MODIS-N CONTAMINATION MODEL

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and
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MODIS-N Calibration Working Group Meeting
April 14, 1992

Attachment 3.9

BACKGROUND

- Previous contam. analysis performed for MODIS-T
- Used UARS entrance flux
- Assumed constant outgassing rate for 5 years
- Assumed sticking coefficient = 1 on scan mirror
- Predicted 55 to 77 Angstroms of molecular film on scan mirror; thickness varied with location on mirror
- Expected species were hydrocarbons & silicones, but no optical constants available
- To be conservative, used optical constants for C and SiO, as suggested in a paper by Osantowski

SCAN MIRROR SPECTRAL REFLECTANCE; AOI 37°; CARBON 0, 25A, 50A

MODIS-N GSFC SBRC

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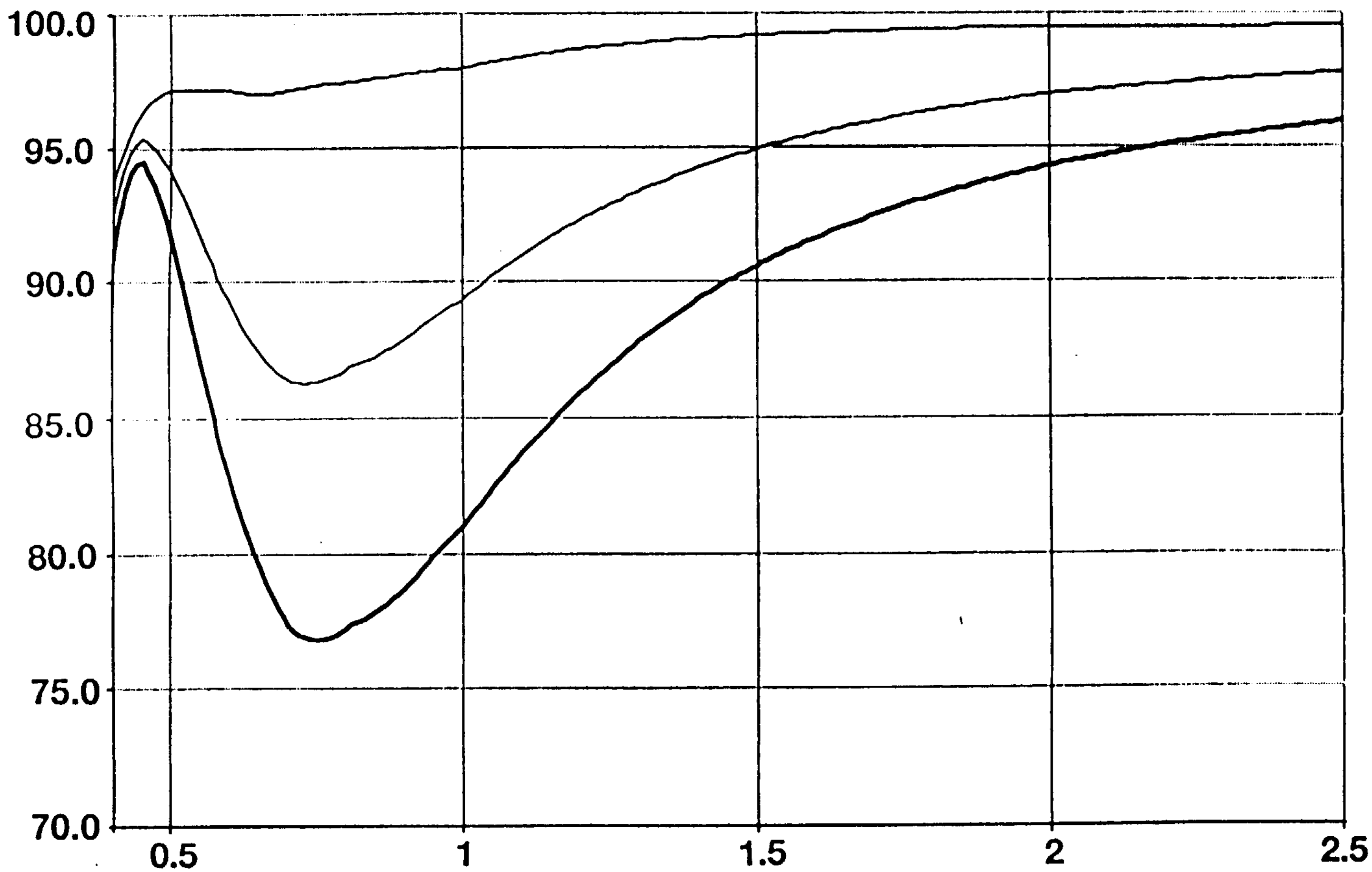

REFLECTANCE (%) VS WAVELENGTH (μm)

SCAN MIRROR SPECTRAL REFLECTANCE; AOI 37°; CARBON 0, 25A, 50A

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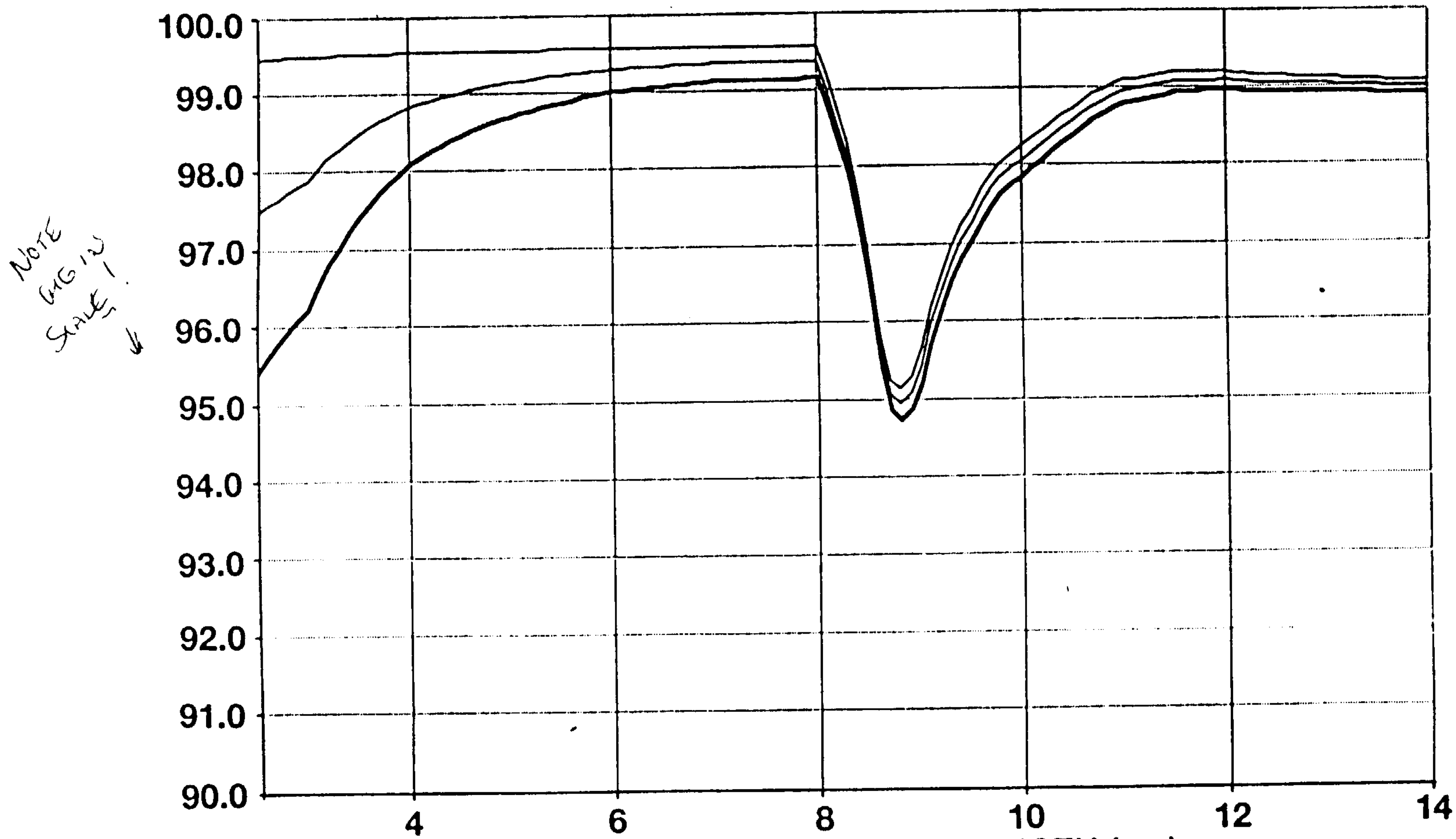


REFLECTANCE (%) VS WAVELENGTH (μm)

MODIS-N CONTAM. MODEL IMPROVEMENTS

- Tailored to MODIS-N geometry
- Used EOS-A1 (not old eos) and UARS entrance fluxes as lower and upper limits
- Used flight data for outgassing rate vs. time (did not assume constant over t)
- To get worst case predictions, still assumed sticking coefficient = 1 on scan mirror
- Plan to use optical constants of actual outgassing products, not C and SiO

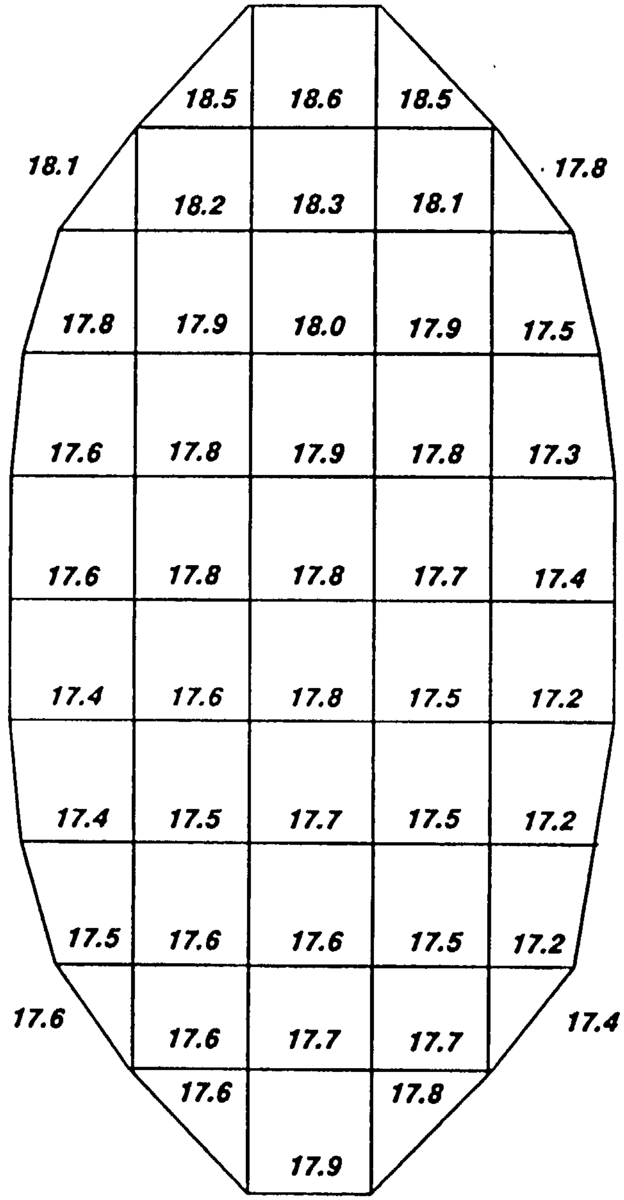
MODIS-N CONTAM. MODEL LIMITATIONS

- Entrance flux for EOS-AM not available yet, so had to use flux range
- Flux includes only spacecraft sources, assumes MODIS-N does not contaminate itself
- Sticking coefficients for scan mirror and scan cavity not known
- Contaminant species not known exactly, so optical constants not well-defined

(assumed same 4 rings as MODIS-T)

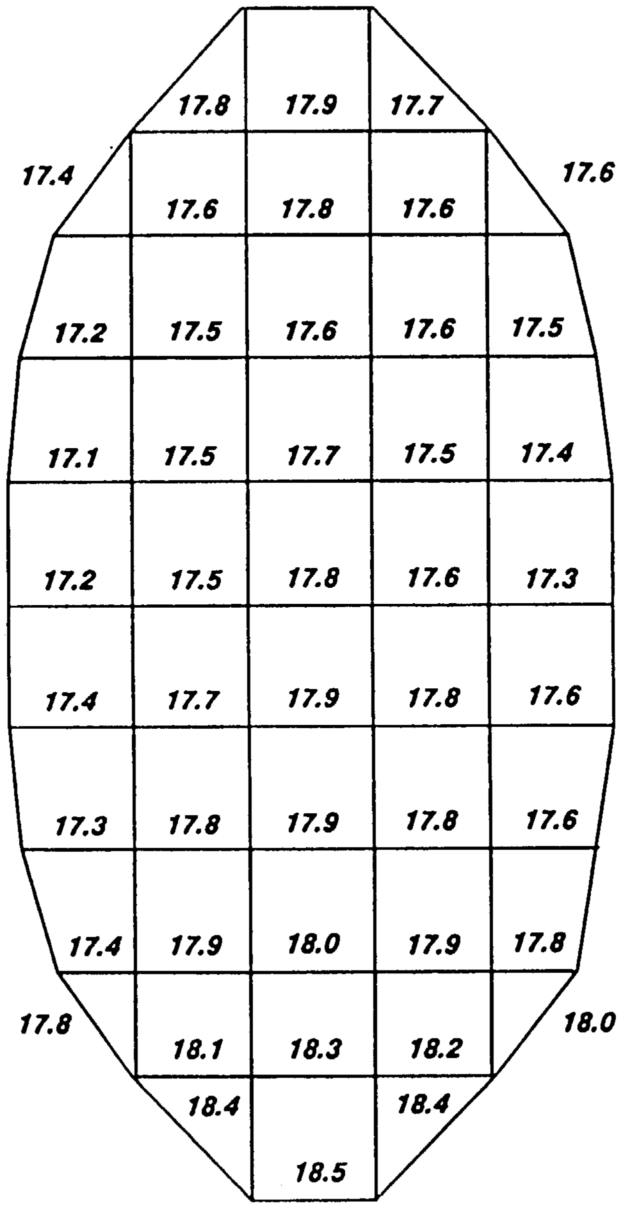
CRITICAL SURFACE	CONTAMINATION MODEL RESULTS		THEORETICAL BOUNDARY	
	Lower Limit	Upper Limit	Lower Limit	Upper limit
SCAN MIRROR (max value)	~0 Å	19 Å	0.2 Å	46 Å
FOLD MIRROR	~0	15	0.2	35
PRIMARY MIRROR	~0	11	0.2	26
AFT-OPTICS APERTURE	~0	12	0.2	28

UNITS OF ANGSTROMS



NOTE: MIRROR DIMENSION NOT TO SCALE

UNITS OF ANGSTROMS



NOTE: MIRROR DIMENSION NOT TO SCALE

SCAN MIRROR SPECTRAL REFLECTANCE; AOI 37°; CARBON 0, 25A, 50A

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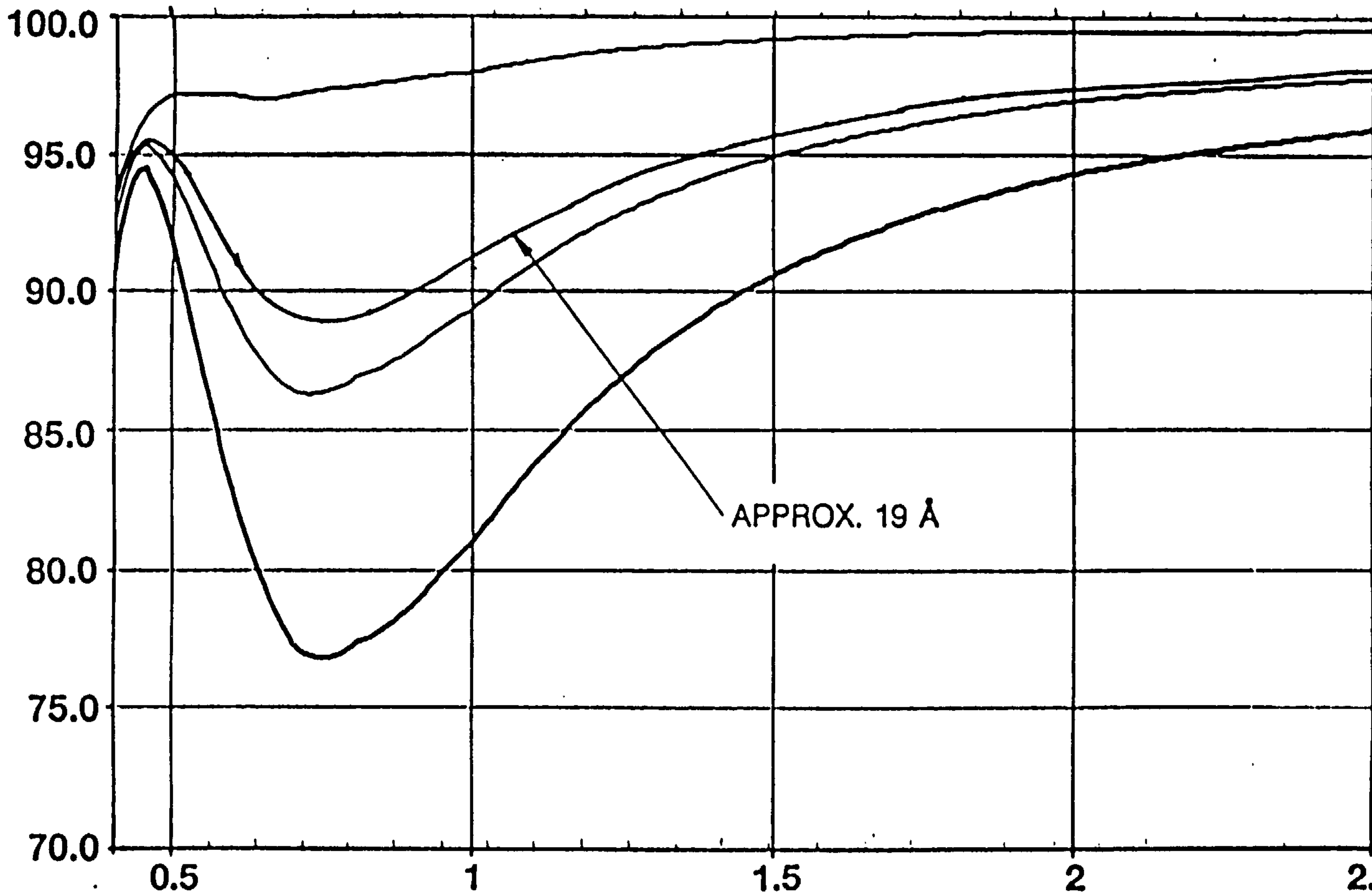

REFLECTANCE (%) VS WAVELENGTH (μm)

SCAN MIRROR SPECTRAL REFLECTANCE; AOI 37°; CARBON 0, 25A, 50A

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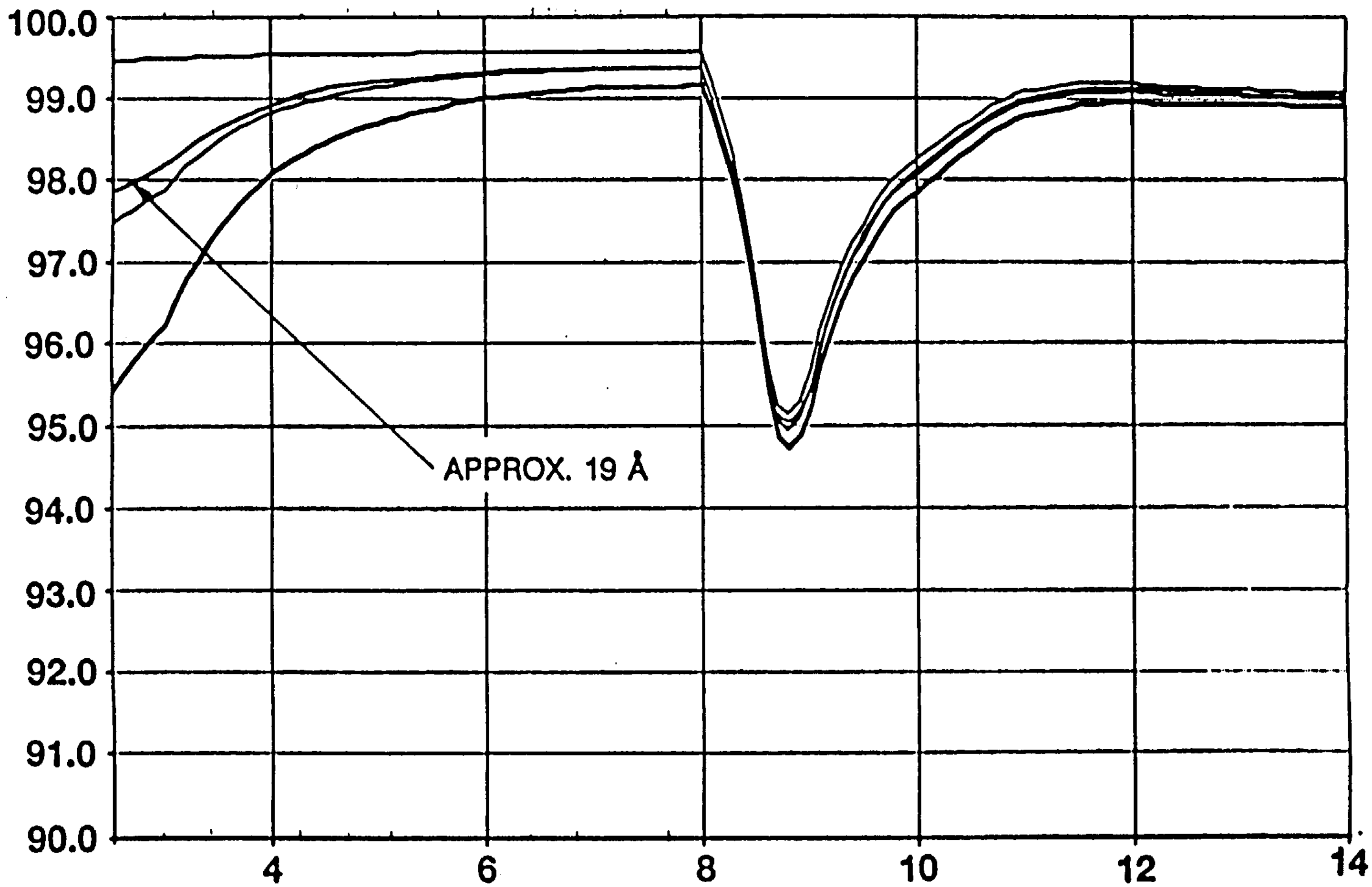


REFLECTANCE (%) VS WAVELENGTH (μm)

April 9, 1992

TO: June Tveekrem\Contamination Engineering Section\Code 732.4
Sharon Straka\Contamination Engineering Section\Code 732.4

FROM: Shaun Thomson\EER Systems\Code 732.4

SUBJECT: Preliminary Evaluation of MODIS-N Molecular Contamination Environment due to External Sources (Worst Case Analysis).

SUMMARY

A contamination modeling effort has been undertaken in an effort to characterize the contamination environment induced within the MODIS-N instrument and to generate predictions of the amounts of deposition produced by this environment. At the present time, this study has been purposely limited to the role of molecular contaminants originating from sources external to the MODIS-N instrument and entering the instrument exclusively through the three viewing/calibration ports. No attempt has yet been made to determine the effect of possible instrument self-contamination (ie. from materials, coatings, lubricants, etc. that are inherent in the construction of the MODIS-N instrument). The critical surfaces accounted for in this study are the scan, fold, and primary mirrors, and aft-optics aperture. The detailed steady-state molecular transport model created for this study employs for its geometric arrangement the most up-to-date MODIS-N drawings available and considers such contamination-determining factors as the continuously rotating two-sided mirror, multiple contaminant reflections, a multi-node scan mirror for contaminant footprint determination, and outgassing decay effects.

The results presented in this memo represent a worst case scenario. In this particular scenario the instrument cavity walls, calibration equipment, and aperture doors are assumed to be perfect reflectors of impinging mass, while the optical surfaces of the instrument are assumed to be perfect adsorbers. In addition, this particular study employs a set of upper and lower values for aperture throughput in an attempt the establish the contamination "envelope" within which MODIS-N will operate.

Worst case predictions obtained from the molecular transport model indicate that the scan mirror will experience maximum end-of-life (EOL) depositions across its surface of ~0 Å for the "lower limit" aperture flux to 19 Å for the "upper limit" aperture flux. At the high end prediction of 19 Å this should correspond to roughly 2-3 monolayers of hydrocarbon material. In the case of the fold mirror housed within the afocal telescope assembly, deposition predictions were found to be ~0 and 15 Å for the lower and upper fluxes, respectively. For the primary mirror, these depositions are ~0 and 11 Å. The aperture located between the afocal telescope and the aft-optics assembly is predicted to experience ~0 to 12 Å of contaminant material. The use of this "aperture deposition" was necessary since detailed information on the geometric arrangement of the mirrors and lenses of the aft-optics section was not available.

As mentioned before, these results represent the predictions obtained from the worst case scenario as described above and should, barring any future instrument or operational changes, be taken as the existing limits of the MODIS-N contamination "envelope". The following sections provide some model particulars as well as the detailed results.

ANALYSIS

Figures 1 through 5 contain illustrations of the geometric model broken down by major mechanical sub-section. The geometric model was constructed with the aid of the Thermal Radiation Analysis System (TRASYS) and is represented by 409 nodes (or surfaces). The scan mirror has been divided into 46 surfaces on each side to facilitate calculations of the contamination footprint. Figure 6 provides an illustration of these divisions as well as furnishing the particular nodal designation of each surface. In order to simulate its motion, the scan mirror is permitted to rotate completely about its minor axis in 20 degree increments. This means that in order to simulate a single scan mirror rotation a total of 18 separate geometric models were created each corresponding to a single snapshot in the rotation. For every one of these scan mirror orientations TRASYS is employed to calculate a set of viewfactors which is then substituted into the contamination model for subsequent deposition calculations.

The contamination model uses a steady-state approach to calculate the EOL deposition on each critical surface. Using the viewfactor sets generated by TRASYS for each orientation of the scan mirror, the contamination model determines the role of multiple reflections and then calculates the resulting amounts of deposition on each critical surface for that scan angle. The depositions at each scan angle are then integrated over the entire 360° mirror sweep to obtain total depositions during a single rotation. These depositions can then be applied to the EOS timeline to obtain mission total depositions.

Contaminants were assumed to enter the MODIS-N instrument only through the apertures of the viewing/calibration ports. MODIS-N possesses three such apertures. The first being the earth viewing aperture through which the science data is gathered, the second is the space/lunar aperture which is used to perform space and lunar calibration procedures, and the third is the sun aperture which serves as the conduit for illumination of the solar diffuser. Only the earth and space/lunar apertures were considered open in this model. It was determined that the 2 minute per week operating cycle of the sun aperture negates any concerns that this port will produce an appreciable amount of contamination. Therefore, the sun door remains closed throughout and serves only to reflect contaminants back towards the scan cavity.

Two contaminant throughput rates, representing the upper and lower bounds of the expected aperture flux, were employed for each viewing/calibration port of the instrument. This action was necessary in order to combat the possible inaccuracies in the rates predicted by AST's "Earth Observing System On-Orbit Contamination Analysis"[1]. The predictions of aperture flux presented in this EOS analysis were based on the older observatory design and therefore may no longer be appropriate. In order to provide some security, the aperture rates from this study were employed in the MODIS-N model as the lower limit for aperture throughput. The upper limit was chosen to be representative of rates predicted for the Upper Atmospheric Research Satellite (UARS). Although differing in configuration and operation from EOS, the UARS observatory by virtue of its much lower altitude should experience much higher levels of scattered contaminants than EOS. Therefore, by employing these predictions we are both injecting some conservatism into the MODIS-N results and hedging ourselves from the possible inaccuracies of the previous EOS contamination analysis work. These rates are provided below for each port aperture:

APERTURE	molecules/cm^2/s	
	LOW VALUE (EOS Analysis)	HIGH VALUE (UARS)
EARTH APERTURE	1.45×10^5	2.67×10^7
SPACE/LUNAR APERTURE	3.00×10^5	5.50×10^7

In an effort to establish a "worst case" scenario, the nodes making up the scan and afocal cavity walls, the aperture doors, and the calibration equipment were modeled as perfect reflectors while those forming the critical surfaces of the instrument were designated as perfect adsorbers. The result of this situation is that contaminants injected into the instrument will reflect continuously within the instrument until they acquire a trajectory that causes them to: (1) collide with a critical surface and become permanently retained by that surface or; (2) pass through either the earth or space/calibration ports and back into space.

To add realism to the model, the throughput of both apertures was permitted to decay with time. This throughput decay is representative of a depletion of contaminants within the outgassing materials of the EOS platform. Unfortunately, no decay data specific to EOS is currently available. Therefore, the decay behavior obtained from the flight data of NOAA-7 was employed. This behavior should allow for an adequate representation of the EOS decay since the NOAA-7 spacecraft, like EOS, is a high altitude polar orbiting spacecraft.

RESULTS AND CONCLUSIONS

Figures 7 and 8 list the depositions resulting from the lower limit aperture fluxes of the earth and space/lunar ports, respectively. On the whole, these lower limit aperture fluxes produce extremely small amounts of deposition. Normally, when encountering depositions of such small magnitudes the assumption is made that they are zero. However, for comparison purposes the exact values generated within the contamination model are presented. Please note that accuracy to this degree is not implied. The majority of deposition that does occur is on the scan mirror and is due to contaminants entering via the earth aperture. This observation is to be expected since the scan mirror is located just above the earth aperture and always in full view of contaminants passing through the aperture. Contaminants entering through the space/lunar aperture produce substantially lower levels of deposition when compared to that of the earth aperture. This is due entirely to the more tortuous pathway that exists between that aperture and the critical surfaces. The total of both contributions (earth and space/lunar) can be found listed in Figure 9. In general, scan mirror contaminant thicknesses vary by less than 10% across the mirror surface and depositions are approximately zero. The same is true for the fold and primary mirrors as well as for the aft-optics aperture. The footprint produced by these depositions is presented in Figures 10(a) and (b).

Figures 11 and 12 list the depositions resulting from the upper limit aperture flux cases. The results for the upper limit values are substantially higher than that found for the lower limit flux. On the whole, deposition ranges between 16-17 Å for the earth aperture contribution and around 1 Å for the space/lunar aperture contribution. As was the case with the lower limit fluxes, contaminants entering through the earth aperture produce the largest depositions. Totals of both aperture contributions are provided in Figure 13. For every point on its surface the scan mirror receives less than 19 Å of deposition and each point varies from the maximum deposition by less than 10%. The general footprint results are presented in Figures 14(a) and (b). The fold mirror experiences less than 12 Å while the primary mirror receives about 7 Å. Less than 8 Å worth of material pass through the aperture to the aft-optics assembly.

Note that a "theoretical" worst case deposition can be acquired for each flux by ignoring such realism factors as the decay of spacecraft outgassing rates with time on orbit. If one assumes that the outgassing remains constant for 5 years, then for the scan mirror this theoretical boundary is about 0.2 Å for the lower limit flux and 46 Å for the upper limit flux. The outer bounds for the fold mirror, primary mirror, and aft-optics aperture are 35, 26, and 28 Å respectively. It should be stressed that this is the theoretical limit based solely on the geometry of the instrument and the rotation of the scan mirror, it is not representative of any possible operational situation. It is intended to establish the outermost boundary of the problem.

All deposition results presented above can be summarized in the table below:

CRITICAL SURFACE	CONTAMINATION MODEL RESULTS		THEORETICAL BOUNDARY	
	Lower Limit	Upper Limit	Lower Limit	Upper limit
SCAN MIRROR (max value)	~0 Å	19 Å	0.2 Å	46 Å
FOLD MIRROR	~0	15	0.2	35
PRIMARY MIRROR	~0	11	0.2	26
AFT-OPTICS APERTURE	~0	12	0.2	28

The effect of deposited carbon on the reflectance loss of the MODIS-N scan mirror has been investigated by Hughes/SBRC. The results of this reflectance loss study taken over the entire spectral range of the MODIS-N instrument have been reproduced in Figure 15(a) and (b)[2]. Superimposed on these plots is an approximated response curve for the largest deposition encountered by the contamination analysis, approximately 19 Å. This curve represents the effect that the worst case deposition would have on the scan mirror if the organic contaminants were to behave, optically, like pure carbon. This method is generally considered to be a very worst case assumption. Without experimentation with likely organic contaminants it will be difficult to make any further refinements. Overall, this worst case contamination layer is responsible for some degree of reflectance loss over the majority of the spectral range. The loss appears to be most evident in the range between .5μm and 1.25μm where reflectance losses reach a maximum. No information could be found to determine the effect of contaminants on the fold or primary mirror.

The conclusions made above concerning possible reflectance losses induced by deposited contamination are to indicate possible maxima (or maximum losses) based on the existing reflectance data. The actual performance losses associated with each optical component and how these components interact with each other are best left to the instrumenters.

REFERENCES

1. S.D. Chinn, Earth Observing System On-Orbit Contamination Analysis, Contract No. N31-222, Applied Science Technologies, Littleton, Colorado, November, 25,1991.

2. System Study Review (SSR) Data Package, A presentation to Goddard Space Flight Center by Hughes/SBRC, Santa Barbara, California, December 4 and 5, 1991.

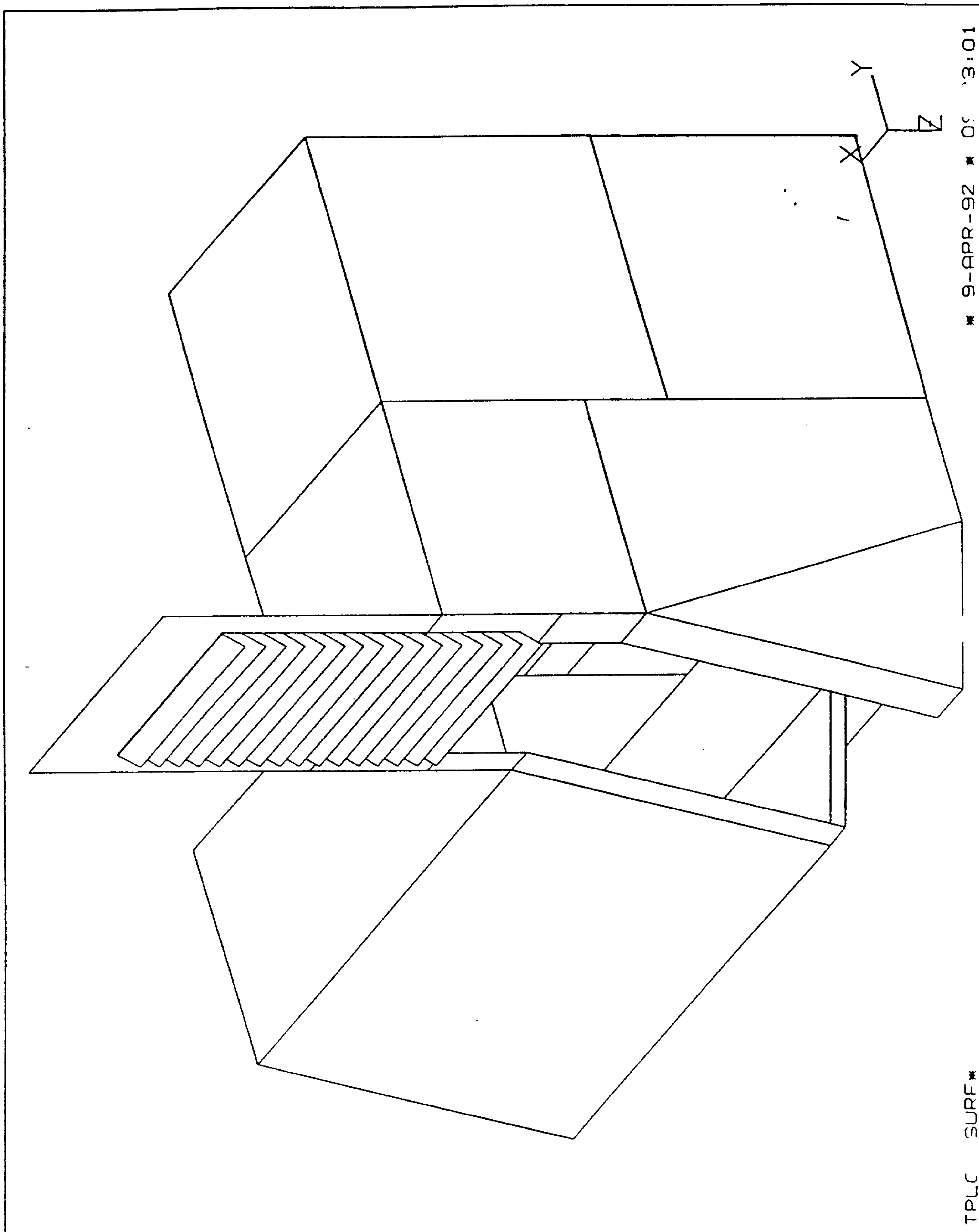


FIGURE 1. AFOCAL TELESCOPE

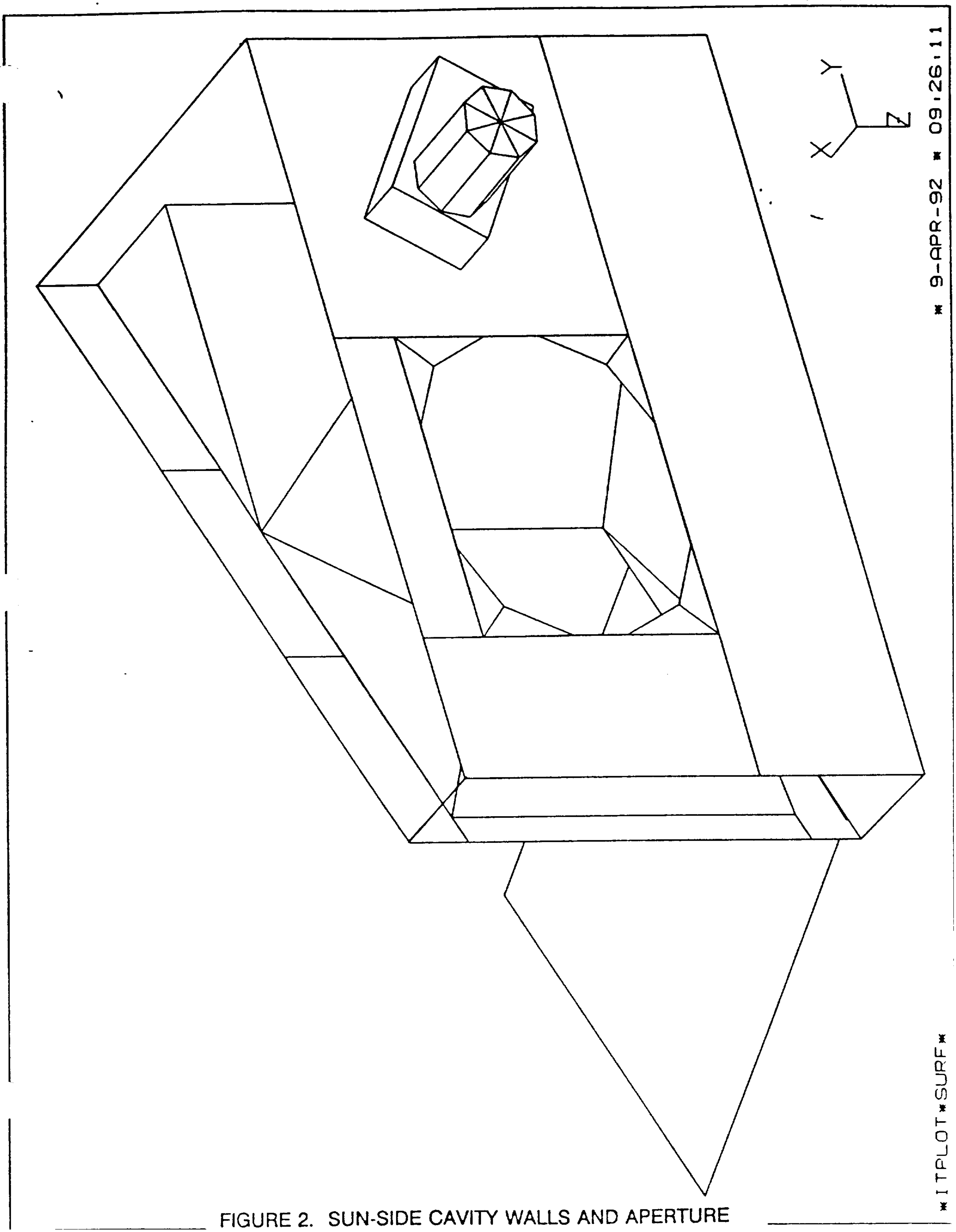


FIGURE 2. SUN-SIDE CAVITY WALLS AND APERTURE

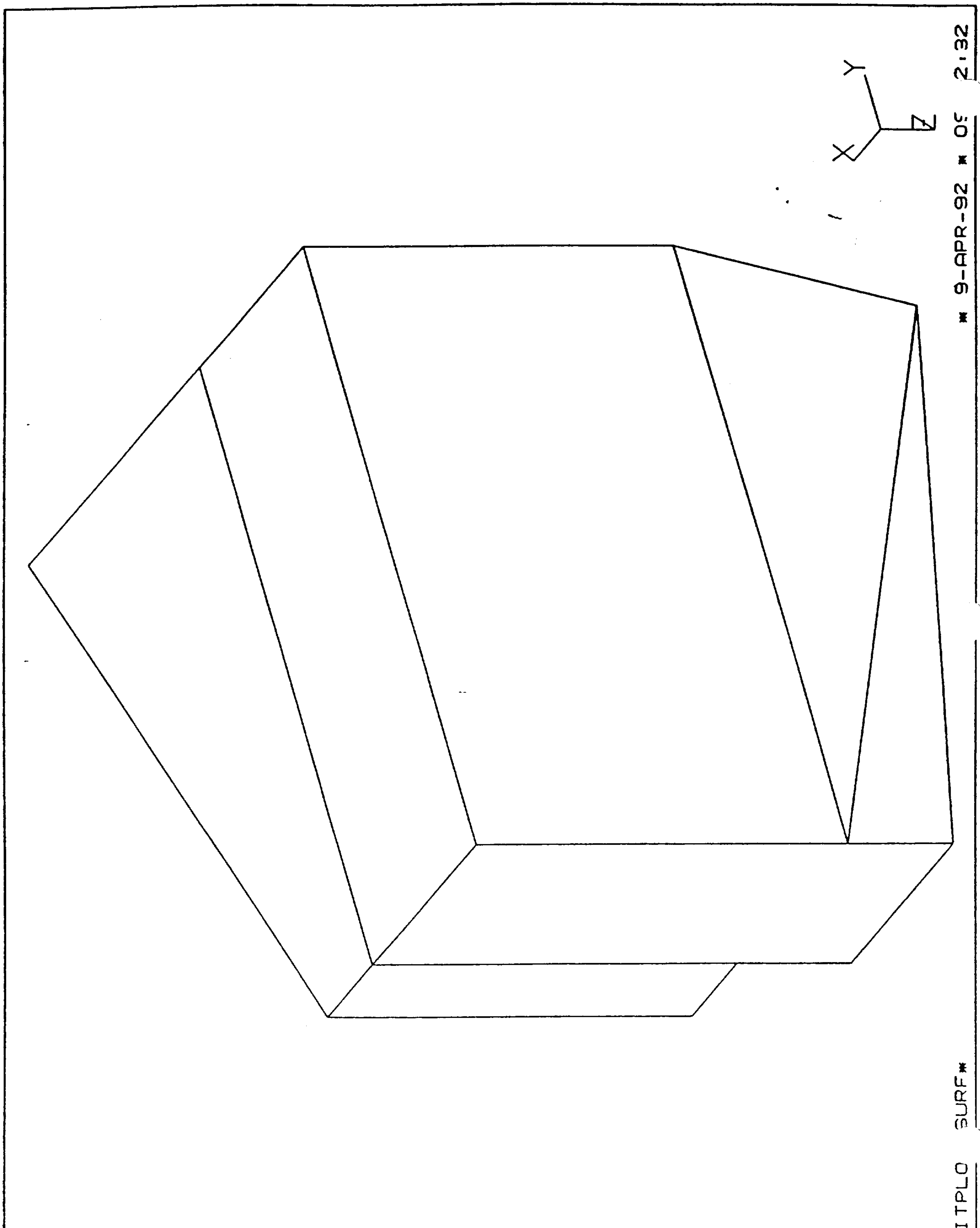
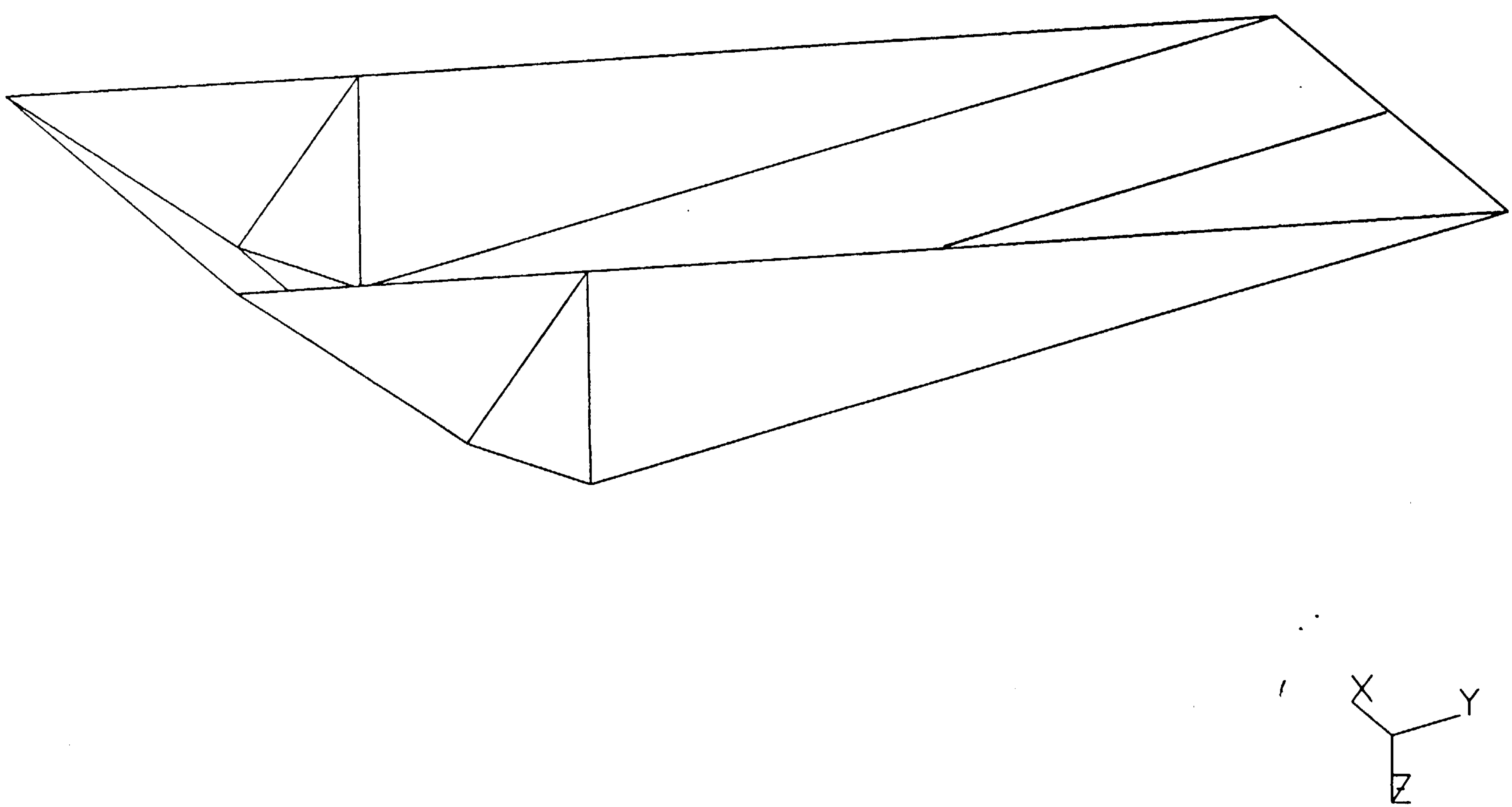


FIGURE 3. SCAN CAVITY WALLS



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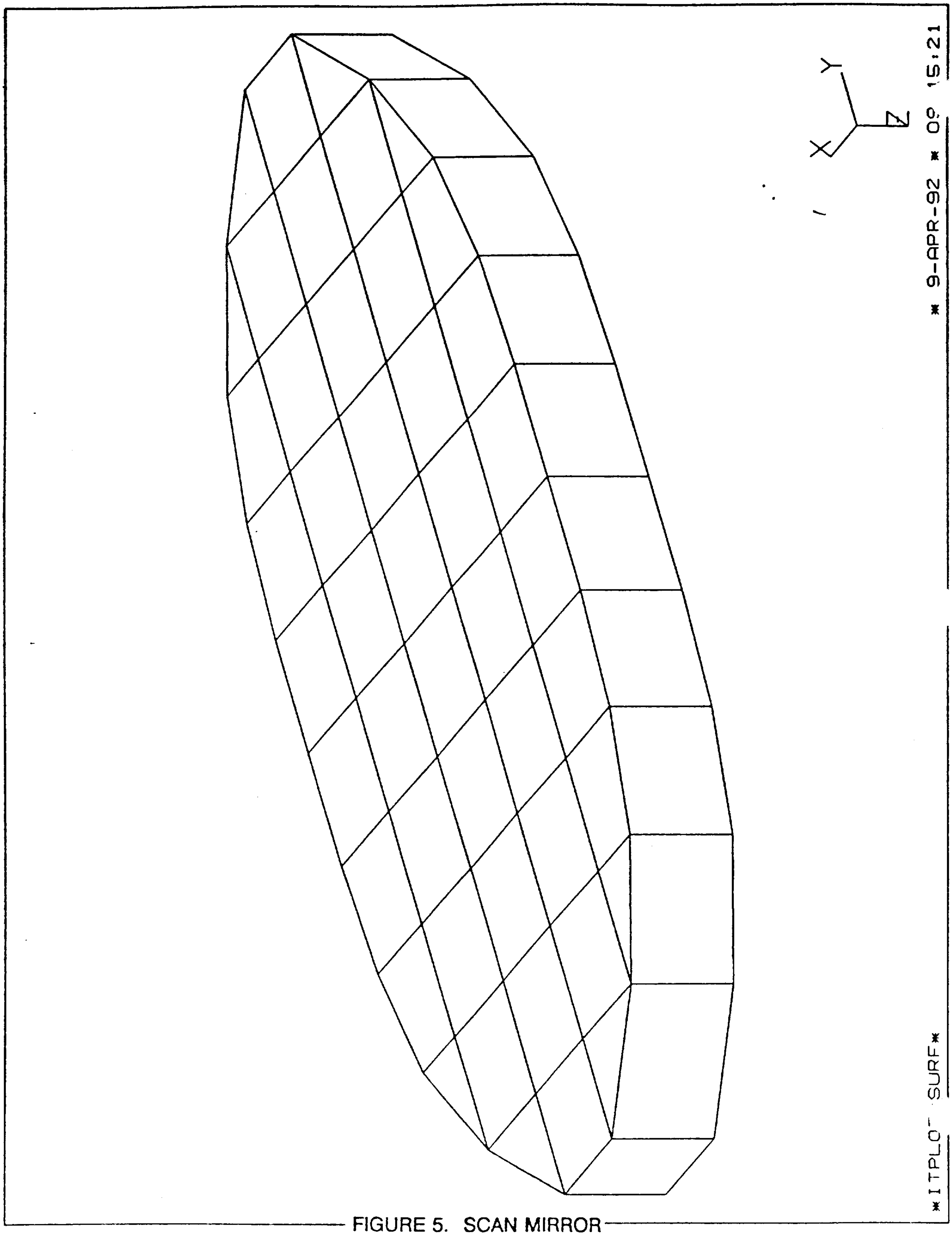

FIGURE 5. SCAN MIRROR

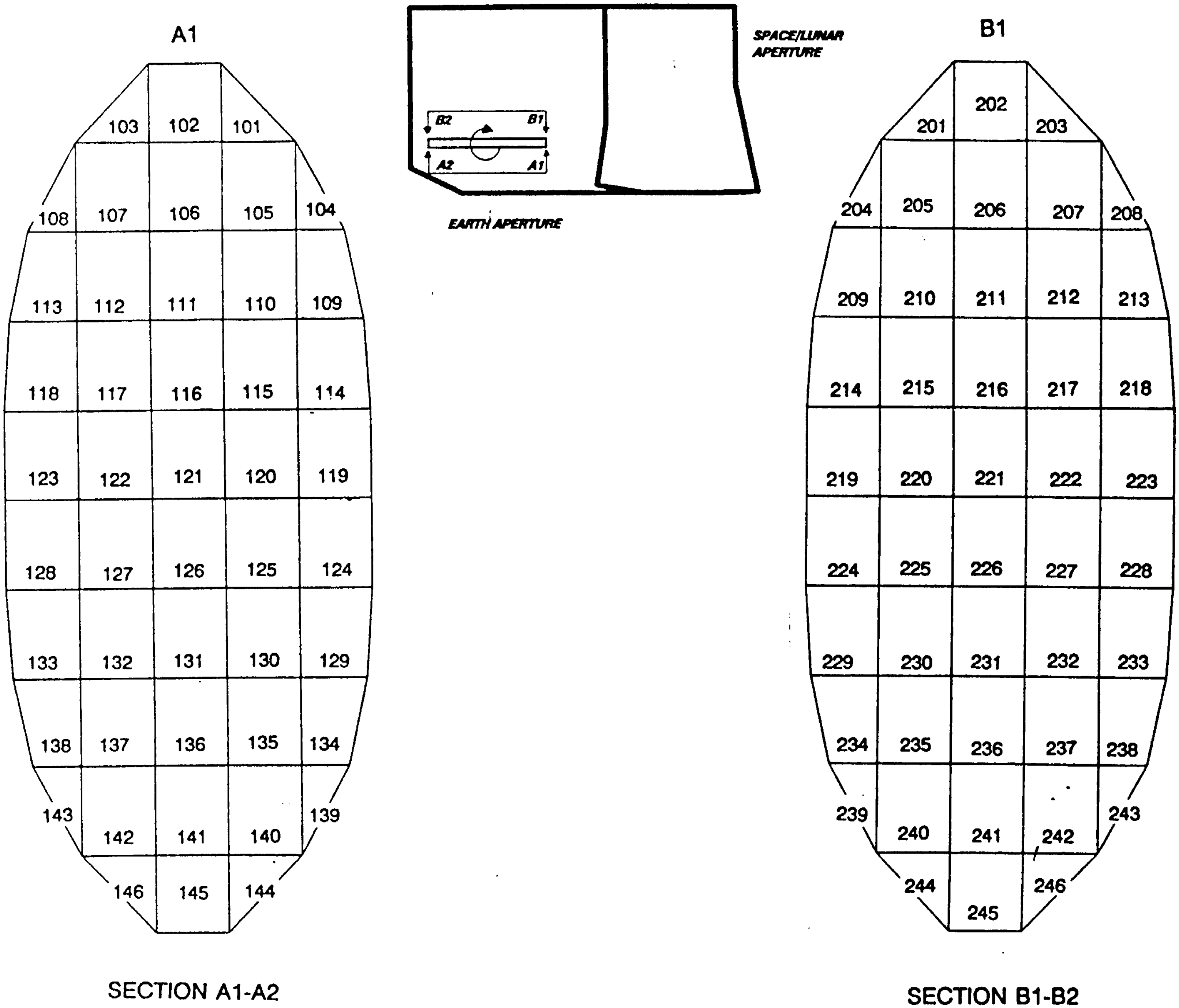

FIGURE 6. SCAN MIRROR DIVISIONS AND NODAL DESIGNATIONS

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* MODIS-N DEPOSITION RESULTS *
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APERTURE FLUX: 145000.0 MOLECULES/CM^2/S
EXPOSURE TIME: 43830.00 HOURS
DECAY CONSTANT: NOAA-7 FLIGHT DATA

[UNITS OF ANGSTROMS]

SCAN MIRROR, SIDE #1

101=	0.094	102=	0.095	103=	0.094	104=	0.090	105=	0.092
106=	0.093	107=	0.093	108=	0.092	109=	0.088	110=	0.090
111=	0.091	112=	0.091	113=	0.090	114=	0.087	115=	0.090
116=	0.090	117=	0.090	118=	0.089	119=	0.087	120=	0.089
121=	0.090	122=	0.090	123=	0.088	124=	0.086	125=	0.088
126=	0.089	127=	0.089	128=	0.087	129=	0.086	130=	0.088
131=	0.089	132=	0.088	133=	0.088	134=	0.086	135=	0.088
136=	0.089	137=	0.089	138=	0.088	139=	0.088	140=	0.089
141=	0.089	142=	0.088	143=	0.089	144=	0.089	145=	0.090
146=	0.089								

SCAN MIRROR, SIDE #2

201=	0.089	202=	0.090	203=	0.089	204=	0.088	205=	0.089
206=	0.090	207=	0.089	208=	0.089	209=	0.086	210=	0.088
211=	0.089	212=	0.088	213=	0.088	214=	0.086	215=	0.088
216=	0.089	217=	0.088	218=	0.087	219=	0.086	220=	0.088
221=	0.089	222=	0.088	223=	0.087	224=	0.087	225=	0.089
226=	0.090	227=	0.089	228=	0.088	229=	0.087	230=	0.090
231=	0.090	232=	0.090	233=	0.089	234=	0.088	235=	0.090
236=	0.091	237=	0.091	238=	0.090	239=	0.090	240=	0.092
241=	0.093	242=	0.093	243=	0.092	244=	0.094	245=	0.095
246=	0.094								

FOLD MIRROR (AFOCAL TELESCOPE) = 0.063

PRIMARY MIRROR (AFOCAL TELESCOPE) = 0.037

APERTURE TO AFT-OPTIC ASSEMBLY = 0.042

NOTE: RESULTS TO THREE DECIMAL PLACES ARE FOR COMPARISION PURPOSES ONLY. ACCURACY TO THIS DEGREE IS NOT IMPLIED.

FIGURE 7. EARTH APERTURE CONTRIBUTION (LOWER LIMIT FLUX)

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*******************************
* MODIS-N DEPOSITION RESULTS *
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APERTURE FLUX: 300000.0 MOLECULES/CM^2/S
EXPOSURE TIME: 43830.00 HOURS
DECAY CONSTANT: NOAA-7 FLIGHT DATA

[UNITS OF ANGSTROMS]

SCAN MIRROR, SIDE #1

101=	0.006	102=	0.006	103=	0.006	104=	0.007	105=	0.007
106=	0.006	107=	0.006	108=	0.006	109=	0.007	110=	0.007
111=	0.007	112=	0.007	113=	0.007	114=	0.007	115=	0.007
116=	0.007	117=	0.007	118=	0.007	119=	0.007	120=	0.007
121=	0.007	122=	0.007	123=	0.007	124=	0.007	125=	0.007
126=	0.007	127=	0.007	128=	0.007	129=	0.007	130=	0.007
131=	0.007	132=	0.007	133=	0.007	134=	0.007	135=	0.007
136=	0.007	137=	0.007	138=	0.007	139=	0.007	140=	0.007
141=	0.007	142=	0.007	143=	0.007	144=	0.007	145=	0.007
146=	0.007								

SCAN MIRROR, SIDE #2

201=	0.007	202=	0.007	203=	0.007	204=	0.007	205=	0.007
206=	0.007	207=	0.007	208=	0.007	209=	0.007	210=	0.007
211=	0.007	212=	0.007	213=	0.007	214=	0.007	215=	0.007
216=	0.007	217=	0.007	218=	0.007	219=	0.007	220=	0.007
221=	0.007	222=	0.007	223=	0.007	224=	0.007	225=	0.007
226=	0.007	227=	0.007	228=	0.007	229=	0.007	230=	0.007
231=	0.007	232=	0.007	233=	0.007	234=	0.007	235=	0.007
236=	0.007	237=	0.007	238=	0.007	239=	0.007	240=	0.007
241=	0.006	242=	0.006	243=	0.006	244=	0.006	245=	0.006
246=	0.006								

FOLD MIRROR (AFOCAL TELESCOPE) = 0.015

PRIMARY MIRROR (AFOCAL TELESCOPE) = 0.021

APERTURE TO AFT-OPTIC ASSEMBLY = 0.021

NOTE: RESULTS TO THREE DECIMAL PLACES ARE FOR COMPARISION PURPOSES ONLY.
ACCURACY TO THIS DEGREE IS NOT IMPLIED.

FIGURE 8. SPACE APERTURE CONTRIBUTION (LOWER LIMIT FLUX)

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* MODIS-N TOTAL EOL DEPOSITIONS *
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INPUT PARAMETERS:

EARTH APERTURE FLUX:	145000.0	molecules/cm^2/s (EOS ANALYSIS)
SPACE APERTURE FLUX:	300000.0	molecules/cm^2/s (EOS ANALYSIS)
EXPOSURE TIME:	5.0	years
DECAY ALGORITHM:	'NOAA-7 FLIGHT DATA'	
MIRROR STICKING COEFF:	1.0	(PERFECT ADSORBER)
CAVITY STICKING COEFF:	0.0	(PERFECT REFLECTOR)

RESULTS:

[UNITS OF ANGSTROMS]

SCAN MIRROR, SIDE #1

101=	0.100	102=	0.101	103=	0.100	104=	0.097	105=	0.099
106=	0.099	107=	0.099	108=	0.098	109=	0.095	110=	0.097
111=	0.098	112=	0.098	113=	0.097	114=	0.094	115=	0.097
116=	0.097	117=	0.097	118=	0.096	119=	0.094	120=	0.096
121=	0.097	122=	0.097	123=	0.095	124=	0.093	125=	0.095
126=	0.096	127=	0.096	128=	0.094	129=	0.093	130=	0.095
131=	0.096	132=	0.095	133=	0.095	134=	0.093	135=	0.095
136=	0.096	137=	0.096	138=	0.095	139=	0.095	140=	0.096
141=	0.096	142=	0.095	143=	0.096	144=	0.096	145=	0.097
146=	0.096								

SCAN MIRROR, SIDE #2

201=	0.096	202=	0.097	203=	0.096	204=	0.095	205=	0.096
206=	0.097	207=	0.096	208=	0.096	209=	0.093	210=	0.095
211=	0.096	212=	0.095	213=	0.095	214=	0.093	215=	0.095
216=	0.096	217=	0.095	218=	0.094	219=	0.093	220=	0.095
221=	0.096	222=	0.095	223=	0.094	224=	0.094	225=	0.096
226=	0.097	227=	0.096	228=	0.095	229=	0.094	230=	0.097
231=	0.097	232=	0.097	233=	0.096	234=	0.095	235=	0.097
236=	0.098	237=	0.098	238=	0.097	239=	0.097	240=	0.099
241=	0.099	242=	0.099	243=	0.098	244=	0.100	245=	0.101
246=	0.100								

FOLD MIRROR (AFOCAL TELESCOPE) = 0.078

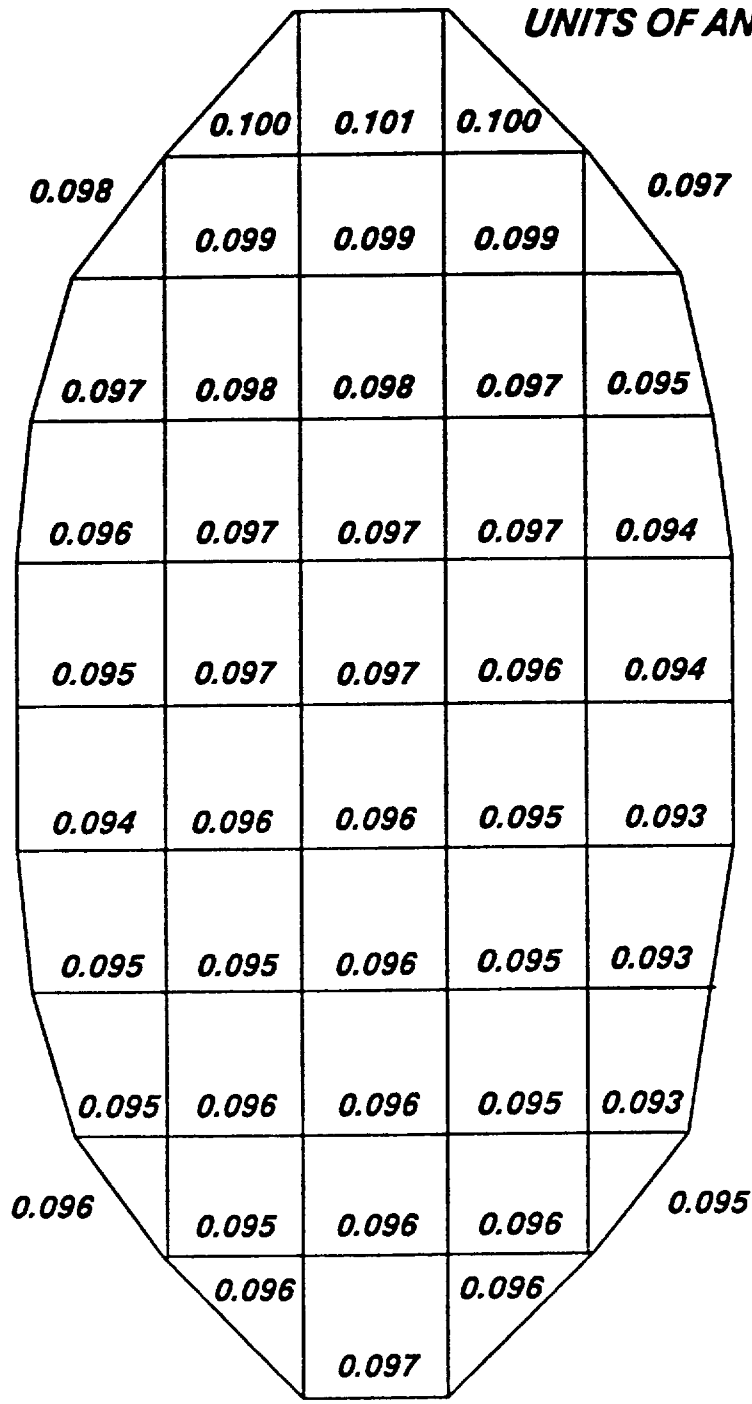
PRIMARY MIRROR (AFOCAL TELESCOPE) = 0.058

APERTURE TO AFT-OPTIC ASSEMBLY = 0.063

NOTE: RESULTS TO THREE DECIMAL PLACES ARE FOR COMPARISON PURPOSES ONLY. ACCURACY TO THIS DEGREE IS NOT IMPLIED.

FIGURE 9. TOTAL DEPOSITION - LOWER LIMIT APERTURE FLUX

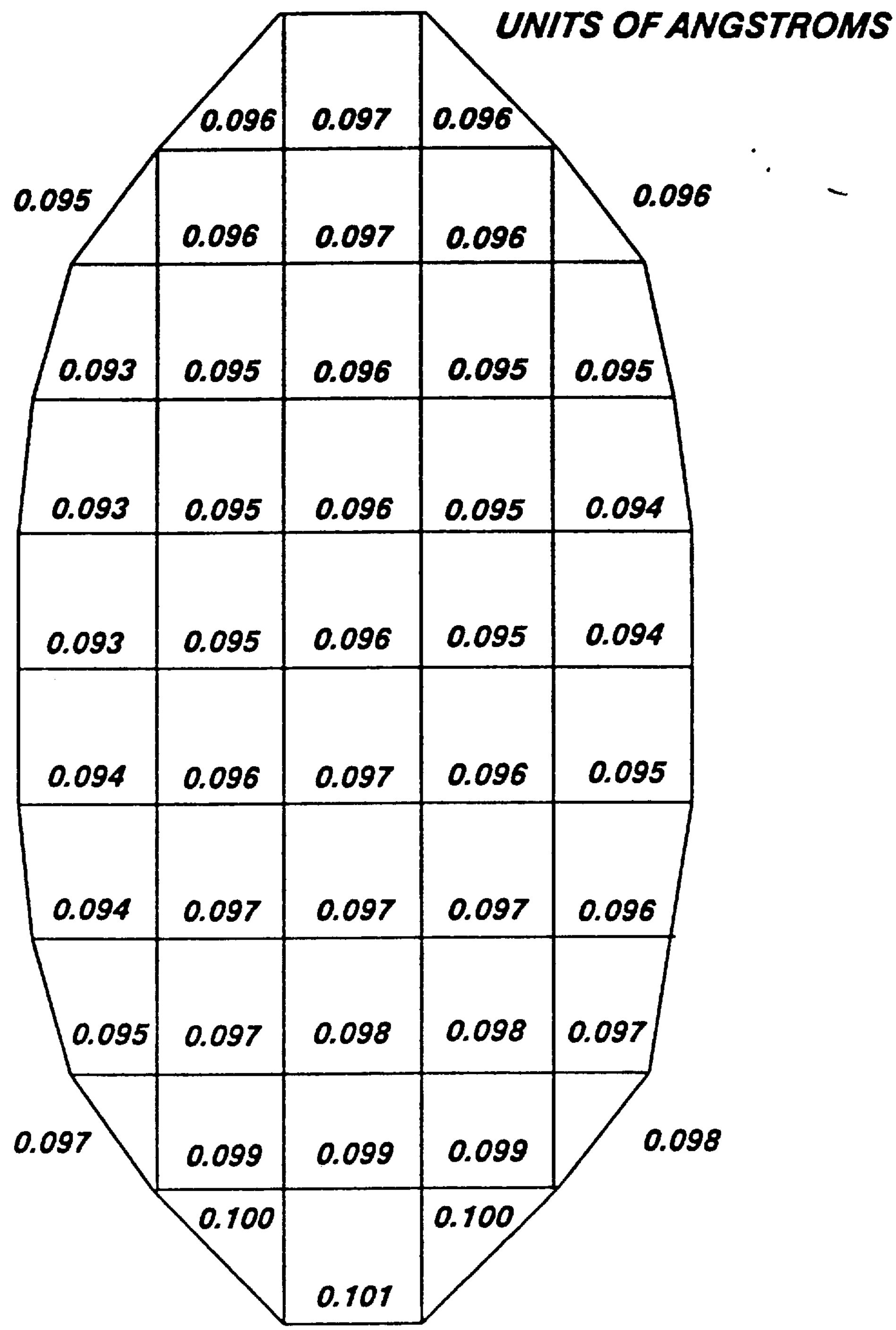
UNITS OF ANGSTROMS



SECTION A1-A2

NOTE: MIRROR DIMENSION NOT TO SCALE
VALUES TO THREE DECIMAL PLACES FOR COMPARISON PURPOSES ONLY, DEPOSITION IS NEGLIGIBLE

FIGURE 10(a). GENERAL FOOTPRINT - SIDE #1



SECTION B1-B2

NOTE: MIRROR DIMENSION NOT TO SCALE
VALUES TO THREE DECIMAL PLACES FOR COMPARISON PURPOSES ONLY,
DEPOSITION IS NEGLIGIBLE

FIGURE 10(b). GENERAL FOOTPRINT - SIDE #2

****
* MODIS-N DEPOSITION RESULTS *
****

APERTURE FLUX: 2.6700000E+07 MOLECULES/CM^2/S
EXPOSURE TIME: 43830.00 HOURS
DECAY CONSTANT: NOAA-7 FLIGHT DATA

[UNITS OF ANGSTROMS]

SCAN MIRROR, SIDE #1

101=	17.326	102=	17.444	103=	17.375	104=	16.607	105=	16.935
106=	17.088	107=	17.067	108=	16.869	109=	16.244	110=	16.663
111=	16.799	112=	16.725	113=	16.577	114=	16.044	115=	16.486
116=	16.640	117=	16.540	118=	16.368	119=	16.048	120=	16.376
121=	16.511	122=	16.494	123=	16.283	124=	15.891	125=	16.214
126=	16.461	127=	16.316	128=	16.082	129=	15.829	130=	16.177
131=	16.413	132=	16.189	133=	16.129	134=	15.912	135=	16.226
136=	16.297	137=	16.310	138=	16.199	139=	16.138	140=	16.363
141=	16.431	142=	16.288	143=	16.352	144=	16.464	145=	16.554
146=	16.326								

SCAN MIRROR, SIDE #2

201=	16.455	202=	16.610	203=	16.383	204=	16.141	205=	16.350
206=	16.523	207=	16.359	208=	16.356	209=	15.902	210=	16.210
211=	16.343	212=	16.278	213=	16.195	214=	15.812	215=	16.159
216=	16.387	217=	16.210	218=	16.090	219=	15.859	220=	16.185
221=	16.445	222=	16.295	223=	16.057	224=	16.031	225=	16.358
226=	16.543	227=	16.475	228=	16.261	229=	16.026	230=	16.483
231=	16.596	232=	16.518	233=	16.377	234=	16.204	235=	16.633
236=	16.761	237=	16.699	238=	16.543	239=	16.600	240=	16.939
241=	17.088	242=	17.047	243=	16.851	244=	17.268	245=	17.411
246=	17.321								

FOLD MIRROR (AFOCAL TELESCOPE) = 11.579

PRIMARY MIRROR (AFOCAL TELESCOPE) = 6.893

APERTURE TO AFT-OPTIC ASSEMBLY = 7.669

NOTE: RESULTS TO THREE DECIMAL PLACES ARE FOR COMPARISION PURPOSES ONLY. ACCURACY TO THIS DEGREE IS NOT IMPLIED.

FIGURE 11. EARTH APERTURE CONTRIBUTION (UPPER LIMIT FLUX)

****
* MODIS-N DEPOSITION RESULTS *
****

APERTURE FLUX: 5.5000000E+07 MOLECULES/CM^2/S
EXPOSURE TIME: 43830.00 HOURS
DECAY CONSTANT: NOAA-7 FLIGHT DATA

[UNITS OF ANGSTROMS]

SCAN MIRROR, SIDE #1

101=	1.151	102=	1.129	103=	1.128	104=	1.209	105=	1.197
106=	1.182	107=	1.170	108=	1.184	109=	1.249	110=	1.247
111=	1.239	112=	1.222	113=	1.230	114=	1.299	115=	1.282
116=	1.280	117=	1.259	118=	1.272	119=	1.359	120=	1.323
121=	1.322	122=	1.286	123=	1.306	124=	1.355	125=	1.322
126=	1.323	127=	1.275	128=	1.290	129=	1.335	130=	1.310
131=	1.309	132=	1.277	133=	1.288	134=	1.314	135=	1.289
136=	1.288	137=	1.287	138=	1.275	139=	1.295	140=	1.298
141=	1.292	142=	1.279	143=	1.266	144=	1.308	145=	1.312
146=	1.273								

SCAN MIRROR, SIDE #2

201=	1.306	202=	1.312	203=	1.271	204=	1.298	205=	1.296
206=	1.295	207=	1.279	208=	1.263	209=	1.315	210=	1.289
211=	1.288	212=	1.286	213=	1.277	214=	1.333	215=	1.309
216=	1.308	217=	1.277	218=	1.285	219=	1.352	220=	1.319
221=	1.321	222=	1.273	223=	1.286	224=	1.355	225=	1.319
226=	1.320	227=	1.282	228=	1.302	229=	1.296	230=	1.278
231=	1.273	232=	1.254	233=	1.270	234=	1.244	235=	1.242
236=	1.234	237=	1.218	238=	1.226	239=	1.203	240=	1.196
241=	1.182	242=	1.168	243=	1.179	244=	1.154	245=	1.132
246=	1.127								

FOLD MIRROR (AFOCAL TELESCOPE) = 2.833

PRIMARY MIRROR (AFOCAL TELESCOPE) = 3.857

APERTURE TO AFT-OPTIC ASSEMBLY = 3.815

NOTE: RESULTS TO THREE DECIMAL PLACES ARE FOR COMPARISION PURPOSES ONLY. ACCURACY TO THIS DEGREE IS NOT IMPLIED.

FIGURE 12. SPACE APERTURE CONTRIBUTION (UPPER LIMIT FLUX)

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**********************************
* MODIS-N TOTAL EOL DEPOSITIONS *
**********************************
```

INPUT PARAMETERS:

EARTH APERTURE FLUX:	2.670E7 molecules/cm^2/s	(EOS ANALYSIS)
SPACE APERTURE FLUX:	5.500E7 molecules/cm^2/s	(EOS ANALYSIS)
EXPOSURE TIME:	5.0 years	
DECAY ALGORITHM:	'NOAA-7 FLIGHT DATA'	
MIRROR STICKING COEFF:	1.0	(PERFECT ADSORBER)
CAVITY STICKING COEFF:	0.0	(PERFECT REFLECTOR)

RESULTS:

[UNITS OF ANGSTROMS]

SCAN MIRROR, SIDE #1

101=	18.5	102=	18.6	103=	18.5	104=	17.8	105=	18.1
106=	18.3	107=	18.2	108=	18.1	109=	17.5	110=	17.9
111=	18.0	112=	17.9	113=	17.8	114=	17.3	115=	17.8
116=	17.9	117=	17.8	118=	17.6	119=	17.4	120=	17.7
121=	17.8	122=	17.8	123=	17.6	124=	17.2	125=	17.5
126=	17.8	127=	17.6	128=	17.4	129=	17.2	130=	17.5
131=	17.7	132=	17.5	133=	17.4	134=	17.2	135=	17.5
136=	17.6	137=	17.6	138=	17.5	139=	17.4	140=	17.7
141=	17.7	142=	17.6	143=	17.6	144=	17.8	145=	17.9
146=	17.6								

SCAN MIRROR, SIDE #2

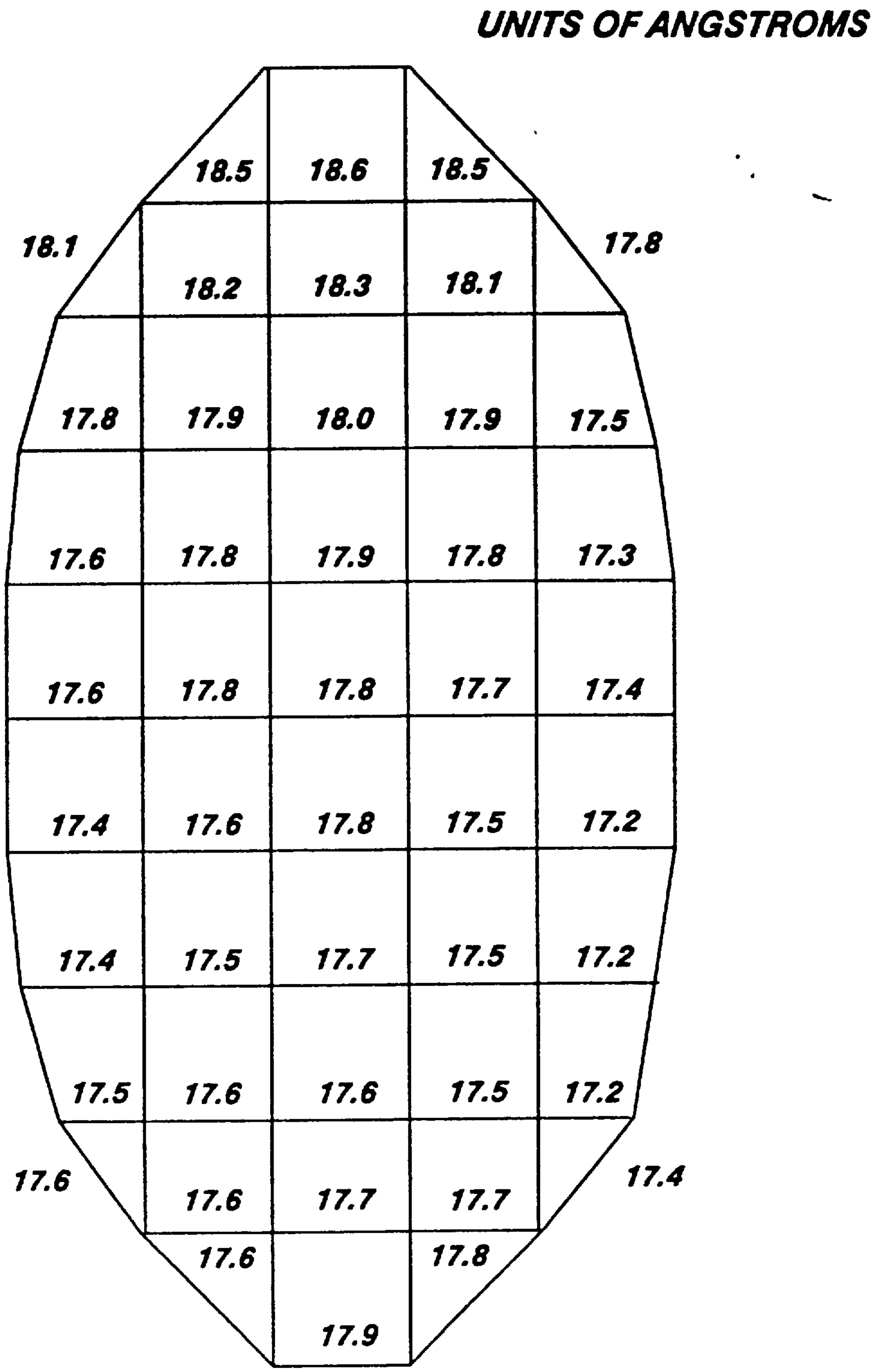
201=	17.8	202=	17.9	203=	17.7	204=	17.4	205=	17.6
206=	17.8	207=	17.6	208=	17.6	209=	17.2	210=	17.5
211=	17.6	212=	17.6	213=	17.5	214=	17.1	215=	17.5
216=	17.7	217=	17.5	218=	17.4	219=	17.2	220=	17.5
221=	17.8	222=	17.6	223=	17.3	224=	17.4	225=	17.7
226=	17.9	227=	17.8	228=	17.6	229=	17.3	230=	17.8
231=	17.9	232=	17.8	233=	17.6	234=	17.4	235=	17.9
236=	18.0	237=	17.9	238=	17.8	239=	17.8	240=	18.1
241=	18.3	242=	18.2	243=	18.0	244=	18.4	245=	18.5
246=	18.4								

FOLD MIRROR (AFOCAL TELESCOPE) = 14.4

PRIMARY MIRROR (AFOCAL TELESCOPE) = 10.8

APERTURE TO AFT-OPTIC ASSEMBLY = 11.5

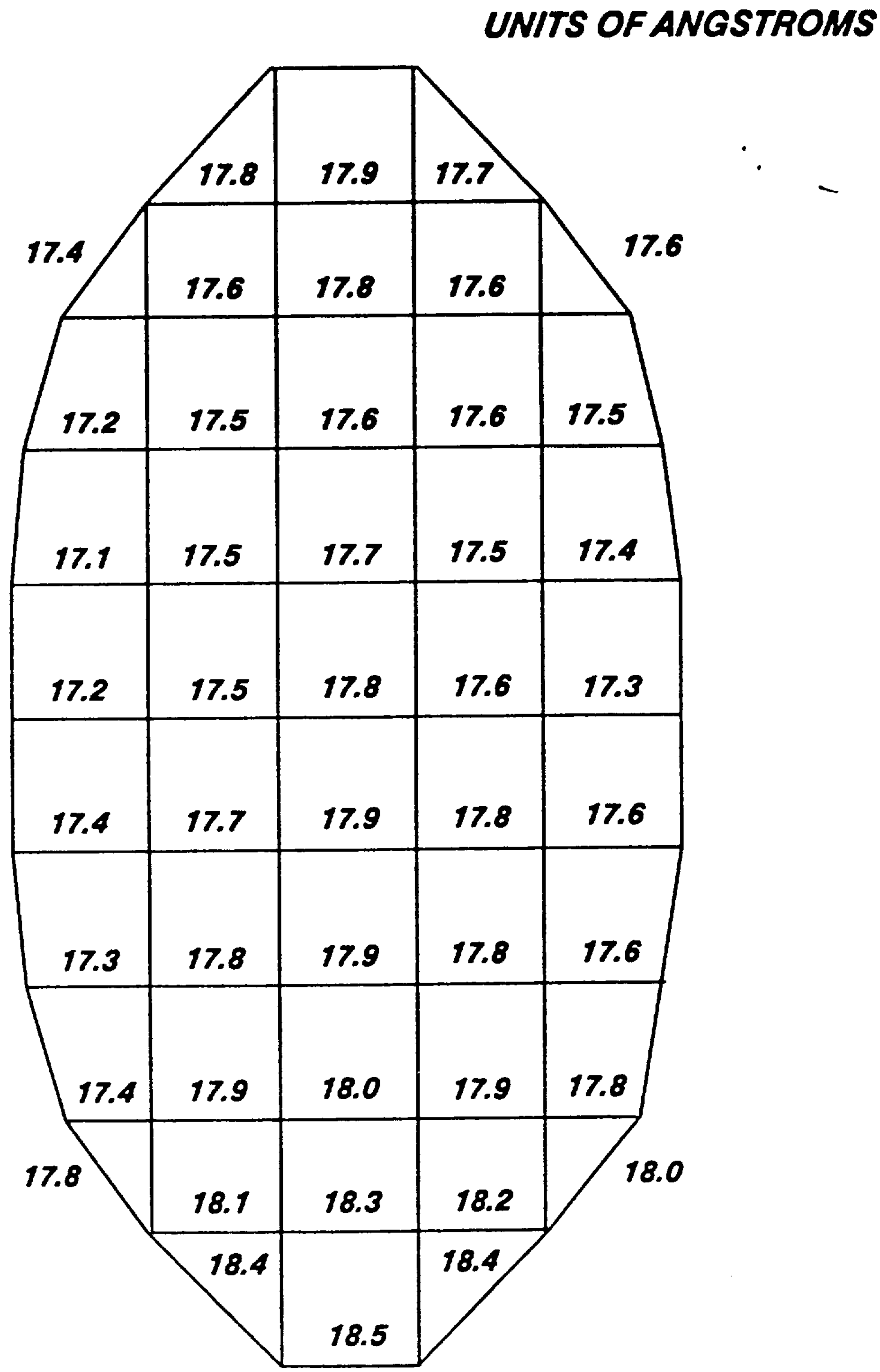
FIGURE 13. TOTAL DEPOSITION - UPPER LIMIT APERTURE FLUX



SECTION A1-A2

NOTE: MIRROR DIMENSION NOT TO SCALE

FIGURE 14(a). GENERAL FOOTPRINT - SIDE #1



SECTION B1-B2

NOTE: MIRROR DIMENSION NOT TO SCALE

FIGURE 14(b). GENERAL FOOTPRINT - SIDE #2

SCAN MIRROR SPECTRAL REFLECTANCE; AOI 37°; CARBON 0, 25A, 50A

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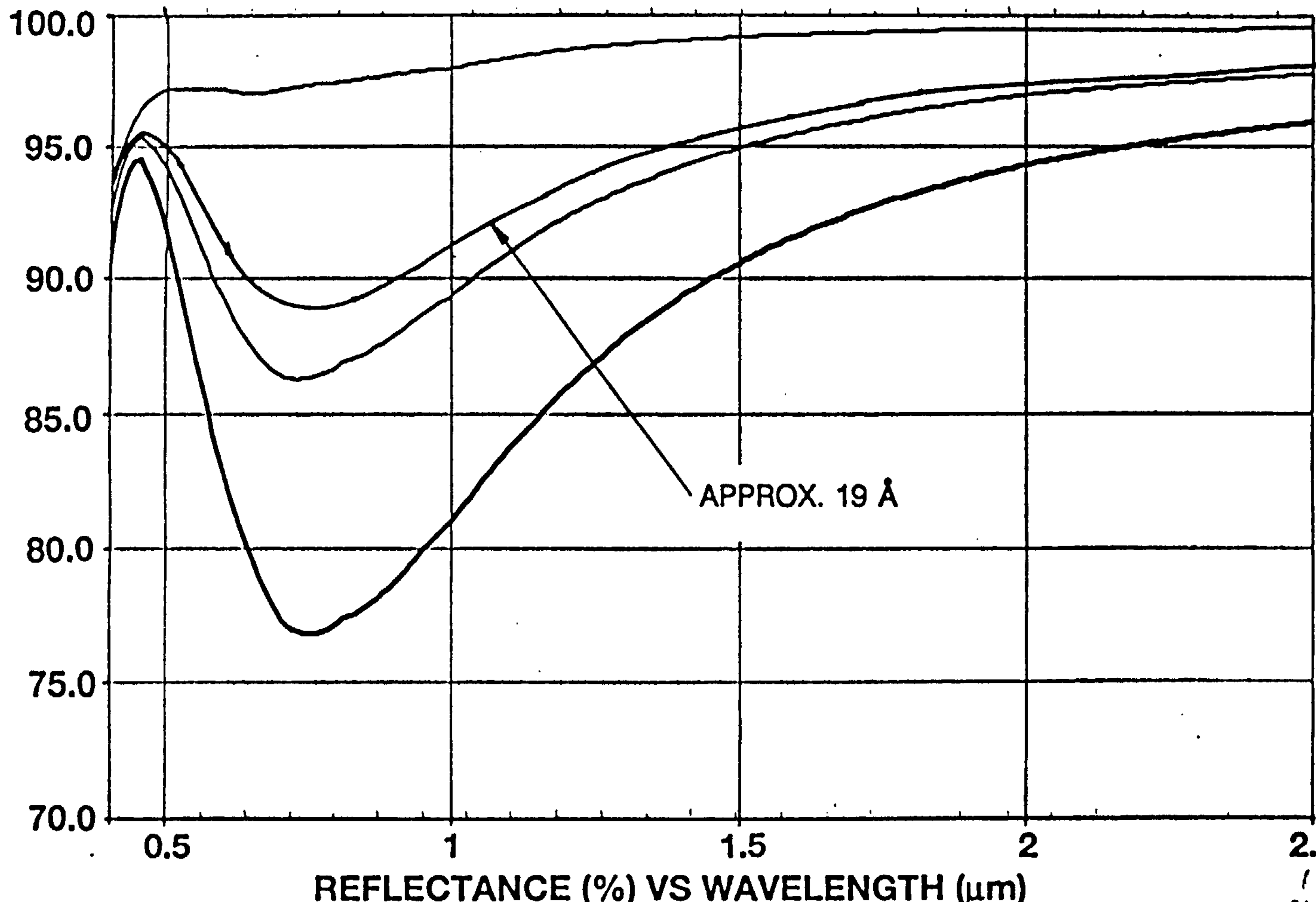

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FIGURE 15(a). SCAN MIRROR SPECTRAL REFLECTANCE

SCAN MIRROR SPECTRAL REFLECTANCE; AOI 37°; CARBON 0, 25A, 50A

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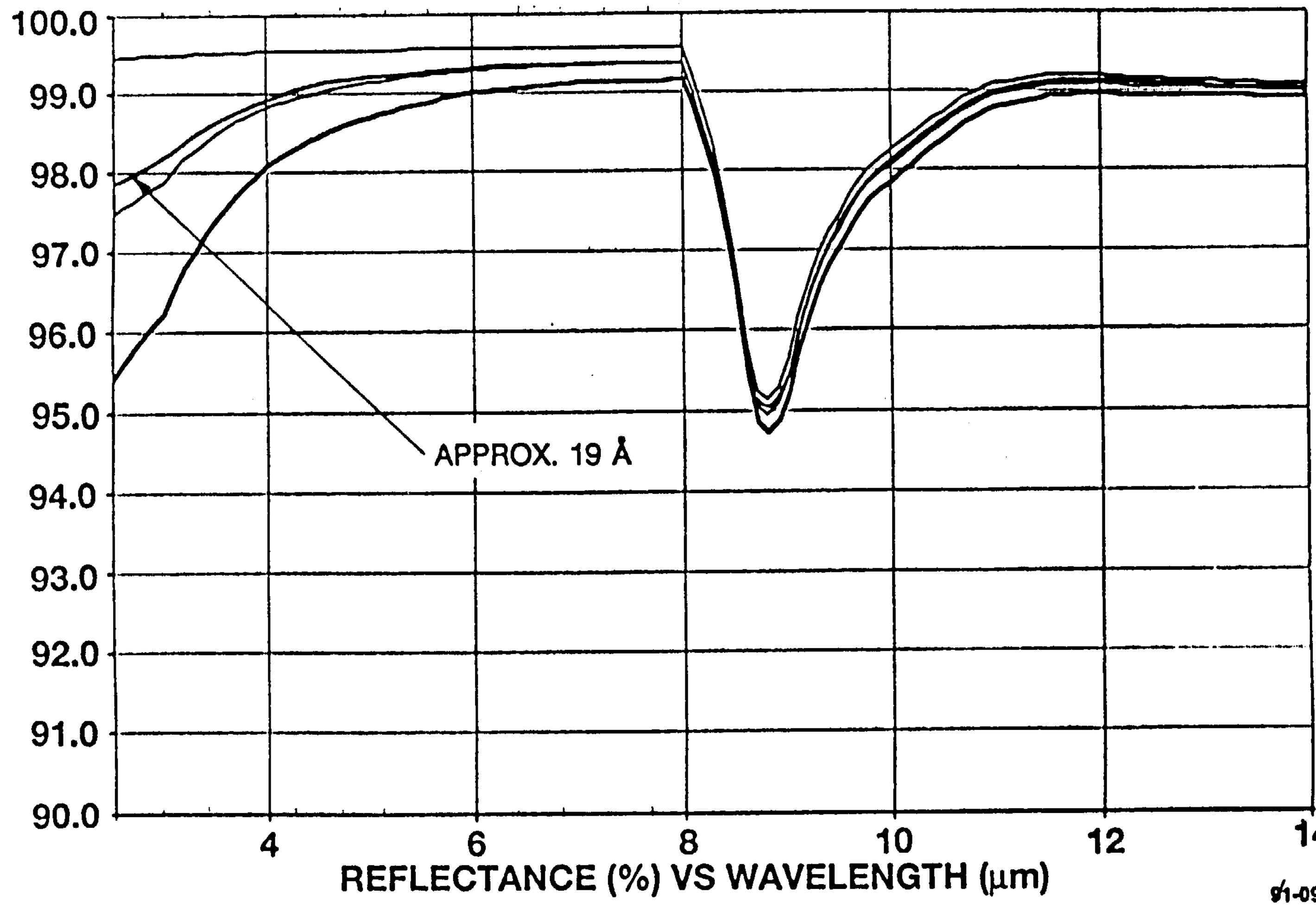

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91-0908-820

FIGURE 15(b). SCAN MIRROR SPECTRAL REFLECTANCE