NON-SEQUENTIAL DATABASE

NSS (REFERENCE MANUAL SECTION) COMMAND PROMPTS

NSS-GENERAL INFORMATION - This manual section describes the establishment and manipulation of the Non-Sequential Surface (NSS) optical system database through which non-sequential rays may be traced. There are no limits to size of the optical system which can be modeled in the NSS database. NSS databases are set up and manipulated using CMD level commands. There is no NSS program sub-level as was used with the sequential lens databases. Alternate configuration data (CFG) and the special surface data (SPSRF) are not explicitly used in the NSS database. Modeling an optical system with the NSS database and tracing NSS rays is totally independent of the standard lens database and sequential ray tracing.
NSSDEL - The NSSDEL command deletes the existing NSS database and frees all allocated memory used by the current NSS database.
NSSNEW - The NSSNEW command deletes the existing NSS database, frees all allocated memory used by the last NSS database and then allocates memory for a new NSS database. The initial size of the NSS database is 200 surfaces is increased automatically as needed.

NSS COORDINATE SYSTEM - The coordinate system for the NSS database is a global coordinate system with origin located at global coordinates X=0.0, Y=0.0, Z=0.0. The coordinate system is pure right handed.

NSS DATABSE - The NSS database consists of database items which relate to the entire database and database items which relate to specific NSS database SURFACES.

NON- SURFACE DATABASE ITEMS - The NSS database items which are not directly related to NSS database SURFACES are controlled by the following CMD level commands:
NSSUNITS (IN or CM or MM or M) - The linear units in an NSS database can be set to INCHES, CENTIMETERS, MILLIMETERS or METERS. The default NSSUNITS are INCHES. Issuing "NSSUNITS" with the interrogative "?" causes the current NSS linear units to be displayed.
NSSWV , λ#(1 to 10) , wavelength in microns - The "NSSWV" command is used to specify the values of any of the 10 wavelengths. Wavelength is ALWAYS expressed in MICRON units, 1.0 micron = 1.0×10^{-6} meter. By default, wavelength #1 = 1.0 micron. All other wavelengths are initially set to 0.0. Issuing "NSSWV" with the interrogative "?" causes the current NSS wavelengths and spectral weighting factors to be displayed.
NSSWT , λ#(1 to 10) , wavelength weight - The "NSSWT" command is used to specify the values of any of the 10 wavelength weights. By default, wavelength weight #1 = 1.0. All other wavelength weights are initially set to 0.0. Issuing "NSSWT" with the interrogative "?" causes the current NSS wavelengths and spectral weighting factors to be displayed.
UNIVERSE , terminal ray distance - The "UNIVERSE" command is used to specify a "terminal ray distance" to trace rays which "miss" all NSS SURFACES during ray tracing. By default the terminal ray distance is = 10000 NSS units.

SURFACES - An NSS SURFACE is an optical surface, such as a mirror surface, a lens surface or any other surface which can refract, reflect, diffract, scatter or absorb radiation.

SURFACE DEPENDENT COMMANDS - The following commands are used to specify NSS database items which are associated with specific NSS SURFACES

THE NSS SURFACE
SURFACE , surf_id - The "SURFACE" command is used to set the NSS SURFACE, designated by the integer "surf_id", to be the "current" NSS SURFACE within the "current" NSS SURFACE modifying commands will always be applied to the "current" NSS SURFACE. If the SURFACE specified by "surf_id" does not exist, it will be created. Issuing the "SURFACE" command with the interrogative "?" causes the current NSS SURFACE "surf_id" value to be displayed.

NSS SURFACE DATA COMMANDS
SNAME , (1 to 80 character identifier for the "current" SURFACE") - The "SNAME" command is used to attach or change the name label associated with the "current" SURFACE. The default name is "(surf_id)", the surface ID number only..
SPROFILE (qualifier word) , v1 , v2 , v3 , v4 , v5 - The "SPROFILE" command uses the optional qualifier word and numeric words 1,2 , 3, 4 and 5 to specify the shape of the "current" NSS SURFACE. The following table lists allowed qualifier words with the meaning of the values "v1", "v2", "v3", "v4" and "v5". The default surface is a plano surface. If the qualifier word USER is used, the ray intersection and surface interaction for that surface type will need to be coded by the user in the NSS_USER.FOR subroutine. The * designates that the surface uses additional profile coefficients input using the "PARAM" command. In order for a surface to be considered an "active" surface which can be "seen" during NSS analysis or display operations, the NSS surface profile MUST BE ENTERED EXPLICITLY USING THE "PROFILE" command. All toric profiles are in the local XZ-plane.

Qualifier	NW#1	NW#2	NW#3	NW#4	NW#5
PLANO	2^{nd} order	4^{th} order	6^{th} order	8^{th} order	10^{th} order
SPHERIC	Radius of Curvature	Conic Constant	4^{th} order aspheric	6^{th} order aspheric	8^{th} order aspheric
ANAMORPH	Radius of Curvature	Conic Constant	4^{th} order aspheric	6^{th} order aspheric	8^{th} order aspheric
MEM	# elements in X	# elements in Y	MEM Data File #	MEM pixel X-pitch	MEM pixel Y-pitch
USER	Value passed	Value passed	Value passed	Value passed	Value passed
TUBE	R (radius)	L (length)	not used	not used	not used

The "MEM" surface type is a "Multiple Element Mirror". It comprises an array of flat, rectangular mirror elements. The # of elements in each direction, the MEM data file # and the length of a single element in X and Y are specified by the 5 numeric words of the commend. MEN data files

have the naming convention MEMxxx.DAT where xxx can be any numeric value (001, 002 etc). Addressing of elements starts at local -x, -y with address 1,1 and proceeds to the local +x, +y corner addressed as # elements in X, # elements in Y. Each line of the MEMxxx.DAT file has the following entry:
x-address, y-addrress, element state-x, element state-y, x-tilt error, y-tilt error.
where:
element state-x is:
0 = no x-tilt
1= +x-tilt
-1= -x-tilt
where:
element state-y is:
0 = no y-tilt
1= +y-tilt
-1= -y-tilt

x and y-tilt angles and errors are signed using the right-hand rule.

The power on a MEM pixel, acts to change the surface slope only. This is done since surface deflections are extremely small and ray trace speed would be adversely effected by implementing an aspheric surface intersection routine here.

The "TUBE" type of surface is a surface comprising a cylindrical tube with radius "R" and length "L". Before being positioned and oriented, it is considered to start at 0,0,0 and at 0,0,L. The inside of the tube is always media 1, the outside is always media 2.

SPARAM , parameter # , parameter value - The "SPARAM" command sets the values of additional NSS SURFACE profile parameters as described in the following table:

Parameter Number	PLANO	SPHERIC	ANAMORPH	MEM
1	(not used)	10^{th} order aspheric	10^{th} order aspheric	Angle (deg) for x-tilt (positive right-hand rule)
2	(not used)	12^{th} order aspheric	4^{th} order anamorphic	Angle (deg) for y-tilt (positive right-hand rule)
3	(not used)	14^{th} order aspheric	6^{th} order anamorphic	R^2 order power
4	(not used)	16^{th} order aspheric	8^{th} order anamorphic	R^4 order power
5	(not used)	18^{th} order aspheric	10^{th} order anamorphic	R^6 order power
6	(not used)	20^{th} order aspheric	Toric Curvature (1/R)	R^8 order power
7	(not used)	(not used)	Toric Conic Constant	R^{10} order power
8	(not used)	(not used)	(not used)	Sub-pixel FULL length - X
9	(not used)	(not used)	(not used)	Sub-pixel FULL length - Y
10	(not used)	(not used)	(not used)	0 or 1, 0 = all of mem reflects, 1 = only sub-pixel reflects.
11 to 200				

Parameter Number	USER	TUBE		
1	Value passed to subroutine	(not used)		
2	Value passed to subroutine	(not used)		
3	Value passed to subroutine	(not used)		
4	Value passed to subroutine	(not used)		
5	Value passed to subroutine	(not used)		
6	Value passed to subroutine	(not used)		
7	Value passed to subroutine	(not used)		
8 to 200	Value passed to subroutine	(not used)		

SCLEAR - The "SCLEAR" command is used to specify that the current surface is no longer to be considered an active NSS surface. Its internal occupancy flag is cleared. The NSS surface pointer still points to the surface however.
SCLAP - The "SCLAP" command is used to specify the clear aperture assigned to an NSS surface. Issued without a qualifier word, the clear aperture will be circular. Optional qualifier words are "RECT" and "ELIP" for rectangular and elliptical clear apertures. Numeric inputs are defined in the following table. Clear apertures must be assigned to surfaces before ray tracing can proceed. Surfaces without clear apertures assigned would have infinite extents and could not be properly treated during ray tracing. NSS ray tracing must be able to consider every surface as a real bounded surface. The exception to this is the TUBE surface which is self-bounding. No explicit clear aperture is used on TUBE surfaces and if one is entered, it will be ignored.

Qualifier Word	Numeric word #1	Numeric Word #2	Numeric Word #3	Numeric Word #4	Numeric Word #5
(none)	Radius	Radius to flat	x-decenter	y-decenter	(not used)

ELIP	x-semi major axis	y-semi major axis	x-decenter	y-decenter	gamma rotation
RECT	x-half width	y-half width	x-decenter	y-decenter	gamma rotation

Before NSS rays are traced, the program uses the assigned clear aperture to automatically calculate bounding planes for each surface. This is possible for NSS surface profile types 1 to 9. For type 10, the user-defined profile, bounds must be explicitly input.

SBOUNDX - The "SBOUNDX" command is used to specify the –X and +X bounding values for the current surface when a user-defined surface profile has been selected with the "SPROFILE" command. Explicit bounds are ignored for TUBE surfaces.

SBOUNDY - The "SBOUNDY" command is used to specify the –Y and +Y bounding values for the current surface when a user-defined surface profile has been selected with the "SPROFILE" command. Explicit bounds are ignored for TUBE surfaces.

SBOUNDZ - The "SBOUNDZ" command is used to specify the –Z and +Z bounding values for the current surface when a user-defined surface profile has been selected with the "SPROFILE" command. Explicit bounds are ignored for TUBE surfaces.

SHOLE - The "SHOLE" command is used to specify a hole in an NSS surface. Issued without a qualifier word, the hole will be circular. Optional qualifier words are "RECT" and "ELIP" for rectangular and elliptical holes. Numeric inputs are defined in the following table. No explicit holes are used on TUBE surfaces and if entered, they will be ignored.

Qualifier Word	Numeric word #1	Numeric Word #2	Numeric Word #3	Numeric Word #4	Numeric Word #5
(none)	Radius	Radius to flat	x-decenter	y-decenter	(not used)
ELIP	x-semi major axis	y-semi major axis	x-decenter	y-decenter	gamma rotation
RECT	x-half width	y-half width	x-decenter	y-decenter	gamma rotation

NSS SURFACE LOCATION

SPOS , x , y , z , i - The "SPOS" command is used to specify the "x", "y" and "z" location of the vertex of the current NSS SURFACE. If the NSS SURFACE number "i" is not explicitly specified, the "x", "y" and "z" coordinates will be considered to be with respect to the global coordinate system origin. If "i" is explicitly input, "x", "y" and "z" and the "alpha", "beta" and "gamma" of the "SROT" command will be considered to be relative to the global coordinate location of NSS SURFACE "i". The default values are 0.0, 0.0, 0.0 and -1. "i" may not reference a surface which itself uses a relative positional reference. Positional references MAY NOT be nested.

NSS SURFACE ORIENTATION

SROT , alpha , beta , gamma - The "SROT" command is used to specify the orientation of the current NSS SURFACE. If the NSS SURFACE number "i" is not explicitly specified, the "alpha", "beta" and "gamma" Euler angles will be considered to be with respect to the global coordinate system origin. If "i" is explicitly input in the "SPOS" command, "alpha", "beta" and "gamma" will be considered to be relative to the global coordinate orientation of NSS SURFACE "i". The default values are 0.0, 0.0 and 0.0. The rotation angles "alpha", "beta" and "gamma" are specified in "degrees". These are Euler angles applied in the order "alpha", then "beta" and finally "gamma". The sign convention is via the right-hand rule.

DIFFRACTION GRATING

SGRT , m , d , l , m , n - The "GRT" command specifies the current surface is to be defined as a linearly ruled diffraction grating of order “m” with line spacing “d” in current system units. The generating planes which are used to generate this grating have a surface normal in the local coordinate system of the surface specified by the direction cosines “l”, “m” and “n”. This grating is the same type of grating which was described in the LENS section of this manual and used in the sequential lens database.

SGRTD - The "GRTD" command removes any diffraction grating definition on the current surface.

OPTICAL MATERIALS- Prior to the action of any "SPOS" or "SROT" commands, each NSS SURFACE is assumed to be located at the global origin 0.0,0.0,0.0. It is assumed to have two sides with the interfacing surface normal pointing in the +Z direction. The -Z side of a surface is always referred to as the MEDIA1 side/space of an NSS surface. The +Z side of an NSS surface is always referred to as the MEDIA2 side/space. This can also be thought of in terms of local surface normals at the local "vertex" of the surface as in the sequential lens database. In this case, the local surface +Z axis direction always points "into" MEDIA2 and away from MEDIA 1.

MEDIA1 (qualifier) (string) - The "MEDIA1" command specifies the refractive index of the optical material in the MEDIA1 space of an NSS SURFACE. The qualifier word refers to a valid program glass catalog name and the string refers to a valid program glass catalog glass name or number.

MEDIA2 (qualifier) (string) - The "MEDIA2" command specifies the refractive index of the optical material in the MEDIA2 space of an NSS SURFACE. The qualifier word refers to a valid program glass catalog name and the string refers to a valid program glass catalog glass name or number.

NSSN , media space indicator, wavelength number , new real refractive index, new imaginary refractive index - The "NSSN" command specifies the optical material in the space designated by numeric word #1 (value = 1 or 2) and at the wavelength specified by numeric word #2 (value = 1 to 10) should have its real refractive index replaced by the value in numeric word #3 and its imaginary refractive index replaced by the value in numeric word #4. This allows for full refractive index customization by the user.

NSSCOAT1 , n and **NSSCOAT2 , n** The "NSSCOAT1" and "NSSCOAT2" commands specify the NSS optical coating on the current surface will be set to the NSS coating type designated by the coating file number "n" (see the following discussion). NSS coating type numbers and the program coating database are described later in this section of this manual. The nature of the coating defined by the "NSSCOAT1" and NSSCOAT2" commands controls how a ray will interact with a surface when the ray is approaching the surface from the MEDIA1 or the MEDIA2 side of the surface. Multiple layers are always understood to be oriented such that the first layer is farthest from the interface between MEDIA1 and MEDIA2. If no coating is specified, an uncoated optical surface is assumed.

NSS SURFACE INTERACTION CODE

NSSINTER (R or T or A) , (space#) - The “NSSINTER” command is the command which the user uses in order to specify that refraction or reflection will occur at a surface in either space 1 or 2. The "NSSINTER" command sets the NSS ray interaction code on the current surface and in the space# 1 or 2. If space# 1 is specified, the interaction mode is used when a ray approaches the surface from MEDIA1 going toward MEDIA2. If space# 2 is specified, the interaction code is used when a ray approaches the surface from MEDIA2 going toward MEDIA1. If the interaction code is set to "T", the ray will transmit through the surface unless a TIR condition exists. If the interaction code is set to "R", then the ray will reflect from the surface. If the condition is set to "T" and a metallic coating exists on the surface, the ray will naturally be absorbed by the surface. If the condition is set to "A", the ray will be 100% absorbed. Coatings determine the reduction is relative ray energy only.
NSSDET The "NSSDET" command specifies the current surface to be the detector surface. There can be only one detector surface. Spot diagram irradiance plots are always generated at the DETECTOR surface. By default, if one is not explicitly set, and rays do not terminate in any other way, then rays will terminate after traveling the final distance specified by the last "UNIVERSE" command.

NSS SURFACE LINKS
NSSLINK (SPROFILE or SMEDIA or SCOATING or SINTRAC) , i - The “NSSLINK” command causes the NSS SURFACE profile data (including all NSS SURFACE parameters) or the NSS SURFACE media definitions or the NSS SURFACE coating definitions or the NSS SURFACE interaction codes (including diffraction grating definitions) of the current NSS SURFACE to be linked to the corresponding NSS SURFACE parameters of NSS SURFACE "i". By default, an NSS SURFACE is considered to be linked to itself. Issued with a "?", the current surfaces reference surface is displayed.

NSS FILE COMMANDS - The following commands are used to save and reload NSS databases to disk.
NSSSAVE (file name) - The "NSSSAVE" command save the current NSS database to the file designated by the qualifier word "file name" into the directory "NSSDIR". The file extension is ".NSS"
NSSREST (file name) - The "NSSREST" command reloads the NSS database from the file with the name specified in the qualifier word "filename". This file, if it exists, will be retrieved from the "NSSDIR" directory.
NSS RAY TRACING - The following commands are used to prepare for ray tracing through the NSS database. Rays are traced until, their relative intensity drops below the ray trace threshold level set by the "NSSMINE" command or they interact with NSS surfaces more than the interaction threshold limit set with the "NSSNHIT" command.
NSSMINE , minimum relative ray energy - The "NSSMINE" command sets the minimum relative ray energy below which the ray is considered to have no energy. This is a relative fractional value with respect to the starting ray energy. The default value is 0.0.
NSSMHIT , maximum number of ray/surface interactions - The "NSSMHIT" command sets the maximum number of ray/surface interactions before the ray is considered to have no energy. The default value is 1000.
NSSSPLIT , YES or NO - The "NSSSPLIT" command sets the ray splitting command "ON" or "OFF". If "R" on a surface is non-zero and less than 1.0 and ray splitting is "ON" then ray splitting during ray tracing will occur, otherwise it won't. Ray splitting is not yet operational. (Ray splitting not yet operational)
NSSOBJ (REAL or VIRTUAL), X , Y , Z - The "NSSOBJ" command sets the location of the center of the source. The defaults are X = 0.0, Y = 0.0 and Z = -1.0D20. The default qualifier is "REAL" and it represtents rays traced from each object grid point through each reference ray grid and then on into the NSS system. If "VIRTUAL" is issued, rays are traced from each reference grid point, into the NSS system in directions which would have taken the rays through the object point. No ray is actually traced to the object grid points, however.
OBJMEDIA (qualifier word) (string) - The "OBJMEDIA" command specifies the optical material in the OBJECT or starting space of an NSS database. The qualifier word refers to a valid program glass catalog name and the string refers to a valid program glass catalog glass name or number. The refractive index of this MEDIA may not be set so as to be absorptive and individual refractive index values may not be modified from program catalog values. By default, the MEDIA type is AIR.
NSSGRIDS , n , spacing - The "NSSGRIDS" command sets dimension of the source grid for NSS ray tracing. By default, "n" = 1. This grid is centered on the center of the source. "spacing" is the grid spacing in x and y in system units (local coordinate system of the source grid). The source grid lies in a plane perpendicular to the vector connecting the center of the source grid with the center of the reference grid.

NSS REFERENCE RAY GRID - All NSS rays are aimed from locations in the NSS source grid to positions in the NSS reference grid. The NSS reference grid is the grid at which ray grids are defined using the "NSSGRIDR" command.
NSSREF, X , Y , Z - The "NSSREF" command sets the location of the center of the nss REFERENCE GRID. The defaults are X = 0.0, Y = 0.0 and Z = 0.0.
NSSGRIDR (CIRC or RECT) , n , spacing - The "NSSGRIDR" command sets dimension of the reference grid for NSS ray tracing. By default, "n" = 1. This grid is centered on the center of the reference grid. "spacing" is the grid spacing in x and y in system units (local coordinate system of the reference grid). The reference grid lies in a plane perpendicular to the vector connecting the center of the source grid with the center of the reference grid. The grid pattern is always arranged in a rectangular pattern. The default qualifier word is "CIRC" which means that a rectangular grid is clipped, prior to tracing, as if a circular aperture had been assigned to the reference grid. If the qualifier word "RECT" is issued, the rectangular pattern is traced with no clipping.

NSSAPODR , dbloss - The "NSSAPODR" command sets ray intensity level drop (in db) to "dbloss" at the edge (not the corners) of the reference ray grid due to a gaussian distribution intensity apodization. By default, "dbloss" is zero meaning a uniform intensity distribution If the x and y-fractional ray positions in the reference grid are given by "fx" and "fy" then "APX" and "APR" are given by the following equations:

$$APX = -\ln\left(10.0^{-\left(\frac{\text{abs}(\text{dbloss})}{10.0}\right)}\right)$$

$$APR = \left(fx^2 + fy^2\right)$$

and the original ray intensity is reduced by:

$$I = I * e^{-(APX \times APR)}$$

cast in the more familiar optical $1/e^n$ intensity reduction terms, the absolute value of the "dbloss" term is given by:

$$\text{dbloss} = 10 * \text{Log}_{10}\left(e^{-n}\right)$$

NSS RAY AIMING - During NSS ray tracing, rays are traced from each source grid point in the NSS source through every ray grid point in the NSS reference grid and then into the NSS optical system defined in the NSS database. Rays intersect surfaces with the same accuracies as set in sequential ray tracing using the SURTOL parameter.

NSS RAY TRACE - The following command is used to trace rays in the NSS database. Rays will reflect if the TIR condition is found to be true and MEDIA2 is not set to "REFL" or if the TIR condition is not found to be true and MEDIA2 is set to REFL. In all other cases, except during ray splitting, a ray transmits rather than reflects at a surface. Ray splitting is not yet operational.
NSSPOL (ON or YES or OFF or NO) - The "NSSPOL" command turns polarization calculations "ON" or "OFF" during NSS ray tracing. "NSSPOL" is not yet operational.
NSSTRACE (SPOT or SPOTADD) - The "NSSTRACE" command initiates ray tracing in the current NSS database. Results for the ray trace are placed in the RAY HISTORY files NSSRHIST.DAT, NSSHIST.DAT and NSSHT.DAT. If optional qualifier words "SPOT" or "SPOTADD" are issued, then spot diagram files are generated with the next issuance of the "NSSSPOT" command.

NSS SPOT DIAGRAMS.
The qualifier words "SPOT" and "SPOTADD" prepare the program for the generation of a traditional spot diagram or a cumulative spot diagram which will be generated by the next "NSSSPOT" command. Each record in the file comprises:

local X-coord. , local Y-coord. , local Z-coord. , local L-dircos. , local M-dircos. , local N-dircos, Relative Ray Intensity , Physical Length from object, and Optical Path Length from the object.

All at the surface specified in the "NSSSPOT" command. If the distance from the object to the reference grid is greater than 1.0D+10 units, it is left out of the length results.

Data is in a free format, ASCII file named NSSLSPOT.DAT. Direction cosines and intensities are before surface interaction.

If "i" is specified beyond the current maximum active NSS surface, no trace is performed and an error message is issued.

NSSSPOT , i , j - The "NSSSPOT" command creates a spot diagram file names NSSSPOT.DAT for all rays intersecting surface "i". If "j" is issued, the only rays which have made "j" surface intersections will be includes, else all hits on surface "i" are included. Mean and RMS values of this spot may be "gotten" and displayed with the "GET" and "SHO" commands described in the CMD section of the manual with get qualifier words "NSSMEANX", "NSSMEANY", "NSSMEANR", "NSSRMSX", "NSSRMSY" AND "NSSRMSR".

NSS IRRADIANCE PLOTS.
IRRAD , j - The "IRRAD" command creates an irradiance plot from the current spot diagram file. The spot diagram surface must be pixelated using the following pixelization commands or no irradiance plot will be produced.
PIXNXNY , nx , ny , dx , dy , w - The "PIXNXNY" command sets the number of pixels in th x and y local directions on the current spot diagram surface "nx" and "ny" and the dimensions of the pixels in current system units "dx" and "dy". Each ray is assumed (before any apodization or coating losses) to carry "w" watts from the object surface.. By default, "w" is 1.0.
PIXCEN , x , y - The "PIXCEN" command sets the center location of the current pixelated irradiance grid. The default is at the center of the spot diagram surface at x = 0, y = 0.

NSS DATABASE DISLAY - The following command is used to display the NSS DATABASE.
NSSLIST (NOSURF) , i , j - The "NSSLIST" command displays the current NSS database in an "Engineer Friendly Format" to the current display device. If the optional qualifier word "NOSURF" is used, only non-surface specific data is displayed. If "i" is input, only surface "i" data is displayed. If "i" and "j" are input, surface "i" through surface "j" data will be displayed
NSSVERT - The "NSSVERT" command displays the current NSS surface vertex locations and orientation in the global coordinate system to the current display device.

NSS DATABASE OUTPUT - The following command is used to output the NSS DATABASE in a program readable format.
NSSLENO - The "NSSLENO" command outputs the current NSS database in a program readable format.

NSS DATABASE GRAPHICS - The following commands are used to generate a graphical representation of the current NSS database and the rays that have been traced through it. A “PLOT NEW” command should be given at the beginning of all NSS plotting.
PLOT NSSSCALE , sf - The "PLOT SCALE" command sets the NSS plot scale factors. "sf" is the number of thousands of device independent coordinate units which represent one lens unit int the plot. A "sf" scale factor of 10 would scale one unit of the object being plotted so that it plotted in 10,000 units of the device independent coordinate system. For most devices, 1000 units in the device independent coordinate system will be represented as 1.0 inch.
NSSORINT , i , rflag - The "NSSORINT" command causes the "LOOK VECTOR" to be reset so that its X, Y and Z-components are equal to the L, M and N-direction cosines of the local Z-axis of NSS SURFACE "i. The "LOOK VECTOR" passes through the local vertex of that surface. NSSORINT" is used whenever the "LOOK VECTOR" needs to be set so as to look "normal" to an NSS SURFACE looking from the MEDIA 1 sude. The view angles are also reset. If "rflag" is set to any explicit value, the look vector is set so as to look from the MEDIA 2 side of the surface instead of from the MEDIA 1 side.

PLOT NSSSURFS - The "PLOT NSSSURFS" command plots all NSS surfaces in the NSS DATABASE using whatever look vectors and scale factors have been set using the regular plotting commands.
PLOT NSSRAYS - The "PLOT NSSRAYS" command plots all NSS rays traced in with the last "NSSTRACE" command. using whatever look vectors and scale factors have been set using the regular plotting commands described in the GRAPHICS section of this manual.
PLOT NSSSPOT , bar - The "PLOT NSSSPOT" command plots all NSS rays traced in with the last "NSSTRACE" command. using whatever look vectors and scale factors have been set using the regular plotting commands described in the GRAPHICS section of this manual. The parameter "bar" is the semi-width of the bars drawn at each ray location, in device independent coordinates (about 0.001 inch). By default, "bar" is set to 1.

NSS SURFACE COATINGS
SURFACE COATING DATABASE - The SURFACE COATING database consists of user-generated ASCII files COAT0001.DAT through COAT1000.DAT. These files hold the complete description of all the types of single and multi-layer coatings available for use in the program. Up to 1000 individual coating files may be defined and redefined by the user.

NATURE OF THE COATING DESCRIPTIONS - Unlike most other optical design and analysis codes, the program contains a flexible syntax for describing optical surface coatings in many different ways. Each coating definition consists of a series data lines in an ASCII file which describe the type of coating and its characteristics. All coatings are prepared ahead of time by the user using any text editor. The syntax of every coating definition file begins with the header line which contains a single integer that specifies the coating type. The program currently has 4 coating types availabe. Any of these 4 coating types may be used in any of the 1000 different coating database files.
COATING TYPES - Valid coating types are defined below. Coatings are used for energy throughput calculations when surface coating dependent ray trace options are in are in effect. When performing polarization type calculations, only type 1 (no effect on polarization) or type 4 coatings will be used.
COATING TYPE 1 – No coating and no coating losses. Transmissions and reflections are 100% efficient. This is the program default and requires no coating definition file. If this type of coating is to be explicitly set in a coating definition file, only one entry, the coating type number 1 is needed as shown below:

```
1
```

COATING TYPE 2 - Coating type 2 is an uncoated surface with Fresnel losses. Uncoated transmissive surfaces exhibit simple Fresnel reflection losses. Reflections will experience no energy loss. A coating file used to define a type 2 coating has only one entry as shown below:

```
2
```

COATING TYPE 3 - Coating type 3 is a simple "e"% efficient coating where the default value for "e" is 100%. If a "TIR" condition is found, perfect 100% reflection will always occur. If reflection occurs at a surface with a type 3 coating (other than case of TIR), the reflectivity will be assumed to be "e"%. The file entry for this specific coating, if the efficienct were to be 85% is:

```
3
85
```

COATING TYPE 4 - Coating type 4 is the program general coating type. The first line in the coating file must be a **4**. The next N lines in the file comprise the user-supplied data for each of the N-layers of the coating. Each line starting at line 2 consists of a user supplied material name (up to 13 characters) followed by 10 real and then 10 imaginary refractive index values and then the layer thickness in microns. In multiple layer coatings, the first layer is the layer farthest from the substrait. As in regular program input, nested commas represent default values which are 1.0 for the real part and 0.0 for the imaginary part of the complex refractive index. As an example, a type 4 coating defined in the ASCII coating file COAT0025.DAT and consisting of a single layer of MGF2 with a complex refractive index at wavelength #1 of (1.38,0.0) and having a thickness of 0.34 microns would be defined using the following two lines in file COAT0025.DAT.

```
4
MGF2,1.38, , , , , , , , , ,0.0, , , , , , , , , ,0.34
```

NSS DATABASE DXF OUTPUT - The following commands are used to generate a DXF representation of the current NSS database and the rays that have been traced through it.
DXF NSSSURFS - The "DXF NSSSURFS" command adds all NSS surfaces in the NSS DATABASE to the current DXF output file. (See the CAD section for details on DXF output). (Not yet operational)
DXF NSSRAYS - The "DXF NSSRAYS" command adds all NSS rays in the NSSRHIST.DAT file to the current DXF output file. (See the CAD section for details on DXF output). (Not yet operational)

NSS DATABASE RESOLUTION

NSSEOS - The "NSSEOS" command causes an explicit resolution of all NSS DATABASE items including linkages. If NSSMFUNC is set to a specific macro function and that function exists, that macro function is executed. Normally this database resolution is performed automatically but this command is provided to maximize program flexibility.