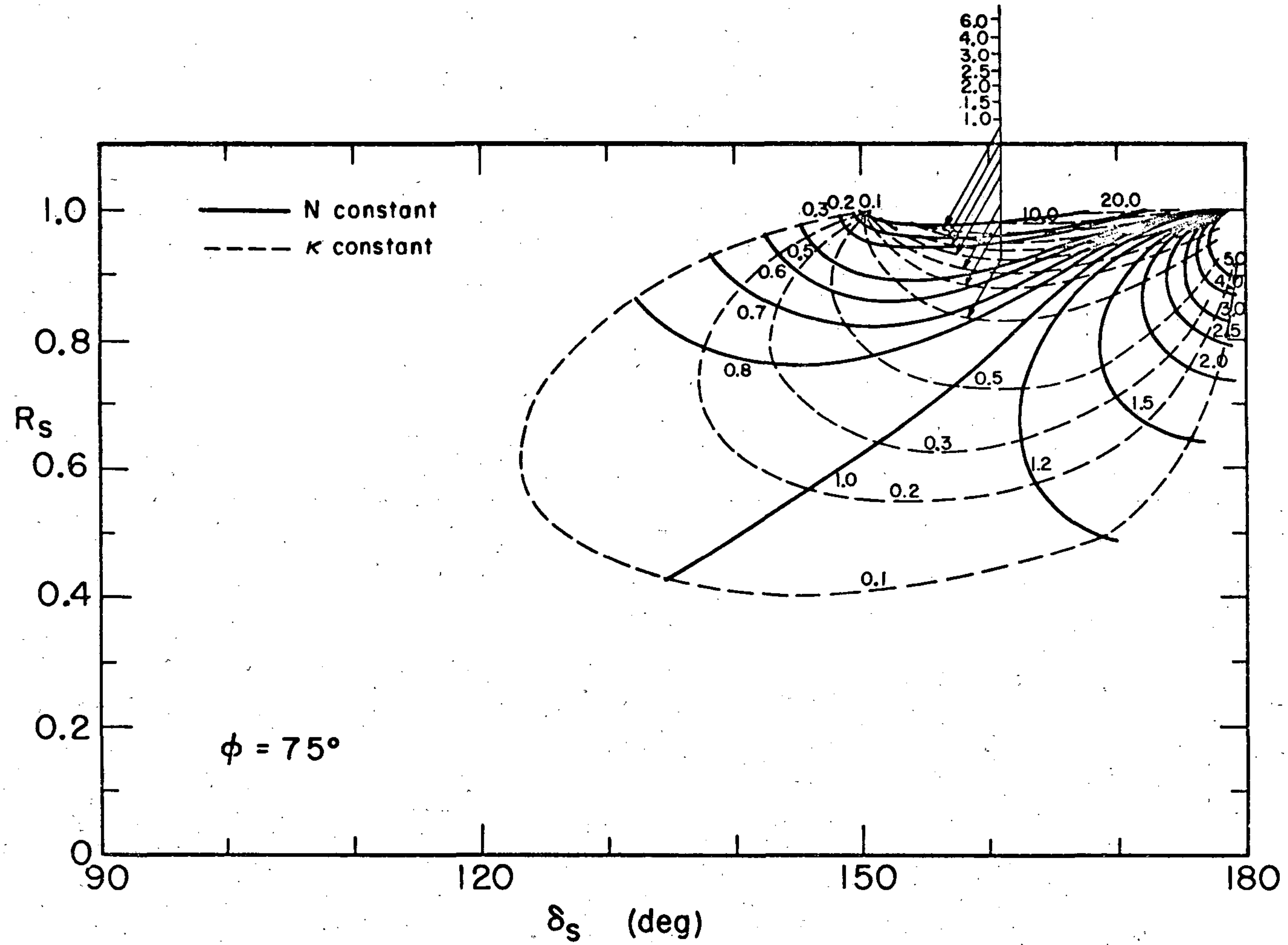
MUB 12909

Fig. 13 Absolute phase change δ_p upon reflection vs. reflected amplitude R_p, with the optical constants n and κ of the reflecting material as parameters. 45° angle of incidence; solid lines: constant $N = n/n_o$; broken lines: constant κ .



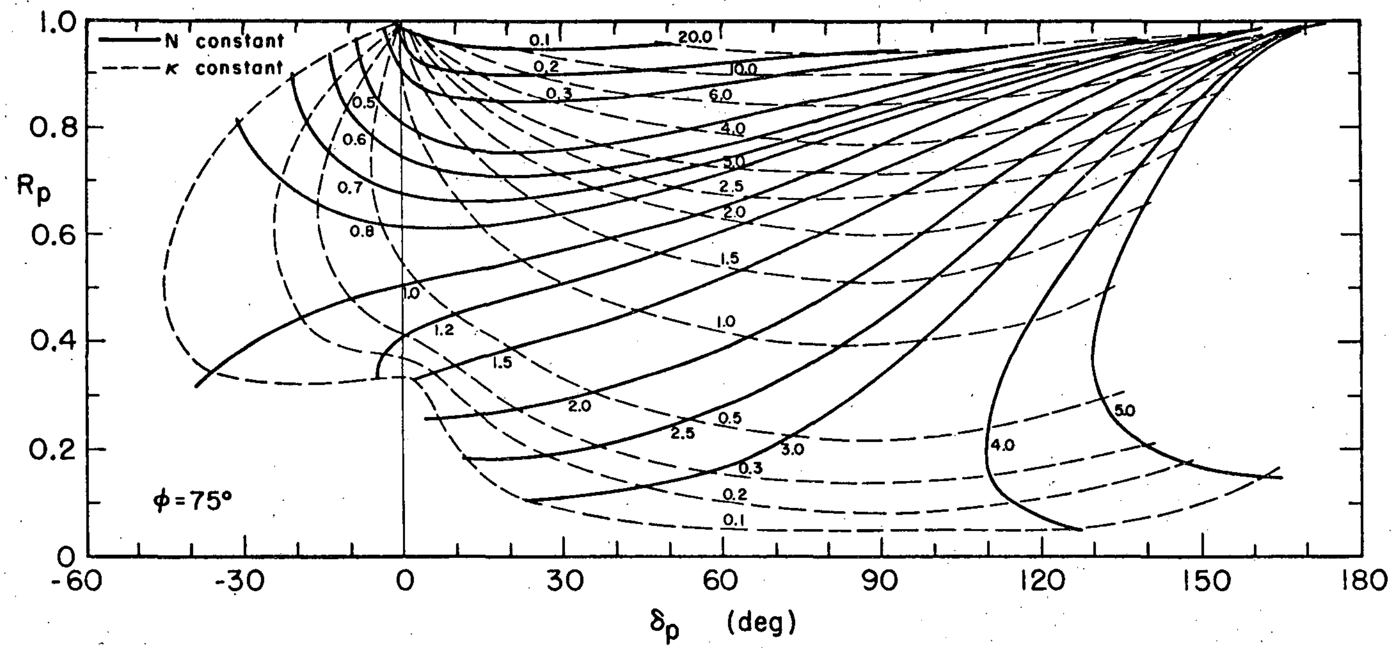
MUB 12910

Fig. 14 Relative phase change Δ and amplitude change ψ between s and p polarization with the optical constants n and κ of the reflecting material as parameters. 75° angle of incidence.



MUB-12903

Fig. 15 Absolute phase change δ_s upon reflection vs. reflected amplitude R_s, with the optical constants n and κ of the reflecting material as parameters. 75° angle of incidence; solid lines: constant $N = n/n_o$; broken lines: constant κ.



MUB 12908

Fig. 16 Absolute phase change δ_p upon reflection vs. reflected amplitude R_p, with the optical constants n and κ of the reflecting material as parameters. 75° angle of incidence; solid lines: constant $N = n/n_o$; broken lines: constant κ.

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