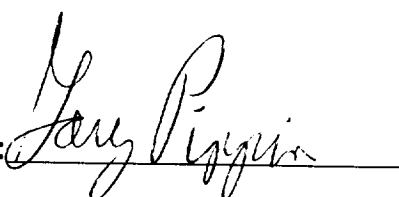


IN-18-02

Comparison of Spacecraft Contamination Models with Well-Defined Flight Experiment

NAS8-40581

Progress Report for November 15, 1995 to February 15, 1996

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1. During this reporting period, the phase I interim report was written and submitted. Detailed computer models were used to predict exposure to atomic oxygen and solar ultraviolet radiation. ESCA survey measurements were started on the tray wall section cut from LDEF tray location E10-3.

Solar exposure in cumulative equivalent Sun hours (CESH) and atomic oxygen fluences in number per square cm were modeled for selected LDEF tray edges near keyhole vent slots in their FEP blankets as indicated in the following table. Vent numbers correspond to those given in figures 3 through 5 of the "Comparison of Spacecraft Contamination Models with Well-Defined Flight Experiment," Phase One Interim Report, NAS8-40581, April 4, 1995 to December 15, 1995.

Tray and Vent Number	Solar Exposure	Atomic Oxygen Exposure
A4-1	Yes	No
A4-9	Yes	No
C6-2	Yes	Yes
C6-4	Yes	Yes
C6-9	Yes	Yes
E10-3	Yes	Yes
E10-7	Yes	Yes

Results of atomic oxygen fluence is shown for locations E10-7, E10-3, and C6-2 in figures 1-3. Cumulative equivalent sun hours of solar exposure is shown for locations E10-7, E10-3, C6-2, and A4-1 in figures 4-7, respectively. Details of the geometry, including the rivet heads, shape of the blanket vents and the underlying frame have been included as part of the model surfaces. The influence of rivets located near a vent can be clearly seen in figures 2, 5, and 7. At each location, the aluminum surface (tray wall) directly across from a vent has slightly decreased exposure relative to the remainder of the tray wall because there is no FEP to scatter the solar radiation and atomic oxygen back on to this area. The exposure through a vent onto the tray wall can be clearly seen in figure 1. This (diminished) exposure is the cause of the faint plumes extending down to near the bottom of the wall at locations with substantial atomic oxygen exposure. Around the semi-circular part of the vent, some of the panels vary in color. This is an artifact of the plotting routine. All This area received the same exposure. The exposure around the rivets does vary, however the representation of these circular objects also leaves one or two rectangular areas right at the base which shows less apparent exposure than is the case. The rivets do create shadow patterns and in each case one side clearly is more exposed.

The LDEF mission ran from April 4, 1984, 17:27:4652 GMT through January 12, 1990, 15:16:00 GMT.

During solar exposure modeling the LDEF orbit was allowed to precess randomly and all LDEF orbit positions were allowed. 1000 LDEF and Sun position pairs were used to model solar exposure. An average orbit altitude of 400 km and an average Earth albedo under the LDEF of 0.246 were assumed. The modeled solar exposure is the total of direct and Earth reflected exposure including exposure reflected from one LDEF surface to another.

The following surface properties were used for solar exposure modeling:

Material	Specular Reflectivity	Diffuse Reflectivity	Absorbtivity
Aluminum	0.06	0.60	0.34
FEP	0.83	0.10	0.07

The following mission average values used for atomic oxygen modeling were derived from the detailed on-orbit atomic oxygen fluence to unshielded surfaces calculations summarized in the mission file /mnt1/gillis/ldef_ao/fluxavg.mission_ldef18-Jan-94.1.

Average resultant ram speed (average speed of satellite through the atmosphere, which rotates with the Earth.	7.21E5 cm/s
Average atmospheric temperature	1182.9 K
Average atomic oxygen density times mission time (used to calculate fluence rather than flux)	1.17E16 AO/(cm ² s)

The atomic oxygen fluences modeled are the total of direct and reflected exposure to surfaces.

The following surface properties were used for atomic oxygen fluence modeling

Material	Specular Reflectivity	Diffuse Reflectivity	Recombination Efficiency	Surface Reactivity
Aluminum	0.50	0.46	0.04	0.0
FEP	0.49	0.49	0.0	0.02

Results from the surface analysis of E10-3 are shown in figure 8. Measurements from cut piece E each show a high silicon content. This area is a highly discolored area directly across from the vent and the measurements were made on the darkest part. Cut piece D has some dark areas (with Silicon above 32%) and lighter regions, which appear to be thinner, and show less Si elemental %. These areas show some aluminum on the surface, suggesting the films are thinner than the darker areas. A detailed location map for E10-3 is not yet complete.

2. At this time there are no technical issues impeding the progress of the required contract tasks.
3. During the next reporting period we will continue to analyze points from tray locations E10-3 and A4-1 using ESCA and auger surface analysis techniques and a detailed location map will be produced.
4. Costs are in line with the percentage of completion of tasks. The expended budget is 18% of the total and the project is approximately 18% complete.

- Figure 1. Atomic oxygen fluence for LDEF tray E10 near FEP vent 7 (E10-7).
- Figure 2. Atomic oxygen fluence for LDEF tray E10 near FEP vent 3 (E10-3).
- Figure 3. Atomic oxygen fluence for LDEF tray C6 near FEP vent 2 (C6-2).
- Figure 4. Equivalent Sun Hours (ESH) solar exposure for LDEF tray E10 near FEP vent 7 (E10-7).
- Figure 5. Equivalent Sun Hours (ESH) solar exposure for LDEF tray E10 near FEP vent 3 (E10-3).
- Figure 6. Equivalent Sun Hours (ESH) solar exposure for LDEF tray C6 near FEP vent 2 (C6-2).
- Figure 7. Equivalent Sun Hours (ESH) solar exposure for LDEF tray A4 near FEP vent 1 (A4-1).
- Figure 8. Results of ESCA measurements at selected locations from area E10-3.

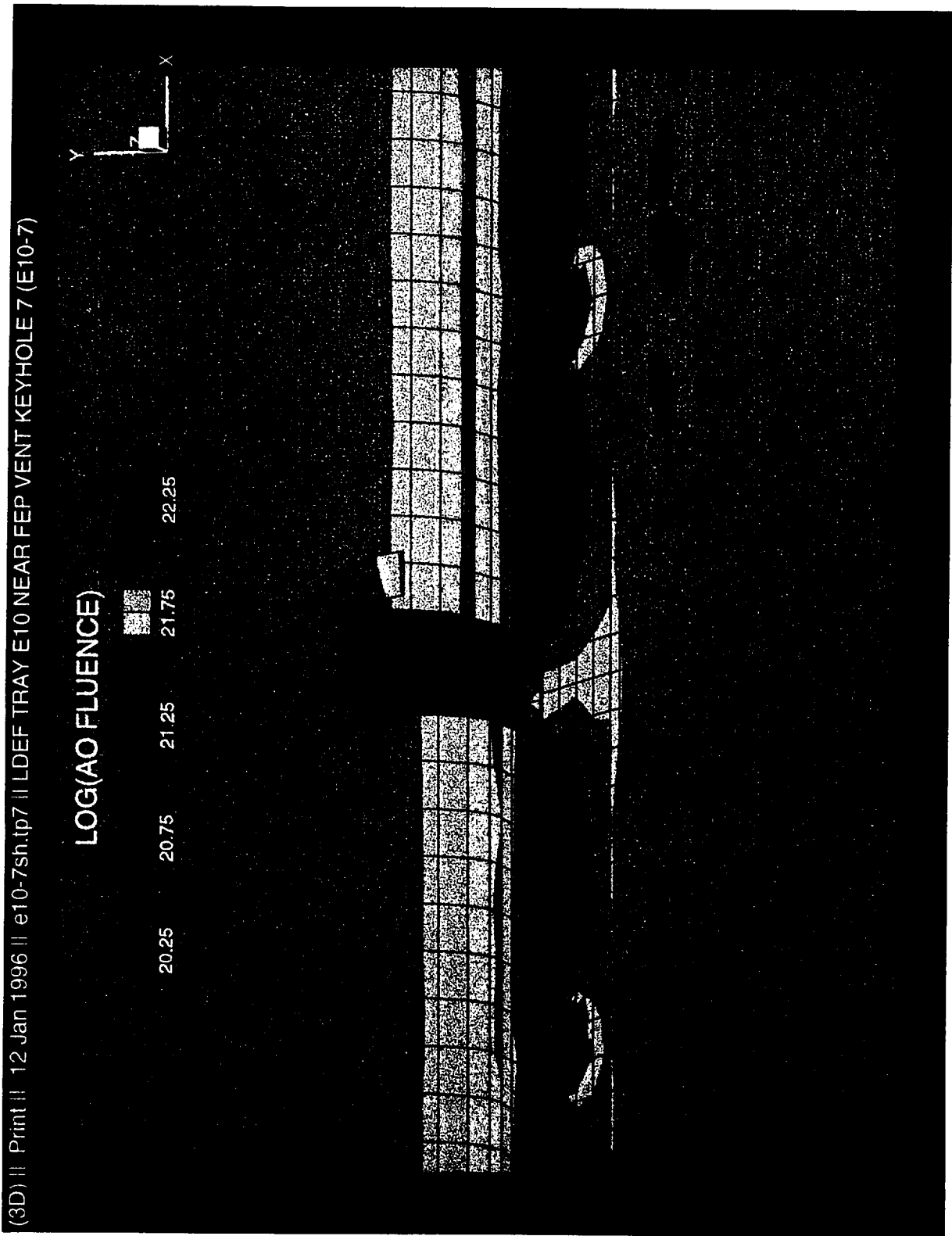


Figure 1. Atomic oxygen fluence for LDEF tray E10 near FEP vent 7 (E10-7).

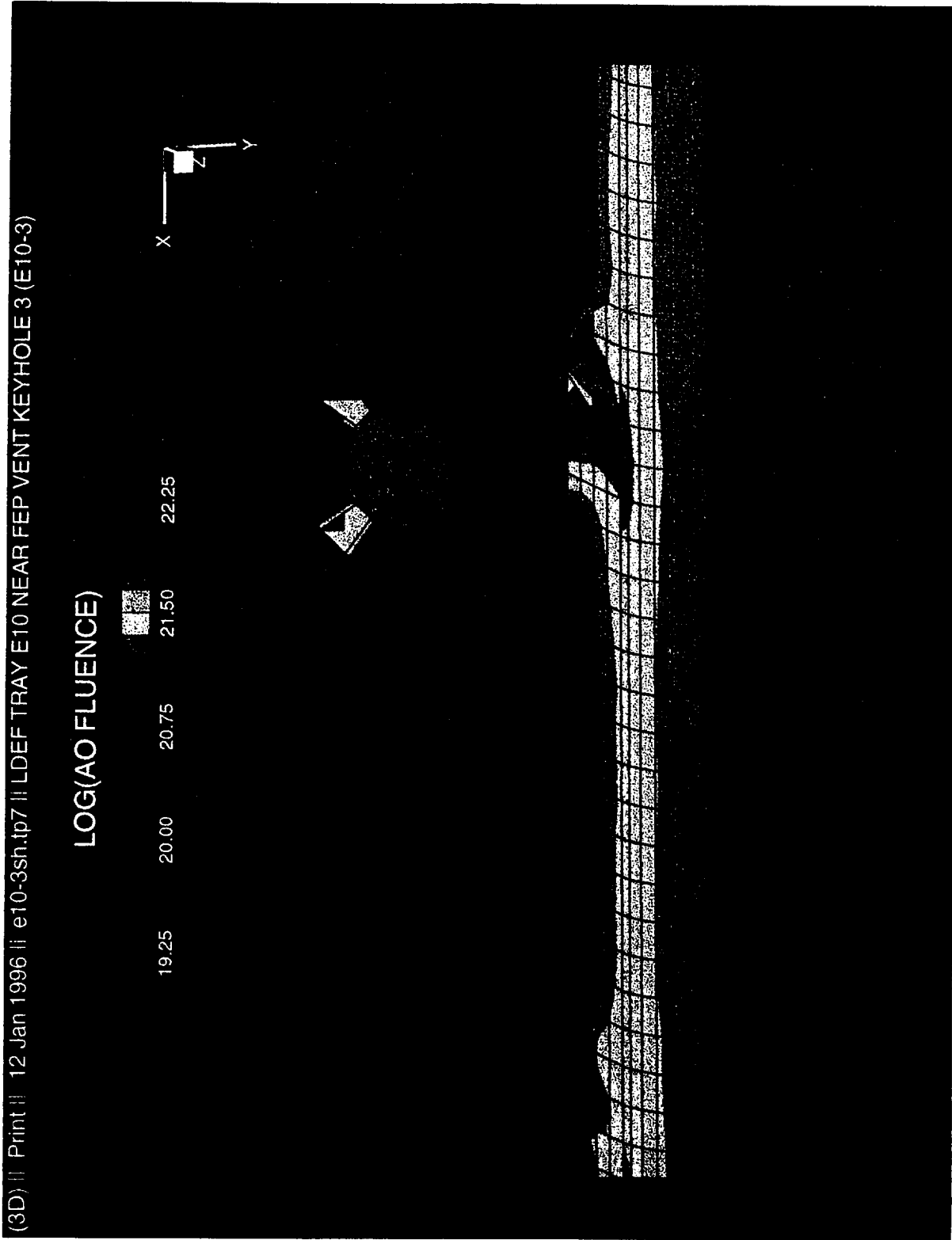


Figure 2. Atomic oxygen fluence for LDEF tray E10 near FEP vent 3 (E10-3).



Figure 3. Atomic oxygen fluence for LDEF tray C6 near FEP vent 2 (C6-2).

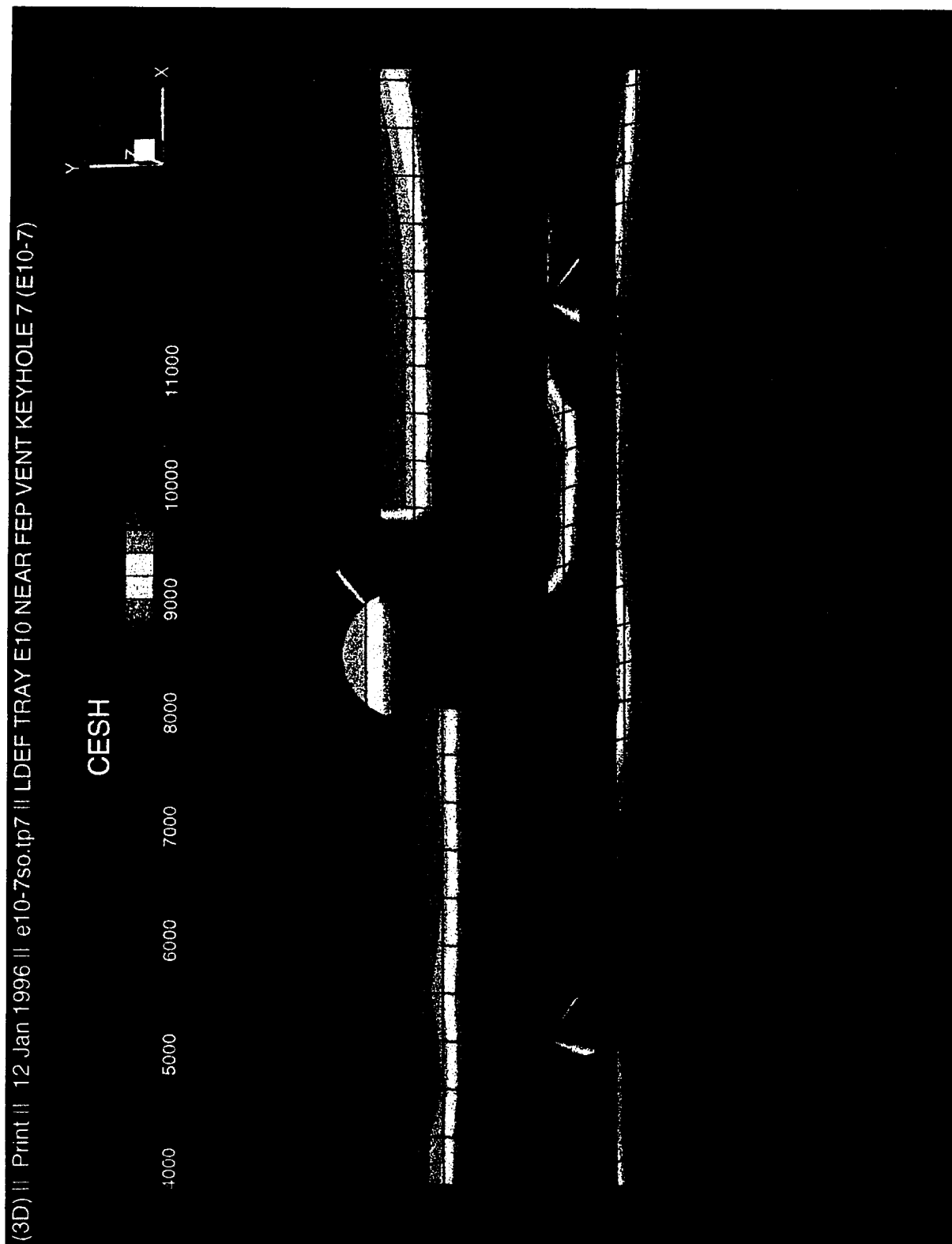


Figure 4. Equivalent Sun Hours (ESH) solar exposure for LDEF tray E10 near FEP vent 7 (E10-7).

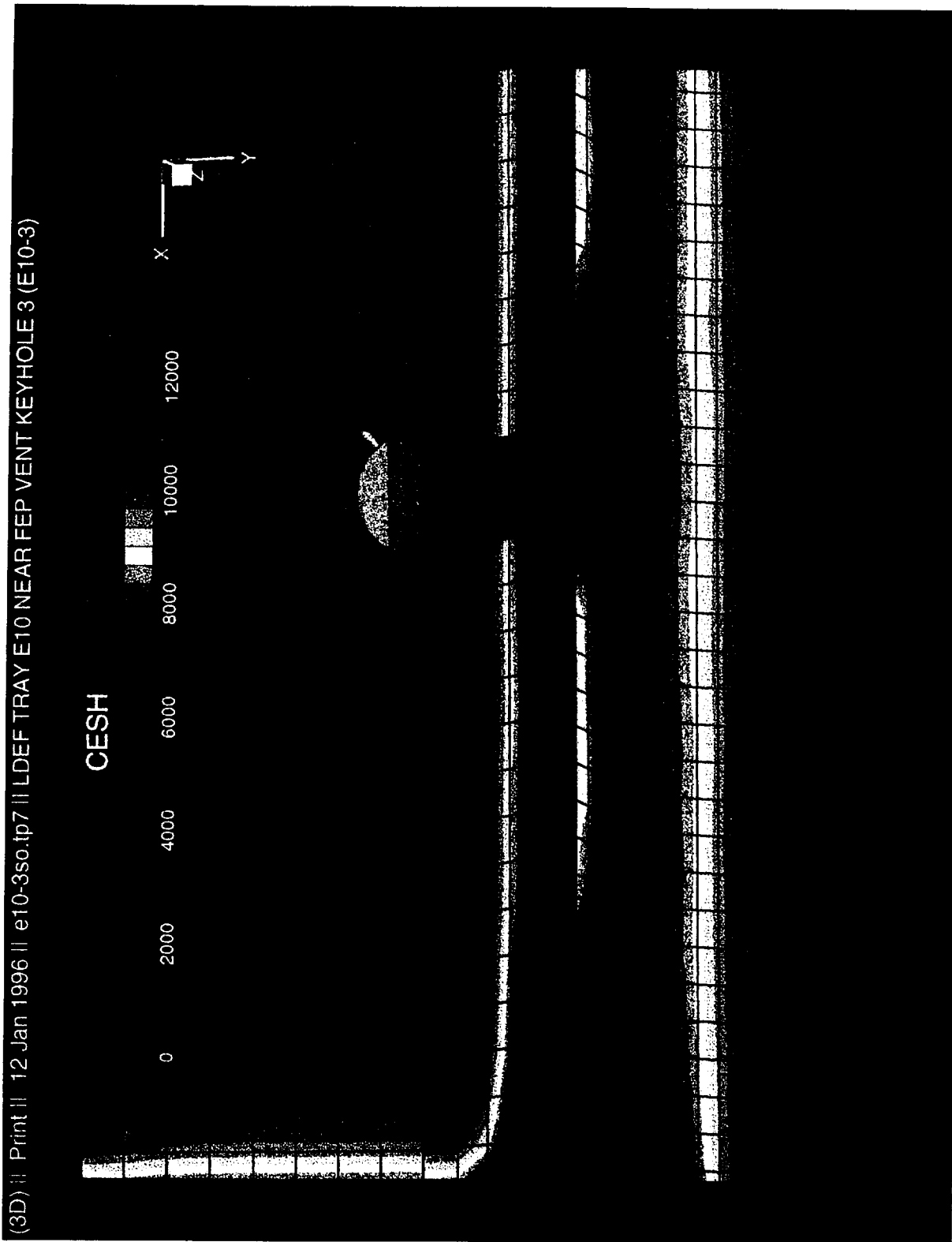


Figure 5. Equivalent Sun Hours (ESH) solar exposure for LDEF tray E10 near FEP vent 3 (E10-3).

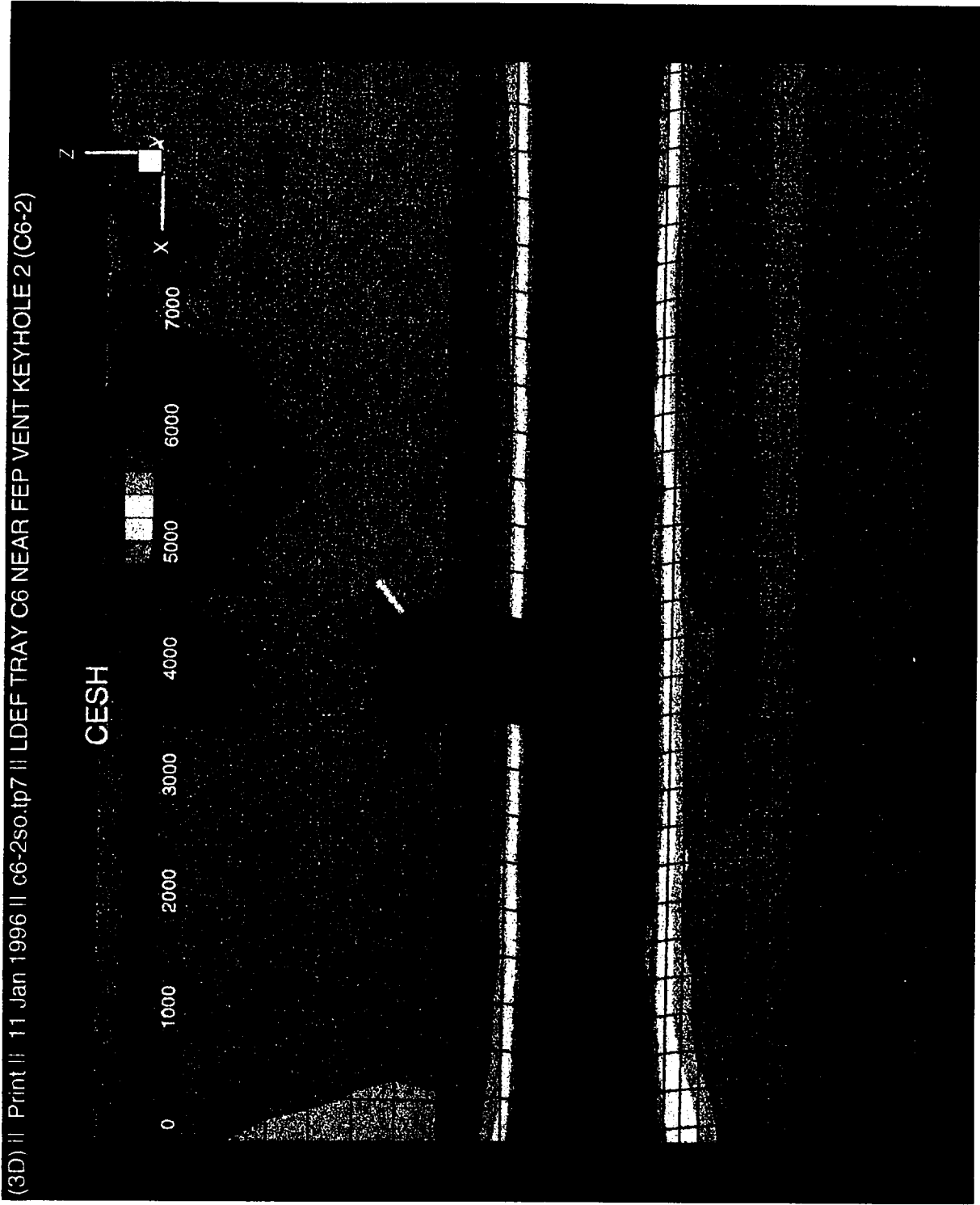


Figure 6. Equivalent Sun Hours (ESH) solar exposure for LDEF tray C6 near FEP vent 2 (C6-2).

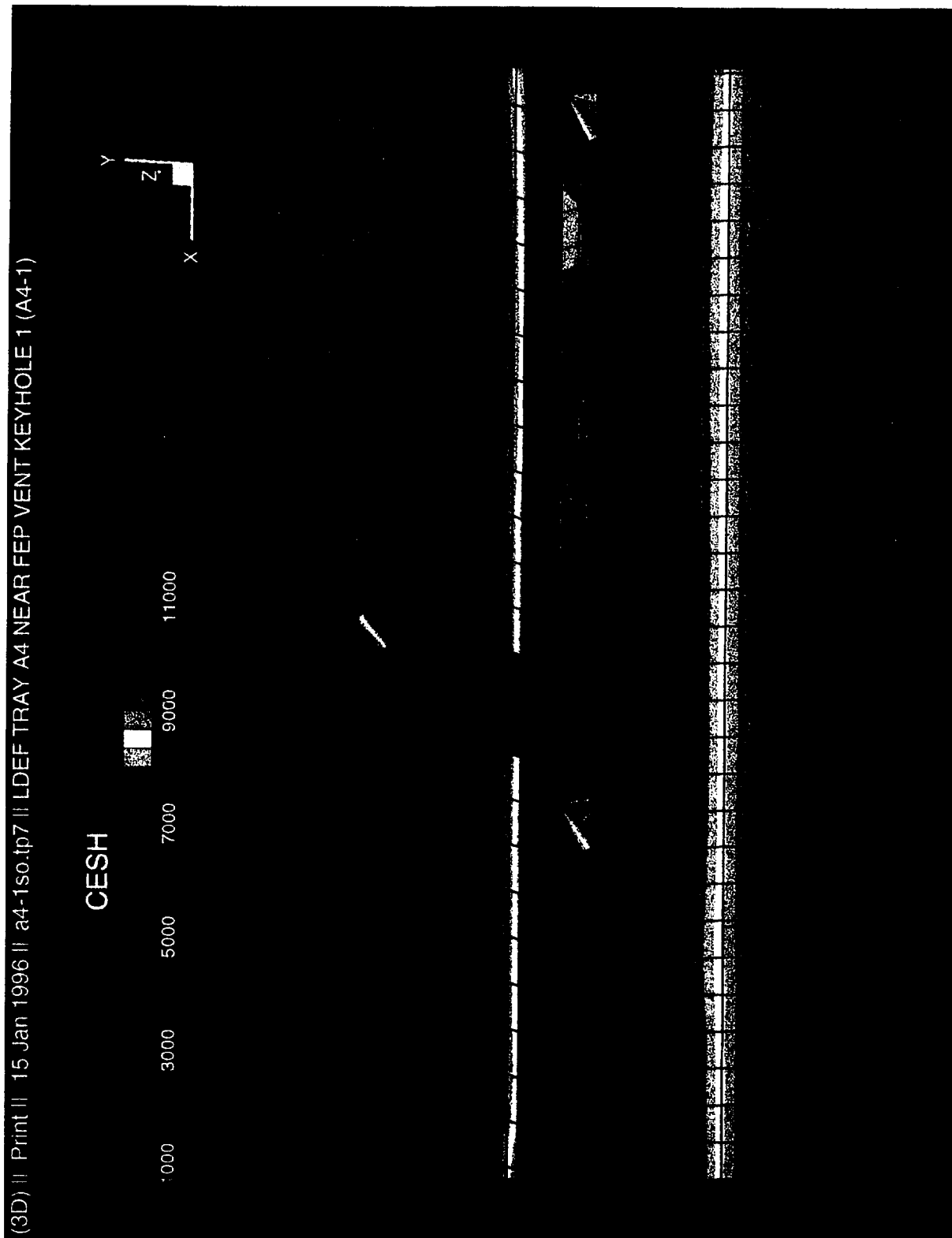


Figure 7. Equivalent Sun Hours (ESH) solar exposure for LDEF tray A4 near FEP vent 1 (A4-1).

E10-3 Unspattered Surfaces only
XPS Survey Scan Composition Table summary

Cut Piece Data File Location	E							D							
	F02A p1	F02B p2	F02C p3	F05B p4	F05C p5	F06A p6	F06B p7	F06C p1	F07A p2	F07B p3	F07C p4	F07D p5	F08B p6	F08C p7	F08D p8
Atomic %:															
Silicon	34.3%	33.2%	33.0%	33.5%	32.3%	34.3%	34.1%	32.3%	15.4%	34.0%	18.5%	33.8%	24.2%	33.0%	32.8%
Oxygen	57.9%	56.2%	56.9%	56.5%	56.8%	57.8%	57.3%	56.6%	45.7%	58.6%	50.2%	57.1%	52.3%	56.9%	57.0%
Aluminum	-	-	-	-	0.9%	-	-	-	13.2%	-	10.6%	-	6.6%	-	0.9%
Carbon	6.6%	9.8%	9.5%	9.6%	8.2%	7.0%	7.5%	10.3%	13.4%	6.3%	11.3%	8.5%	9.2%	6.9%	8.1%
Fluorine	1.2%	0.5%	0.5%	0.3%	1.3%	0.8%	1.0%	0.6%	10.0%	0.9%	7.5%	0.6%	6.4%	2.9%	1.1%
Sodium	-	-	-	-	0.2%	-	-	-	0.3%	-	0.3%	-	0.4%	-	-
Sulfur	-	-	-	-	-	-	-	-	0.8%	-	0.9%	-	-	-	-
Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	0.2%	-	-	-	-	-	-	-	0.2%	0.2%	-
Calcium	-	-	-	-	-	-	-	-	0.5%	-	0.4%	-	0.3%	-	-
Magnesium	-	-	-	-	-	-	-	-	0.4%	-	0.2%	-	0.3%	-	-
Tin	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	-	0.1%	-	0.1%	0.1%	0.1%	0.1%
Chrome	-	0.3%	-	-	-	-	-	-	0.2%	0.1%	-	-	-	-	-

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Figure 8. Results of ESCA measurements at selected locations from area E10-3.