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14. ABSTRACT
The Materials International Space Station Experiment (MISSE-6A and -6B) flight packages were flown on the International Space Station between March, 2008 and August 2009. This report describes the results of work performed during the disassembly and analysis of the MISSE-6 flight package. MISSE-6A and -6B contianed a significant number of active experiments. Power was supplied from the ISS and data was collected on-orbit, stored in ~50 miniture data loggers, and read out upon return to ground.
MISSE-6A and -6B contained the larged number of indiviudal specimens flown on any of the MISSE series of light experiments. The current report provides a summary of the environmental exposures on major surfaces of the experiment containers. The atomic oxygen and solar exposure levels are estimated, a count of impact events visible with the aid of a x4 magnifying glass, examination of contamination levels, and the most comprehensive set of thermal data on any of the MISSE flights to date was also included.

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1 INTRODUCTION

The sixth **M**aterial **I**nternational **S**pace **S**tation **E**xperiment package (MISSE-6) was conceived as a science package to conduct research on the effects of atomic oxygen on materials. Participation was encouraged from multiple universities and ultimately nine different universities flew experiments. Eventually, MISSE-6 was expanded from one Passive Experiment Carrier (PEC) to two. AFRL, NRL, Sandia National Laboratory, The Aerospace Corporation, several NASA centers, The Boeing Company and other companies conducted experiments on MISSE-6.

The MISSE-6A and MISSE-6B experiments were flown on the International Space Station (ISS) between March, 2008 and August, 2009, a total exposure period of 17 months. MISSE-6 included the most individual specimens of any MISSE package to date. MISSE-6A and MISSE-6B were the first of the MISSE packages to receive power from the ISS. Data was collected and stored on-orbit by 48 Veriteq, Inc. data storage devices. The Air Force Academy and Physical Sciences Inc embedded data storage capability into their experiments.

Data included in this report were provided by several organizations. Atomic oxygen fluence estimates were provided by Kim de Groh, Sharon Miller, and Bruce Banks of NASA Glenn Research Center and Miria Finckenor of NASA Marshall Space Flight Center. Miria Finckenor also conducted the impact surveys for every PEC on MISSE 1-4 and MISSE-6A & 6B. Carlos Pagan of the Boeing Space Station program, thermal analysis group provided the solar exposure estimates. Radiation dose level estimates for MISSE-6 were based on results of a NASA Langley Research Center (LaRC) radiation shielding experiment led by Sheila Thibeault.

2 IMAGES

2.1 PRE-FLIGHT

Figures 1 through 3 below contain pre-flight images of the MISSE-6A and MISSE-6B experiment packages in the clean room at NASA LaRC just prior to delivery to the Kennedy Space Center (KSC) for launch.

MISSE-6A and -6B included the largest number of individual specimens of any MISSE experiment packages flown to date, and more than the Mir Environmental Effects Payload-Passive Optical Sample Assembly experiments (which used the same PECs).

Figure 1. MISSE-6B preflight in the NASA LaRC clean room (NASA image).

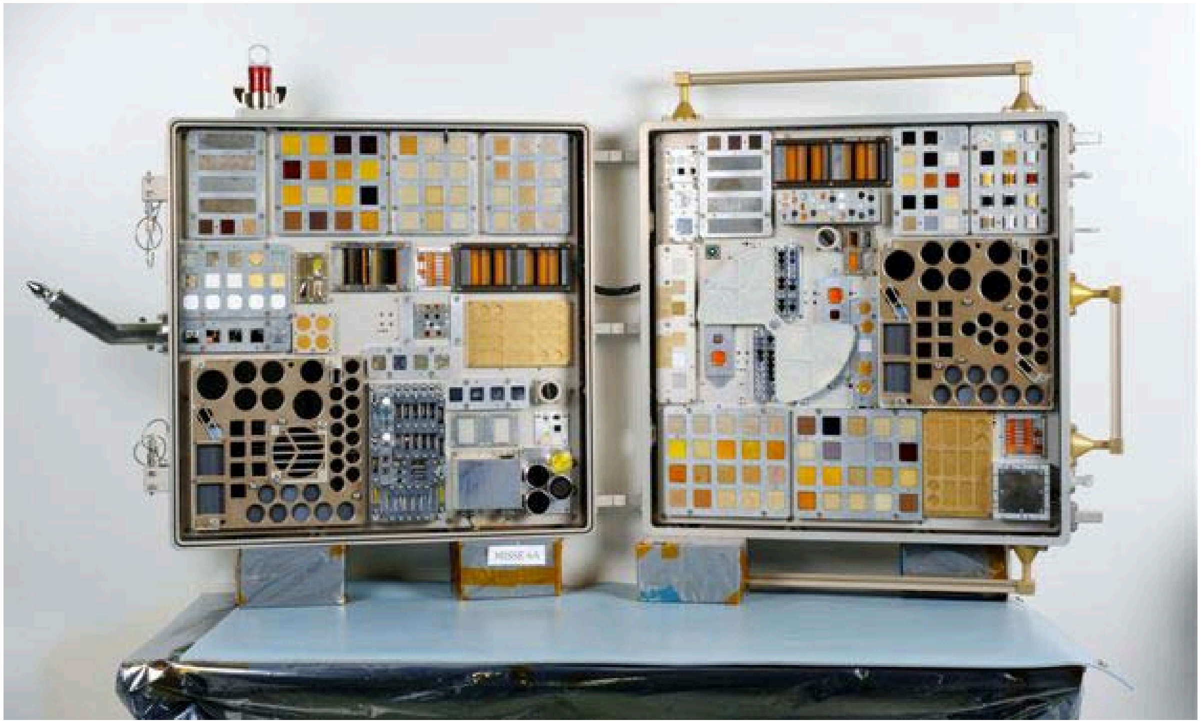


Figure 2 MISSE-6A preflight in the NASA LaRC clean room (NASA image).

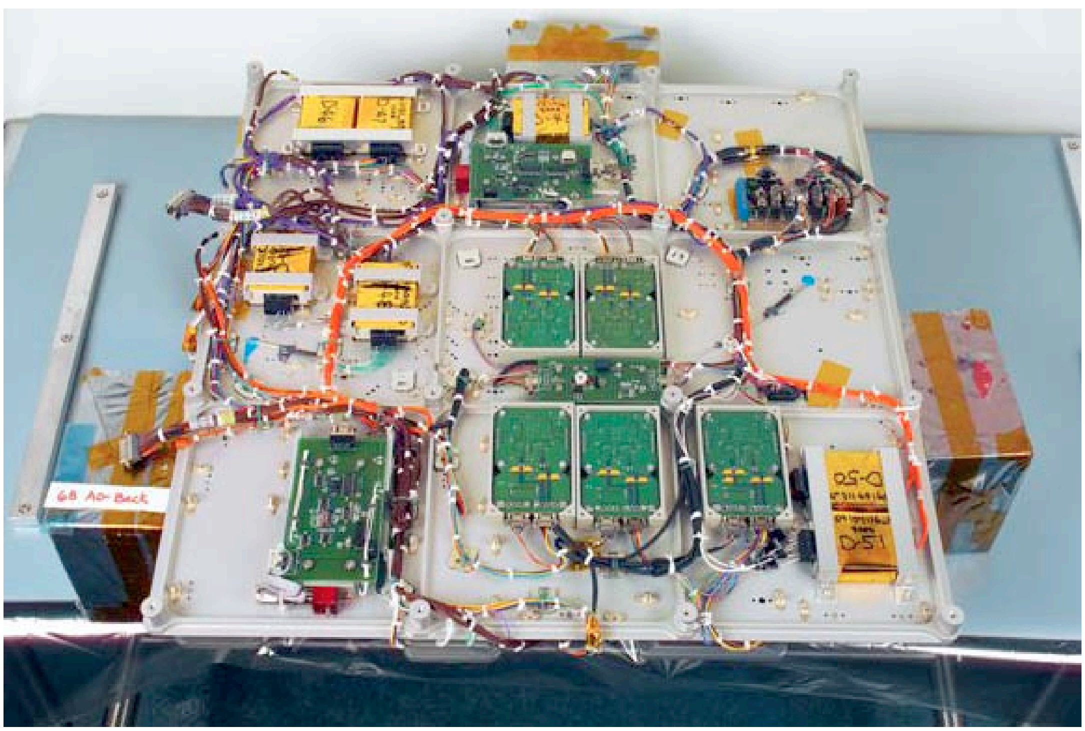
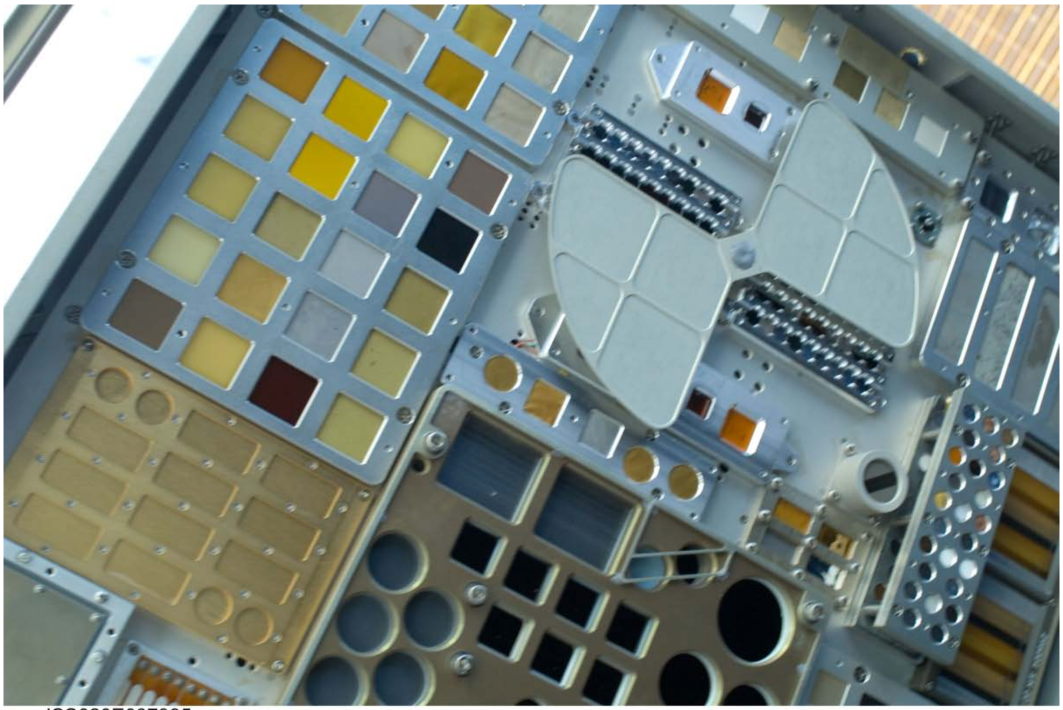


Figure 3. MISSE-6B AO side electronics attached to underside of tray holding experiments, preflight in the NASA LaRC clean room (NASA image).

2.2 ON-ORBIT IMAGES AND OBSERVATIONS

Figures 4 through 11 are close-up images taken on-orbit following the 17 month exposure. Damage to particular specimens is evident in Figure 9, which shows failed thin film specimens on the Ram (AO/UV) side of MISSE-6B. Post-flight, the ram side of MISSE-6B generally showed the most visible damage. Virtually all specimens on the "wake" (UV exposed) side of both 6A and 6B were intact and looked in reasonable condition post-flight.



ISS020E037335

Figure 4. MISSE-6A AO/UV side on orbit (NASA image)

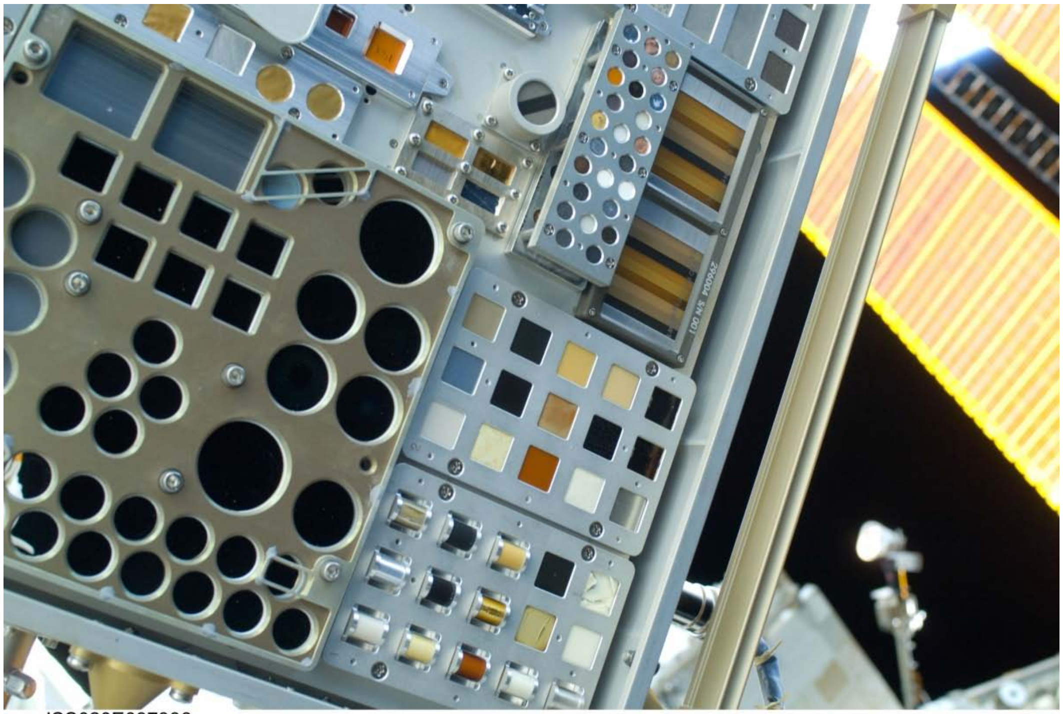


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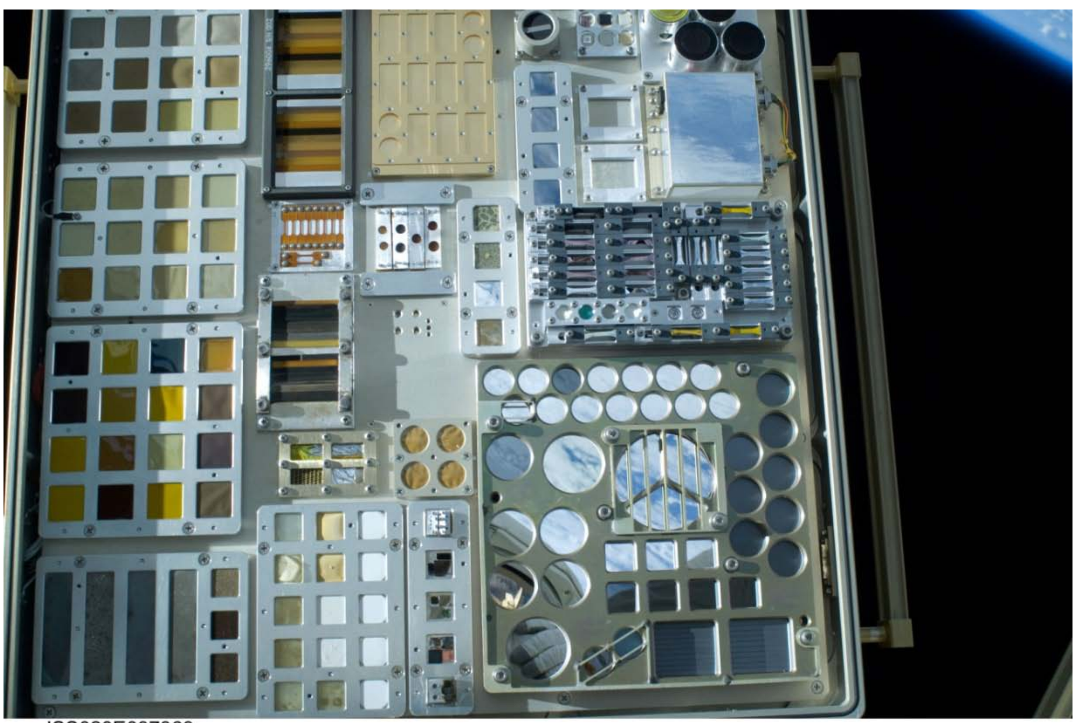
Figure 5. Partial view of MISSE-6A AO/UV side on-orbit (NASA image)



ISS020E037363

Figure 6. MISSE-6A UV side on-orbit (NASA image).

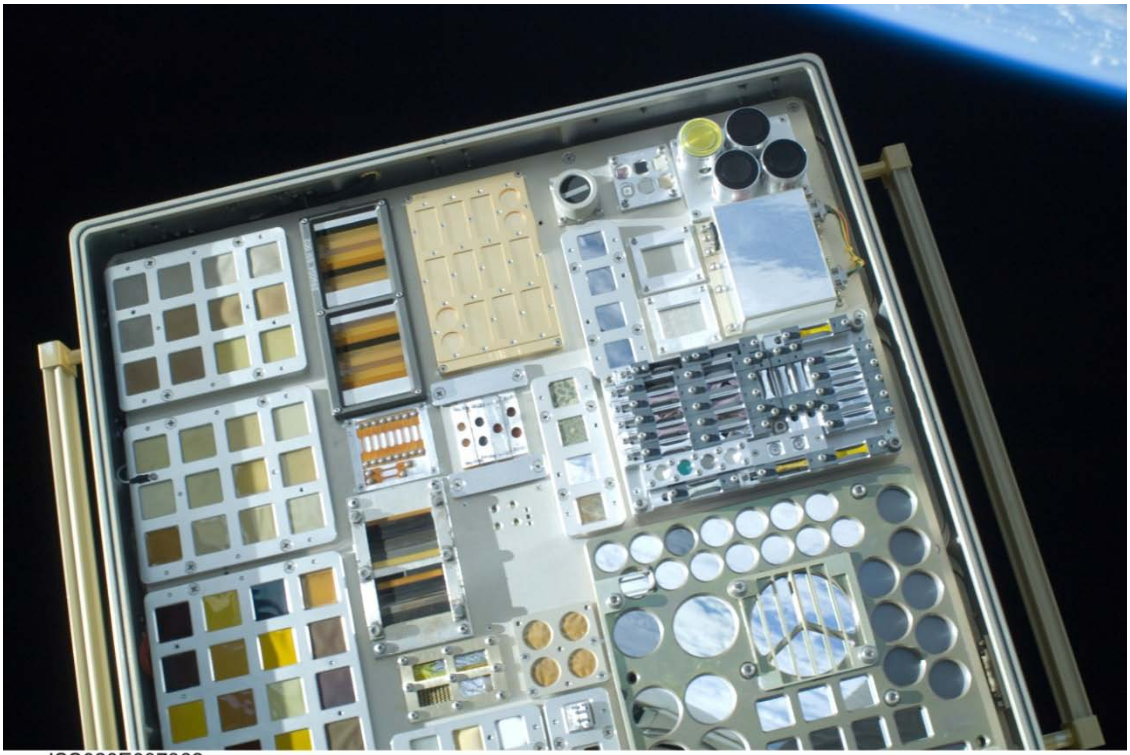


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Figure 7. Partial view of MISSE-6A UV side on-orbit (NASA image).

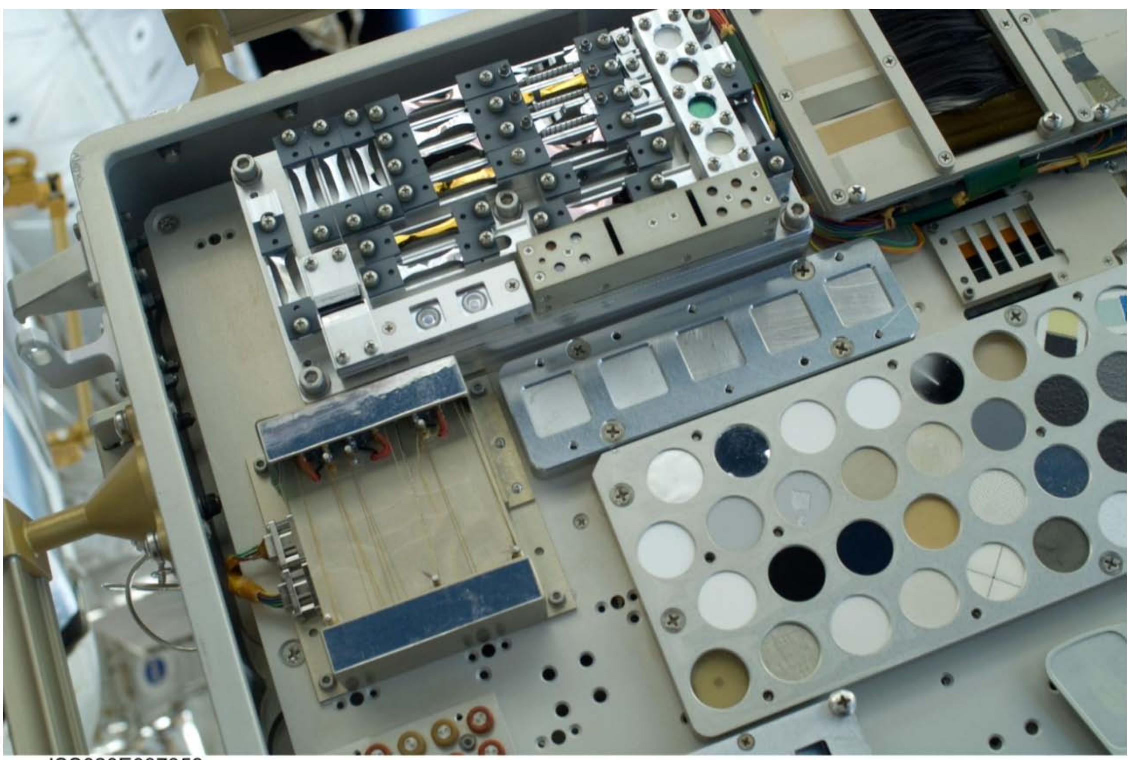

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Figure 8. Close up of MISSE-6B AO/UV side on-orbit (NASA image).

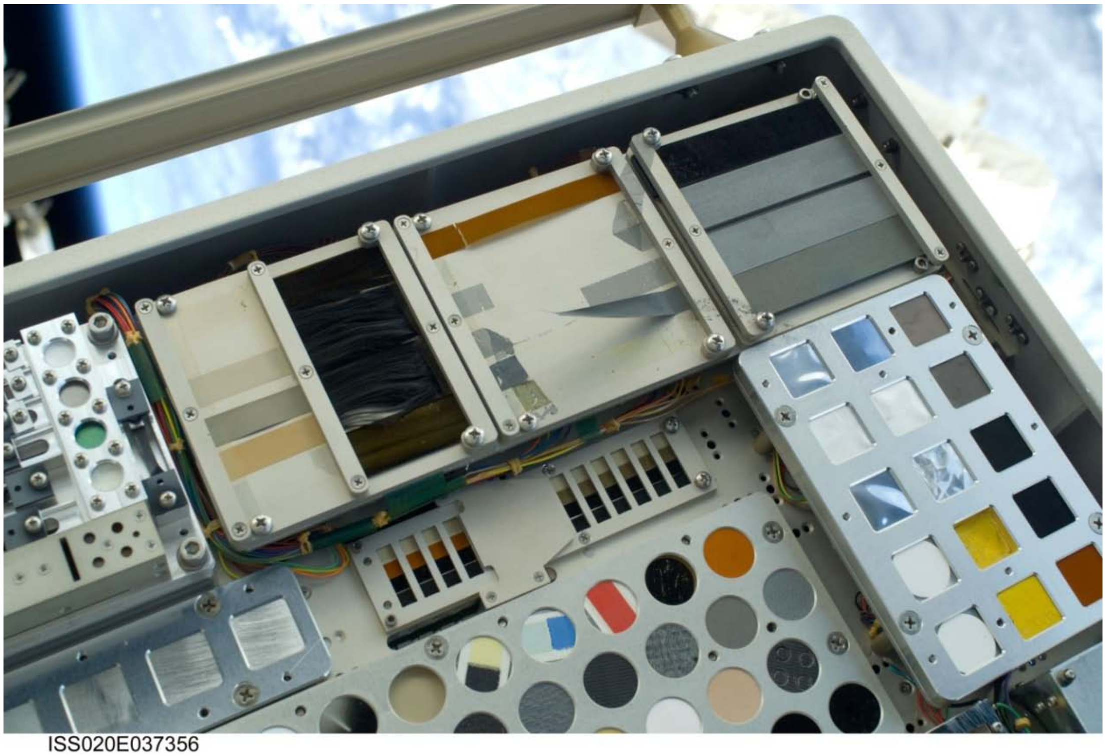


Figure 9. MISSE-6B AO/UV side on-orbit, showing damage to thin films (NASA image).

Figure 10. MISSE-6B UV side on-orbit (NASA image).

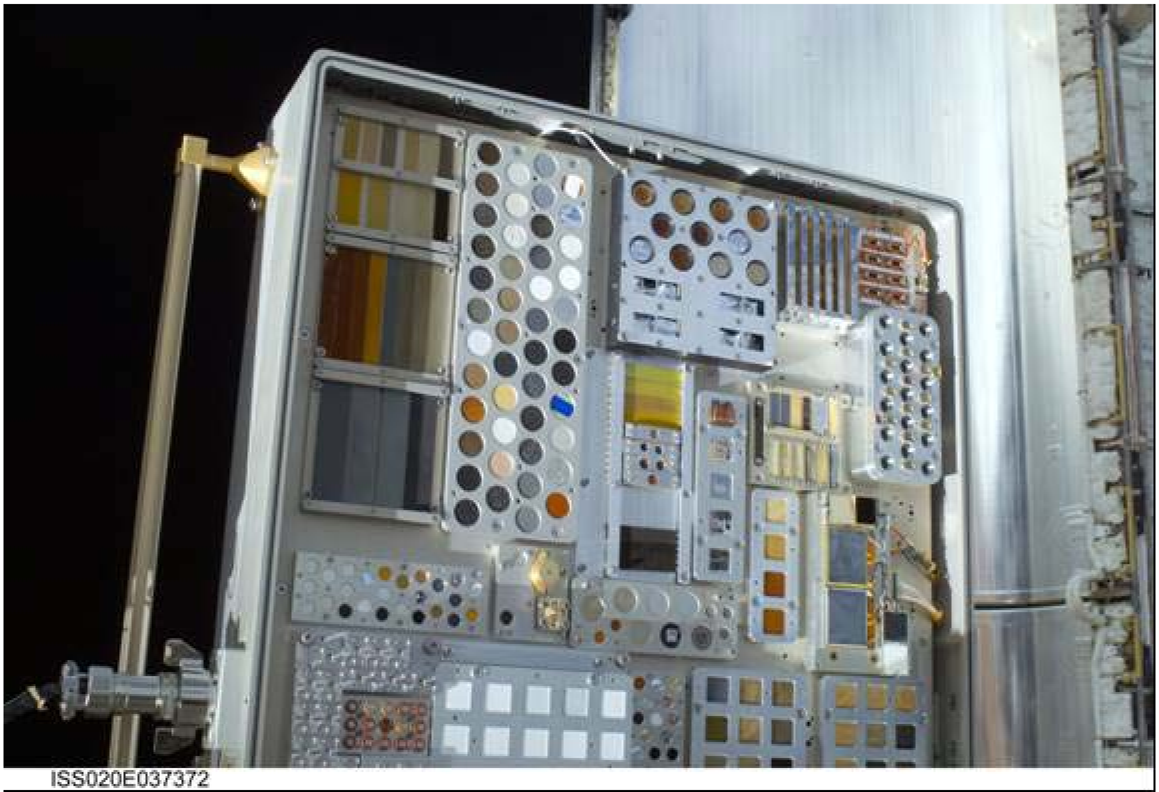


Figure 11. Additional view of MISSE-6B UV side on-orbit (NASA image).

3 ACTIVE EXPERIMENTS

The NASA LaRC mechanical slide mechanism experiment worked as designed. Mechanical attachment points were noticed to be loose after the flight. However, the mechanism was successfully exercised post-flight even with the loose connections.

The coupler between the motor and the drive mechanism for the Notre Dame experiment failed at the start of the exposure period or before. An aluminum cover was designed to slowly move, exposing new material specimens at different times. There is no evidence that the aluminum cover moved at all. The malfunction was presumably caused by a broken motor shaft coupler.

4 ENVIRONMENTAL EXPOSURES

4.1 TEMPERATURE MONITORING

Figures 12 through 15 show the nominal locations of the temperature sensors. The MISSE-6 PECs had multiple temperature sensors. This included eight thermocouples and two thermistors attached to the undersides of the baseplates (that is, not directly exposed to the sun or atomic oxygen). Orbital thermal cycling effects are clearly evident in the temperature data for each sensor, as are Space Shuttle docking and undocking events and other activities that involved significant orientation changes of ISS. Longer term effects from the monthly cycling of solar beta angles are not as easily identified, but are present.

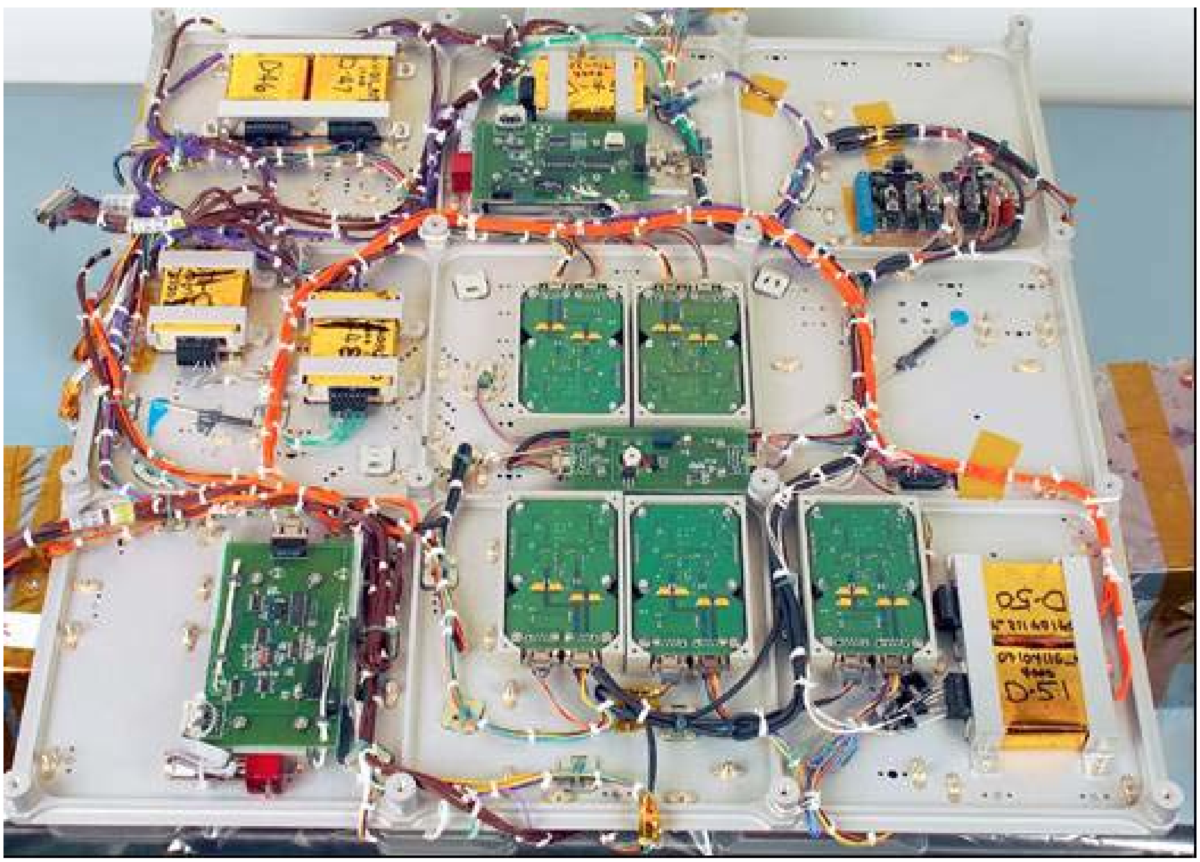


Figure 12. Location of thermistors on MISSE-6B AO/UV side tray.

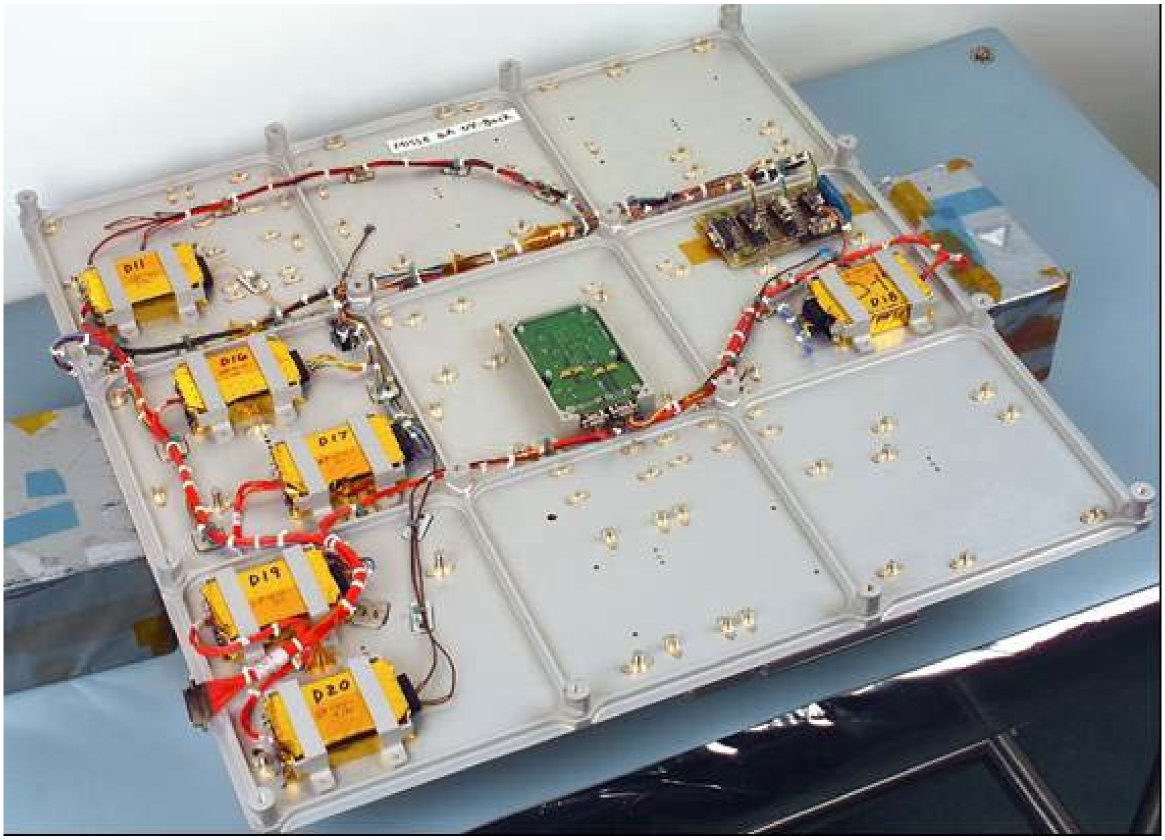


Figure 13. Location of temperature sensors on MISSE-6A UV side tray.

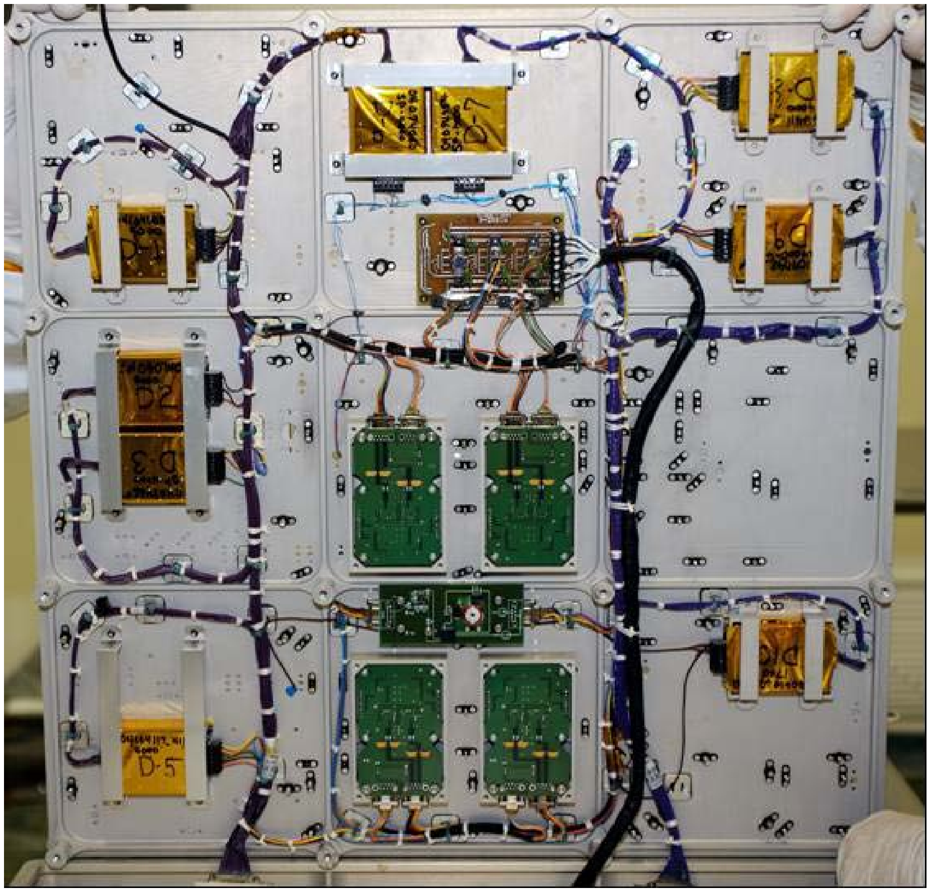


Figure 14. Location for temperature sensors on MISSE-6A, AO/UV side tray.

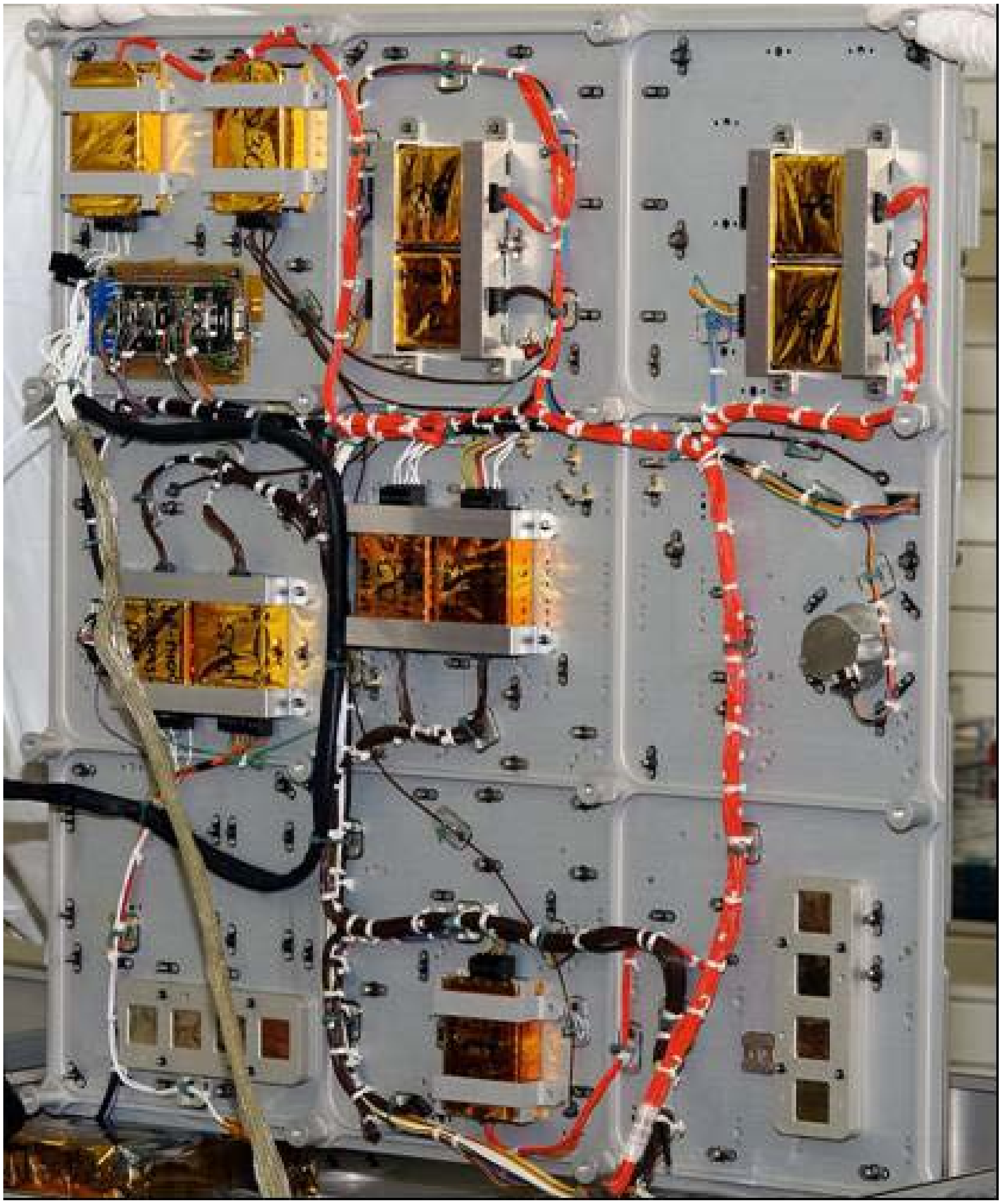


Figure 15. Location for temperature sensors on MISSE-6B, UV side tray.

4.2 ATOMIC OXYGEN FLUENCE ESTIMATES

The ram- and wake-side atomic oxygen fluence measurements and corresponding model predictions are shown in Table 1. The estimated ambient fluence is high given that the exposure occurred during solar minimum conditions. This result is due to the relatively low altitude of the ISS during the 17 month MISSE-6 exposure. The orientation of ISS was relatively more stable during the MISSE-6 exposure period than for any previous MISSE. However, there were nine time periods during which ISS was oriented such that the nominal wake side actually received significant dose of atomic oxygen, resulting in a fluence of ~ 8% of the ram-facing side fluence. Almost all of the atomic oxygen exposure on the nominal "wake" side was during time periods when the space Shuttle was docked to the ISS. The model did not distinguish between MISSE-A and MISSE-6B and also did not account for any shielding or deflection of atomic oxygen by the ISS structure. The calculated results should be considered a "maximum possible value" for the fluence. A table showing detailed results for individual time periods in a specific orientation is presented in Appendix B.

Exposure Conditions	Units	MISSE-6A	MISSE-6B	Calculated
Ram-facing surface	(E+21 atoms/cm2)	2.0	1.8	4.5
Wake-facing surface	(E+20 atoms/cm2)	1.4	1.0	3.6

Table 1. Atomic Oxygen fluences for MISSE-6

4.3 SOLAR EXPOSURE LEVELS

Initial estimates were that the 17 month exposure period allowed a maximum of ~2800 ESH to each of the primary surfaces of MISSE-6A and MISSE-6B. This estimate includes adjustments for the fraction of time spent in the Earth's shadow, the varying position of the sun due to the motion of the ISS during the day-side of the orbit, and the time-varying beta angle of the sun. It does not include shadowing of the experiment packages by the structure of the ISS.

Due to the location of the MISSE-6 Passive Experiment Carriers on the Columbus module, there were significant periods of time when MISSE-6 was in shadow.

A more detailed estimate was requested from the ISS program thermal analysis group. These results indicate the equivalent sun hours (ESH) of solar exposure to be ~2600 ESH for the ram surfaces and ~1950 ESH for the wake surfaces. This estimate was performed using the ISS "TRASYS" model for predicting solar exposure.

4.4 METEOROID AND DEBRIS IMPACT SURVEY RESULTS[1]

Detailed visual impact surveys on MISSE-1, MISSE-2, MISSE-3, MISSE-4, MISSE-6A, and MISSE-6B were primarily conducted by Miria Finckenor, NASA MSFC. Results from MISSE-1 and -2 have been released previously, but are included here for comparison. Table 2 summarizes the MISSE-1 and -2 results. Table 3 provides the results from MISSe-3 and -4 as these results have not been widely shared.

The MISSE-6 impact survey found 41 impacts spread over the experiment and PEC surfaces of MISSE-6A and MISSE-6B, as shown in Table 4. The analysis of the impact results from the three flights shows than on a per area per time basis, the results are quite close. In each case an area of 12 ft^2 was exposed to direct impacts. The results are for MISSE-1 & -2, 2.6

[1] Results in this section provided by Ms. Miria Finckenor, NASA MSFC

Impacts/ft^2/yr, for MISSE-3 & -4, 2.2 Impacts/ft^2/yr, and for MISSE-6A & 6B, 2.4 Impacts/ ft^2/yr.

Table 2. Summary of size and number of impacts from MISSE-1 & -2.

Size (diameter, mm)	Number of Impacts
0.1	1
0.2	8
0.3	45
0.4	2
0.5	30
0.75	8
1	7
1.2	1
1.5	2
2	2
3	2
Total	**108**

Table 3. Summary of impact survey from MISSE-3 & -4.

Side	Location	~Size (mm)	Size	Number of Impacts
3yr_AO_UV_1	exterior	0.1	0.1	17
3yr_AO_UV_1	exterior	0.1	0.2	3
3yr_AO_UV_1	exterior	0.1	0.3	2
3yr_AO_UV_1	exterior	0.1	0.5	1
3yr_AO_UV_1	exterior	0.2	1	1
3yr_UV_2	2-N7	0.1	1.3	1
3yr_UV_2	2-C4	0.1	2	1
3yr_AO_UV_1	1-E13	0.1	Total	**26**
3yr_AO_UV_1	1-E14-8	0.1		
3yr_AO_UV_1	1-J23	0.1		
3yr_AO_UV_1	1-D4-18	0.1		
3yr_AO_UV_2	2-E22	0.1		
3yr_AO_UV_2	2-E22	0.2		
3yr_AO_UV_2	2-E22	0.1		
3yr_AO_UV_2	2-J31	0.1		
3yr_AO_UV_2	2-T3	1.0		
3yr_AO_UV_2	2-E17-33	0.3		
3yr_AO_UV_2	2-E16-9	0.1		
3yr_AO_UV_2	2-E15-10	0.3		
3yr_AO_UV_2	2-E15-34	0.1		
3yr_AO_UV_2	2-E15-29	0.5		
3yr_UV_1	1-Y2	1.3		
3yr_UV_1	1-E19	2.0		
3yr_UV_1	exterior	0.1		
3yr_AO_UV_2	exterior	0.1		
3yr_AO_UV_2	exterior	0.2		

Table 4. Detailed impact survey results from MISSE-6.

Side	On Tray or Plate?	~Size (mm)	Notes	# "New" impacts	Size	# Impacts
6A		0.5	looks old		0.1	1
6A		0.5	looks old		0.2	12
6A		0.3			0.3	17
6A		0.3	looks old		0.5	8
6A		0.2			0.7	4
6A		0.3			0.8	1
6A		0.2			1	3
6A		0.5			1.2	1
6A		0.7			1.5	1
6A		0.3		**7**		**48**
6A AO_UV		0.7				
6A AO_UV	Y	0.2				
6A AO_UV	Y	0.3				
6A AO_UV	Y	0.7				
6A AO_UV	baseplate	0.2				
6A AO_UV		1.5				
6A AO_UV	Y	0.3				
6A AO_UV		0.7	low velocity impact			
6A AO_UV		1	cracked sample	**9**		
6A UV		0.3				
6A UV		1	melted zone	**2**		
6B		0.5	looks old			
6B		0.2				
6B		0.2				
6B		0.3				
6B		0.5	looks old			
6B		0.5				
6B		0.2				
6B		0.3	looks old			
6B		1.2				
6B		0.5				
6B		0.3				
6B		0.2		**9**		
6B AO_UV	Y	0.2				
6B AO_UV		0.2				
6B AO_UV	baseplate	0.2				
6B AO_UV		0.3	split sample			
6B AO_UV	tray	0.3				
6B AO_UV	tray	0.3				

6B AO_UV		0.3				
6B AO_UV		0.8	5 mm spall			
6B AO_UV		1		**9**		
6B UV	baseplate	0.2				
6B UV		0.3				
6B UV	tray	0.3				
6B UV	baseplate	0.5				
6B UV		0.3		**5**		
				41		

Impact examples from MISSE-6 are shown below in figures 16 and 17.

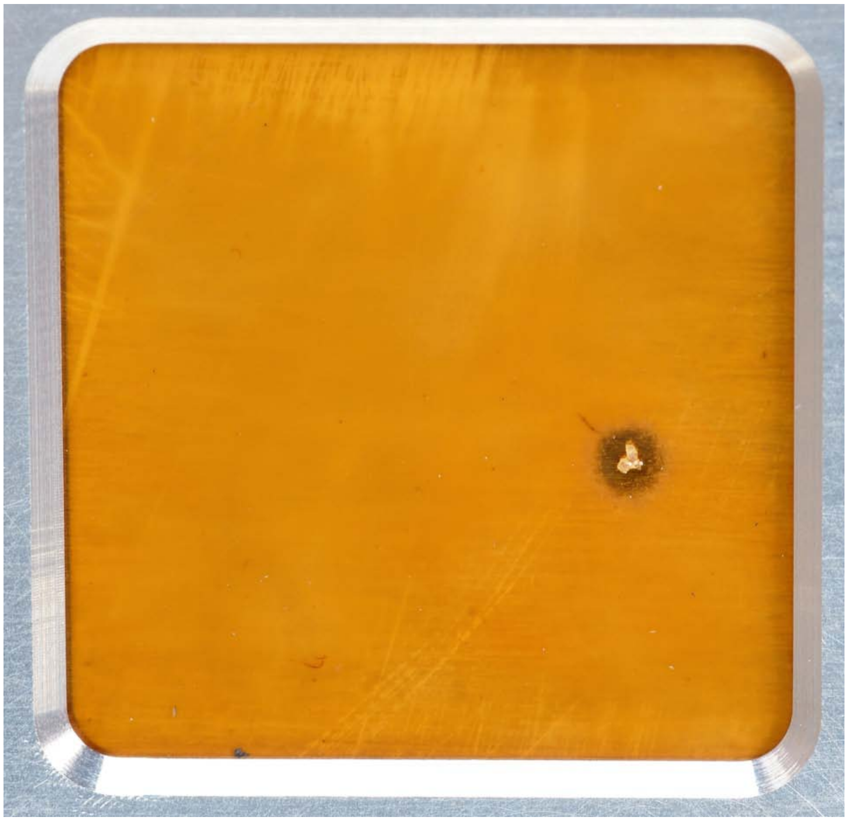


Figure 16. Impact in thin film specimen from MISSE-6 (NASA image).

Figure 17. Impact on specimen from MISSE-6 (NASA image).

4.5 Radiation Exposure Levels

Radiation exposure levels presented in Figure 18 are the results of the NASA LaRC, NASA MSFC, and Plasma Processes, Inc. radiation shielding materials experiment. Results from MISSE-1 through -4, are included in this figure for comparison. Radiation levels for the various MISSE flights show the expected variation with solar cycle and are in the relatively low range of dose levels.

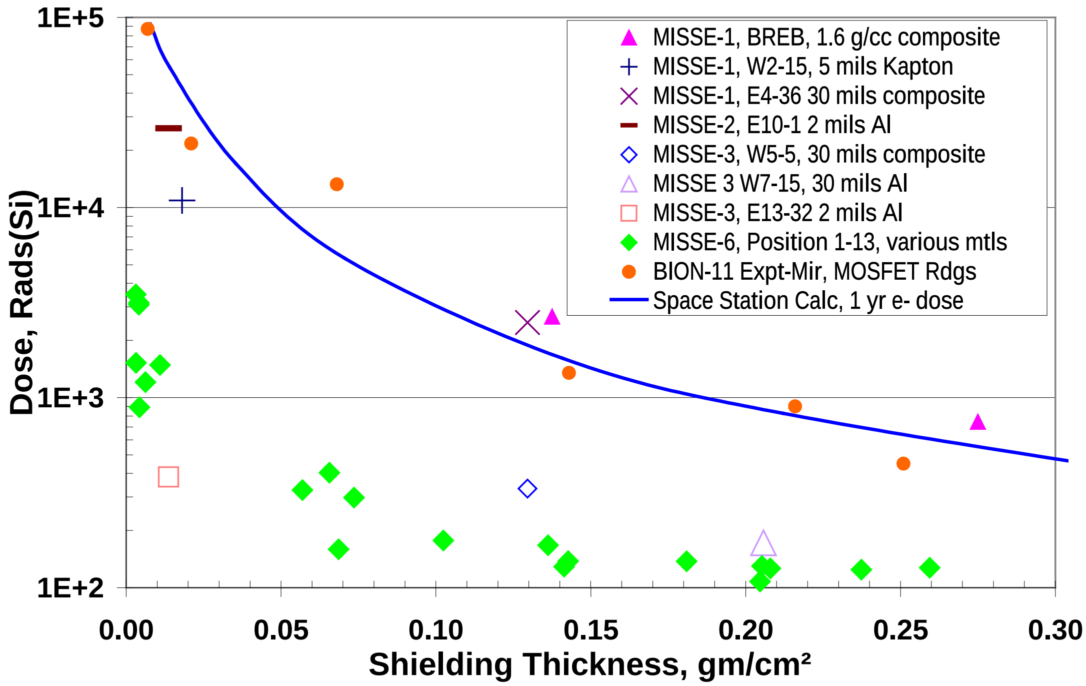


Figure 18. Summary plot of MISSE-6 radiation experiment results with data from previous MISSE flights for comparison.

4.6 Contamination Inspection

Visual inspection of both MISSE-6A and MISSE-6B did not reveal any obvious molecular contamination. These observations were supported by inspections under black light, which also showed the surfaces to be generally clean. Representative black light images for MISSE-6A are shown in Figures 19 and 20. Results from MISSE-6B are similar.

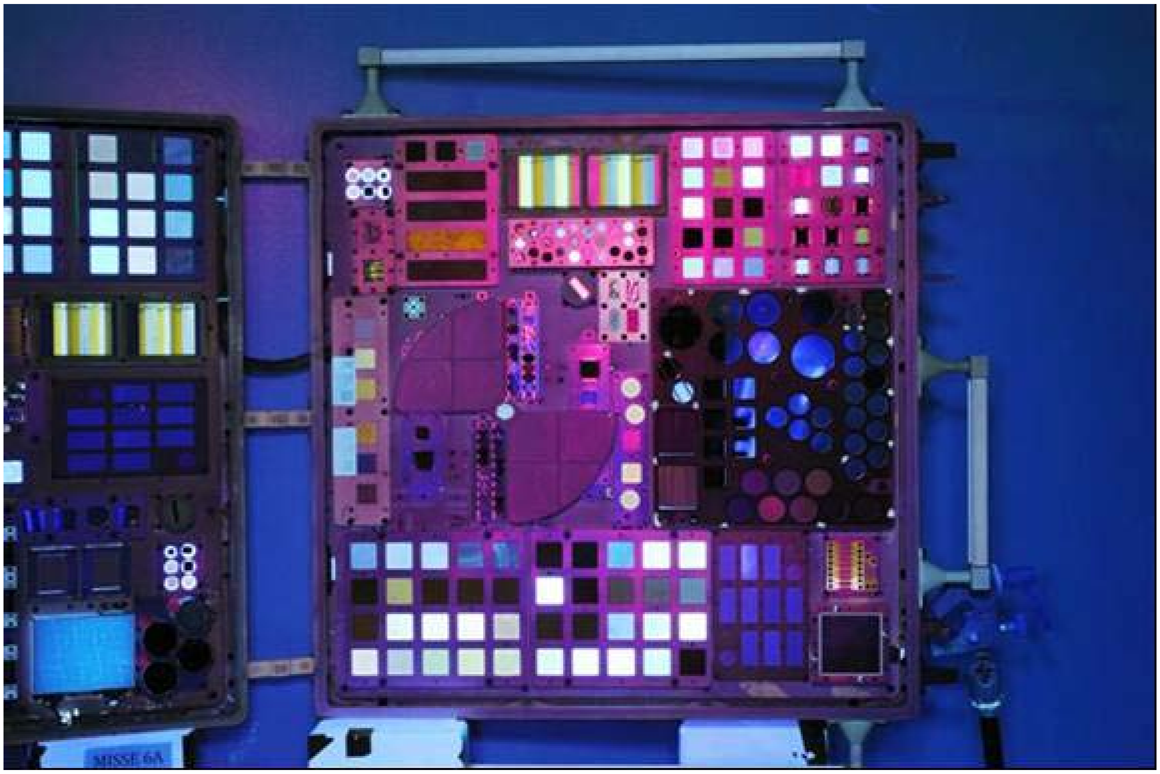


Figure 19. Black light image of MISSE-6A ram-facing surface.

Figure 20. Black light image of MISSE-6A wake-facing surface.

5 ANOMALIES AND FAILURES

The following anomalies and failures were noted for each portion of the MISSE-6 package.

5.1 MISSE-6A-UV EXPOSURE SIDE

No anomalies were noted for this side.

5.2 MISSE-6B-AO/UV EXPOSURE SIDE

The circuit boards for the Q9 and Q10 quartz crystal microbalance boards were labeled backwards. The large mechanical shutter experienced a rotation failure due to mechanical binding of the shutter in contact with the motor housing. Wires for specimen sets P1 and P2 on the University of Pittsburgh experiment lacked a data ground. The data lines to dataloggers D1 and D7 were loose. Thermocouple T1 was disbonded.

5.3 MISSE-6B-UV EXPOSED SIDE

The University of Notre Dame data logger terminals looked loose.

5.4 MISSE-6B-UVEXPOSED SIDE

The mechanism intended to slowly translate a cover plate over the N12 experiment failed due to a loose coupling between the motor and the drive shaft. The power cable for the N9, N11, and N13 experiments was apparently never built, and therefore not installed in the N8 module. Specific dataloggers mounted under sample sets L1, L2, and L3 were in different locations than shown on the pre-flight drawings. Dataloggers D43 and D44 were attached to different quartz crystal microbalance sets than shown in the pre-flight drawings. Datalogger D43 was actually connected to Q5 and datalogger D44 was actually connected to Q4.

Datalogger D45 was actually connected to experiment module N8, whereas the drawing showed D45 connected to N11. Ultimately this point was moot due to the lack of power to the N8 module.

6 POST-FLIGHT IMAGES

A detailed set of digital images were obtained by NASA in the clean room at NASA Langley Research Center. A selection of representative images is included in Figures 21 through 27.

Figure 21. MISSE-6A being opened post-flight in a class 10,000 clean room at NASA LaRC (NASA image).

Figure 22. MISSE-6B being opened post-flight in a class 10,000 clean room at NASA LaRC (NASA image).

Figure 23. MISSE-6A, ram-facing side, post-flight (NASA Image).

Figure 24. MISSE-6A, wake-facing side, post-flight (NASA Image).

Figure 25. MISSE-6B, ram-facing side, post-flight (NASA Image).

Figure 26. MISSE-6B, wake-facing side, post-flight (NASA Image).

Figure 27. Inspection of MISSE-6B tray from the ram-facing side, post-flight (NASA Image).

The underside of the tray and hardware are in good condition post-flight. As with previous MISSE flights, the silver-coated nut plates are significantly oxidized.

7 Summary of Conditions

7.1 MISSE-6A

The quartz crystal microbalance (QCM) electronics packages worked well. Individual QCMs on the wake side operated until the buffer in the datalogger was full. Selected QCMs on the ram side also continued to operate over the several month period required to fill the buffers for their respective dataloggers. Those QCMs with organic coatings on the quartz crystal functioned for relatively short periods of time. Preliminary indications are that the silver electrodes were oxidized and ceased to be electrically conductive within a few days to a few weeks. This hardware continues to be examined.

7.2 MISSE-6B

Even thought the two PECs were in close proximity, only 1-2 ft apart, MISSE-6B appears to have received slightly more atomic oxygen, and likely more solar exposure, than MISSE-6A. This is likely due to greater shadowing of MISSE-6A by the Columbus module at certain orientations.

Appendix A

Post Flight Inspection and Test Results for MISSE-6 Power Distribution System and Boeing Experiment Data Wiring.

Andy Robb

Boeing Research and Technology

November 16, 2009

1. Summary, Scope, and MISSE-6 overview.

This document contains the post flight observations and test results for the MISSE-6 Power distribution board and the power system wiring. In addition there are observations and inspections of the data wiring for the Boeing experiments. In general, the power distribution board, fuses, and power wiring performed well. The small solid body fuses employed were a successful technique for power fault isolation and only 2 fuses were found to be blown post-flight. Three errors were made pre-flight, on experiment G4 and experiment A15 +15V power was inadvertently not provided, and at integration the power line to the Chicago MURI experiment set N8/N10/N11 was not installed, thus it received no power.

2. 6A Power Distribution.

The MISSE-6A PEC power was fed to the 6A-UV tray via a MIL-C-38999 -41 shell connector. The receptacle mounted on the PEC was connected to via a special extra-vehicular activity plug (EVA plug) which brought power from the DC-DC power converter box. Internal wiring on 6A connected the 38999 receptacle to the terminal blocks on the power distribution board. Each terminal on the UV side connected 2 wires, one wire from external connector, one wire going to a cable that crossed from the UV tray to the AOUV tray and into the terminal blocks on the AOUV side. Note that in Figure A28 below the blocks labeled "To AO-UV" and "From-UV" represent the interconnecting cable bringing power from the UV side to the AOUV side.

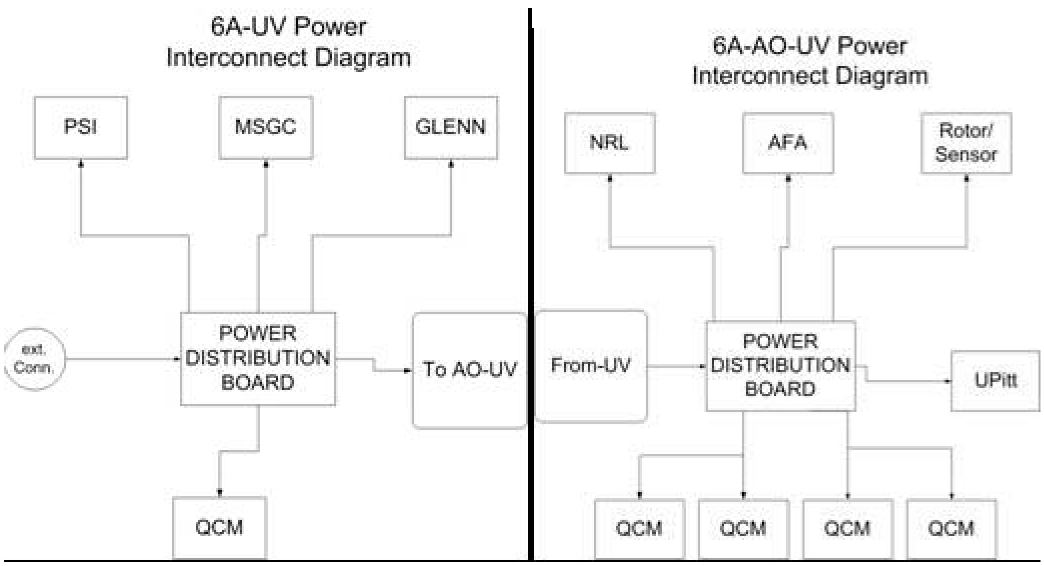


Figure A28: 6A power interconnect diagram

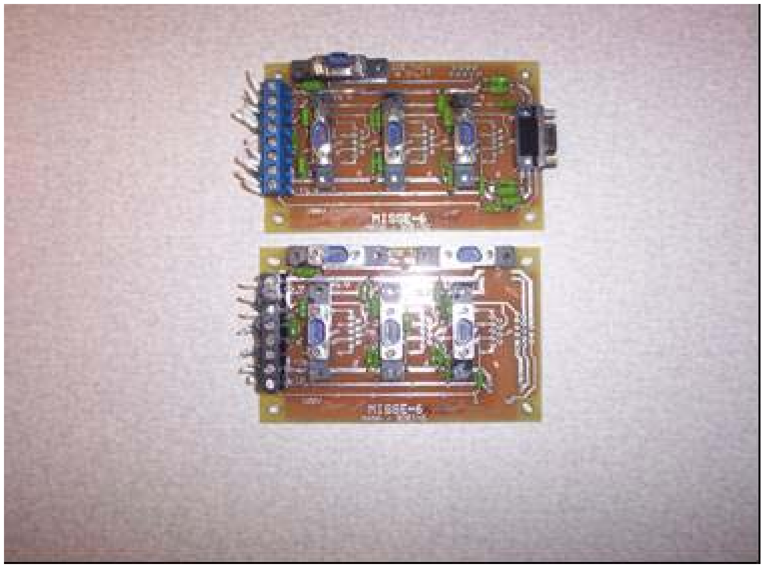


Figure A29: Post Flight Photos of 6A-UV (above) and 6A-AOUV (below) power distribution boards

2.1. 6A 38999 connector & associated wiring

Wiring from the power distribution board was photographed, disconnected from each terminal, and traced to the 38999 connector pin that it was connected to. The table below shows where on the 38999 connector each terminal block was connected to. No anomalies were discovered during the visual/electrical inspection of the board-to-connector wiring.

38999 connector to 6A-UV Power Board Wiring		
Terminal Block	**38999 pin connected to**	**Voltage for term X**
Terminal 1	F & M	Return / common ground
Terminal 2	E	-5V
Terminal 3	A	+5V
Terminal 4	L	+28V
Terminal 5	No connection	Return / common ground

Terminal 6	C	+15V
Terminal 7	G	-15V
Terminal 8	J	+100V

Table A30: 6A-UV External Connector to Power Distribution Board wiring

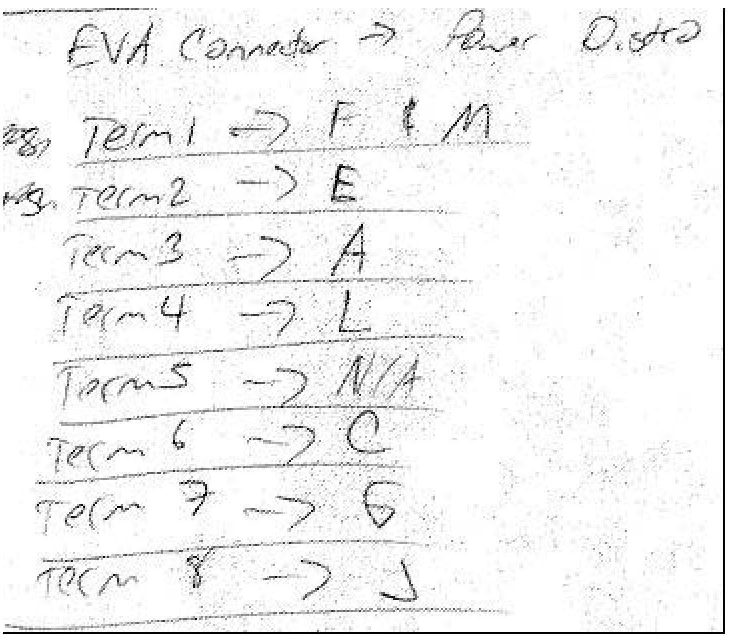
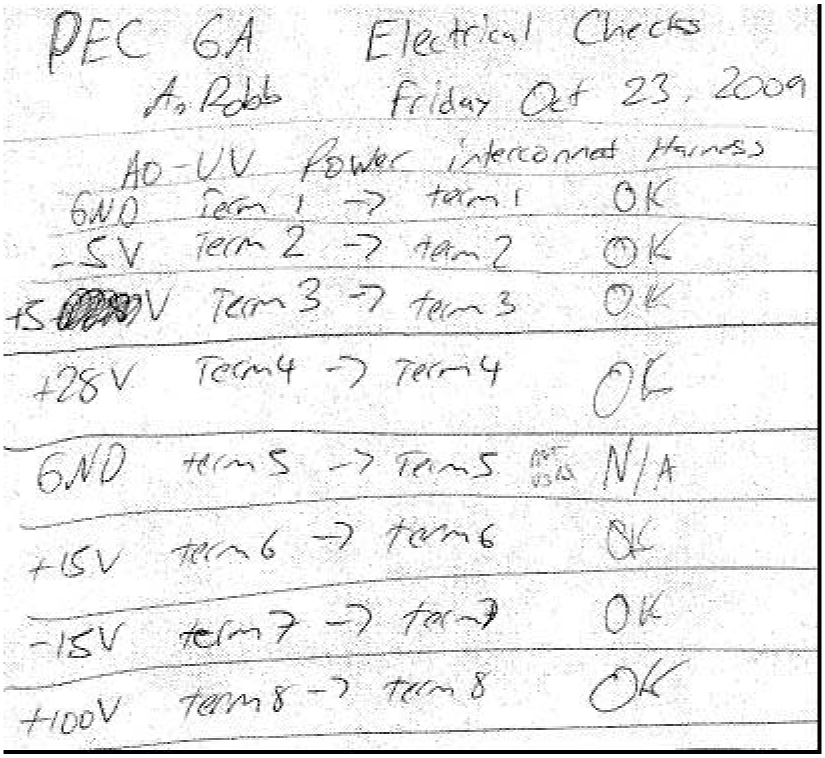


Figure A31: 6A-UV Power Board to ext. connector wiring notes

2.2. 6A UV->AOUV power feed interconnect

The cable passing from the UV tray to the AOUV side carries power from the terminals of the UV power distribution board to the AOUV power distribution board. This interconnecting cable was photographed, labeled, and disconnected. Each wire was traced from one side to the other. No anomalies were discovered during the visual / electrical inspection


PEC 6A Electrical Checks
A. Robb Friday Oct 23, 2009

AO-UV Power interconnect Harness

GND	Term 1 → term 1		OK
-5V	Term 2 → term 2		OK
+5V	Term 3 → term 3		OK
+28V	Term 4 → Term 4		OK
GND	term 5 → Term 5	not used	N/A
+15V	term 6 → term 6		OK
-15V	term 7 → term 7		OK
+100V	term 8 → term 8		OK

Figure A32: 6A Interconnect Cable Notes

2.3. 6A-UV Power Distribution

During de-integration each individual power line from the power distribution board was visually inspected, photographed, and labeled. The power wiring and the power distribution boards were removed and shipped back to the Boeing Radiation Effects Lab. Continuity checks were performed on all traces and fuses on the power distribution board and on all wiring. For 6A-UV the only anomaly discovered was a blown fuse feeding +5V to connector slot 5. This power plug was connected to the PSI experiment P1. The cause of the short is unknown.

6A-UV Power Distribution				
Power Slot	Experiment	Power Supplied	Wire / Fuse Continuity	Comments
Slot 1	MSGC M3	+5V, +15V	All OK	
Slot 2	N/C	N/C		
Slot 3	GRC G2	+5, +15	All OK	
Slot 4	N/C	N/C		
Slot 5	PSI P1	+/-5V, +/-15V,	Wires & -5, +/-15 OK. +5 Blown	+5V fuse is blown
Slot 6	N/C	N/C		
Slot 7	QCM Q6	+15V	All OK	
Slot 8	N/C	N/C		

Table A33: Results of continuity checks of power wiring and fuses for 6A-UV experiments.

2.4. 6A-AOUV Power Distribution

During de-integration each individual power line from the power distribution board was visually inspected, photographed, and labeled. The power wiring and the power distribution boards were removed and shipped back to the Boeing Radiation Effects Lab. Continuity Checks were performed on all traces and fuses on the power distribution board and on all wiring. For 6A-AOUV No Anomalies were discovered during visual or electrical inspections.

6A-AOUV Power Distribution				
Power Slot	Experiment	Power Supplied	Wire /Fuse Continuity	Comments
Slot 1	AFA A1	+5V,	OK	
Slot 2	N/C			
Slot 3	Rotor/Slide B8/S5	+/-5V, +15V	OK	
Slot 4	N/C			
Slot 5	Upitt P3/P4	+/-5V, +/-15V, 100V	OK	
Slot 6	N/C			
Slot 7	QCM Q7/Q8	+15V	OK	
Slot 8	QCM Q9/Q10	+15V	OK	

Table A34: Results of continuity checks of power wiring and fuses for 6A-AOUV experiments.

3. MISSE-6B Power wiring and power distribution

The MISSE-6B PEC power was fed in via the same method as 6A, a MIL-C-38999 -41 shell connector with an EVA plug bringing in power from an external power LRU. Internal wiring on 6B was also similar. Note that in Figure A35 below the blocks labeled "To AO-UV" and "From-UV" represent the interconnecting cable bringing power from the UV side to the AOUV side.

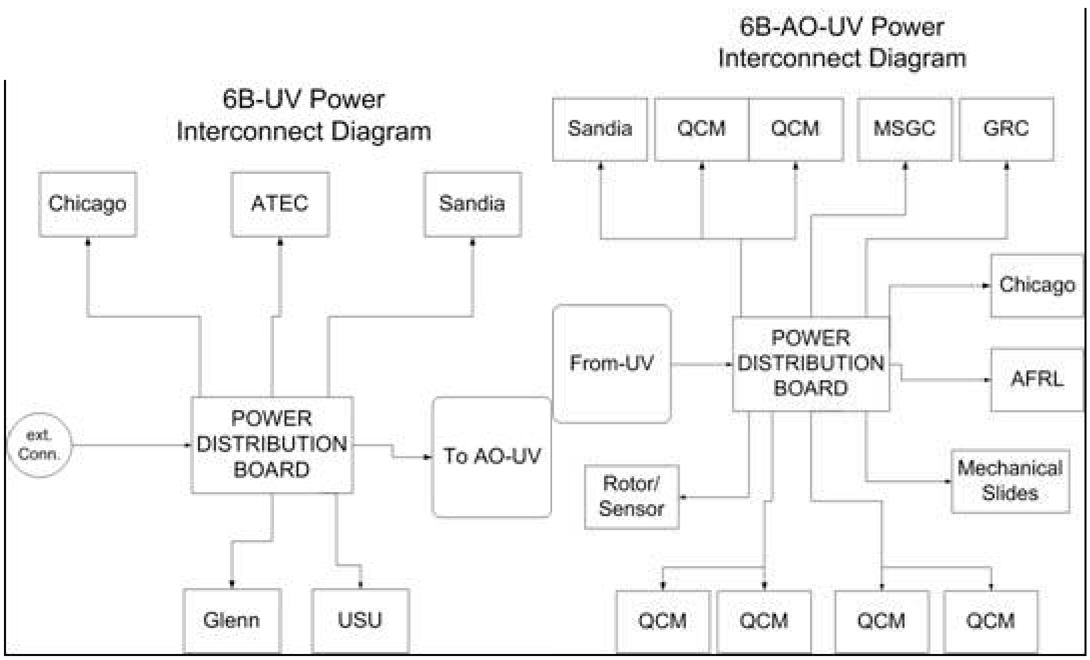


Figure A35: 6B power interconnect diagram

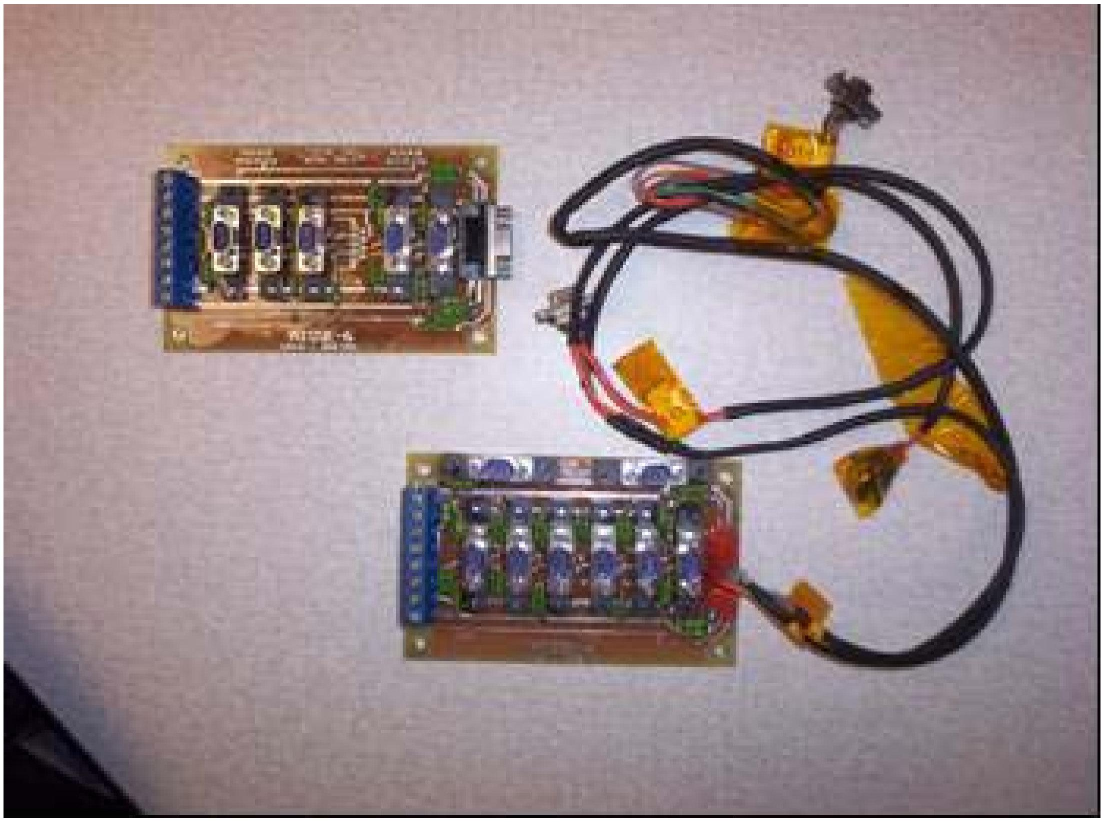


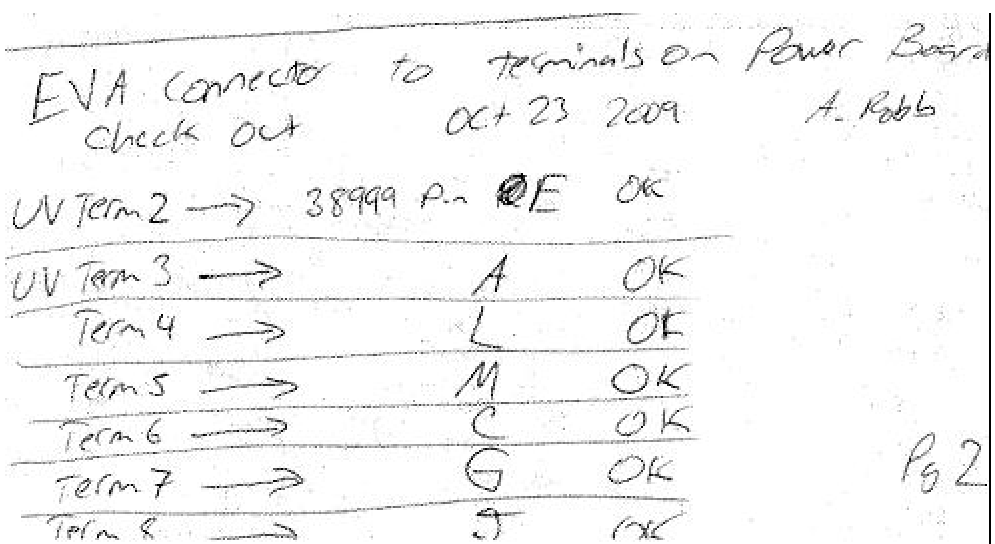
Figure A36: Post Flight Photos of 6B-UV (above) and 6B-AOUV (below) power distribution boards

3.1. 6B 38999 connector & associated wiring

Wiring from the power distribution board was photographed, disconnected from each terminal, and traced to the 38999 connector pin that it was connected to. The table below shows where on the 38999 connector each terminal block was connected to. No anomalies were discovered during the visual/electrical inspection of the board-to-connector wiring.

38999 connector to 6A-UV Power Board Wiring		
Terminal Block	**38999 pin connected to**	**Voltage for term X**
Terminal 1	N/C	Return / common ground
Terminal 2	E	-5V
Terminal 3	A	+5V
Terminal 4	L	+28V
Terminal 5	M	Return / common ground
Terminal 6	C	+15V
Terminal 7	G	-15V
Terminal 8	J	+100V

Figure A37: 6B-UV External Connector to Power Distribution Board Wiring


EVA Connector to terminals on Power Boar
Check out Oct 23 2009 A. Robb

UV Term 2 → 38999 Pin E OK
UV Term 3 → A OK
Term 4 → L OK
Term 5 → M OK
Term 6 → C OK
Term 7 → G OK
Term 8 → J OK

Pg 2

Figure A38: 6B-UV Power Board to ext. connector wiring notes

3.2. 6B UV->AOUV power feed interconnect

The cable passing from the UV tray to the AOUV side carries power from the terminals of the UV power distribution board to the AOUV power distribution board. This interconnecting cable was photographed, labeled, and disconnected. Each wire was traced from one side to the other. No anomalies were discovered during the visual / electrical inspection.

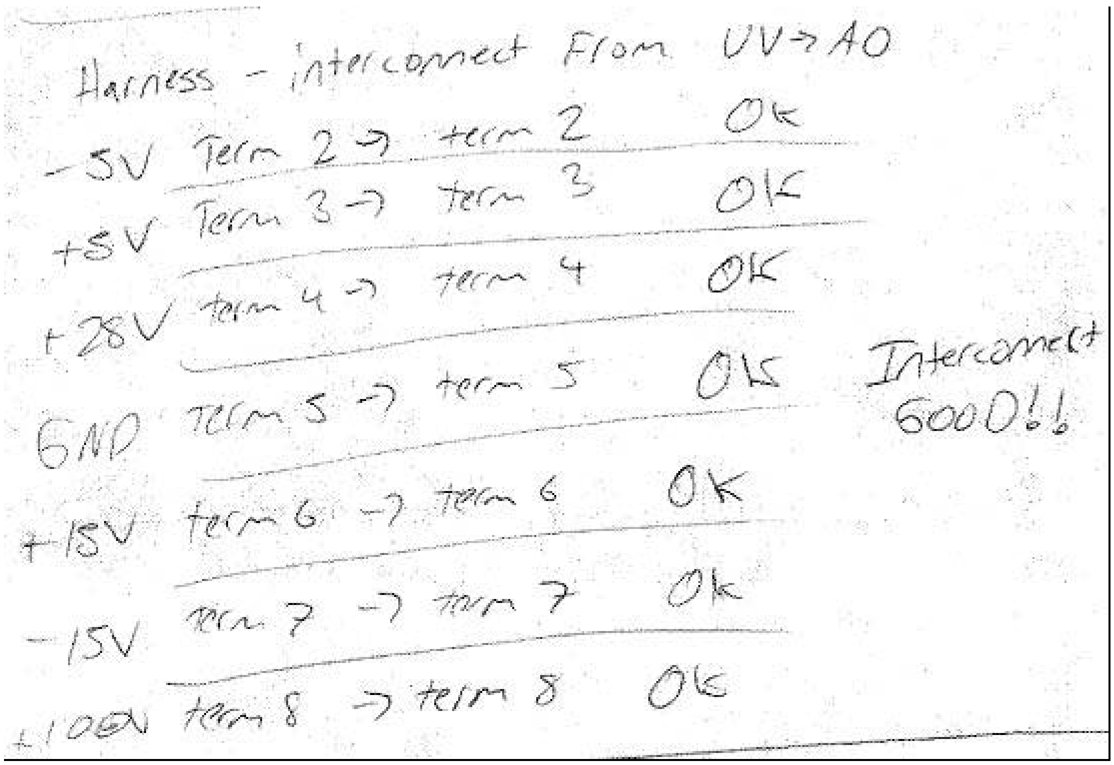

Harness - interconnect From UV->AO
-5V Term 2 -> term 2 OK
+5V Term 3 -> term 3 OK
+28V term 4 -> term 4 OK
GND Term 5 -> term 5 OK
+15V term 6 -> term 6 OK
-15V term 7 -> term 7 OK
+100V term 8 -> term 8 OK
Interconnect GOOD!!

Figure A39: 6A Interconnect Cable Notes

3.3. 6B-UV Power Distribution

During De-integration each individual power line from the 6B-UV power distribution board was visually inspected, photographed, and labeled. The power wiring and the power distribution boards were removed and shipped back to the Boeing Radiation Effects Lab. Continuity Checks were performed on all traces and fuses on the power distribution board and on all wiring. For 6B-UV the only anomaly discovered was omission of a fuse that should have connected +15V to slot 6. This oversight resulted in the NASA Glenn experiment G4 flying without +15V power. The lack of the +15V fuse on slot 6 was not detected pre-flight because no functional checks of the G4 experiment was conducted after being integrated onto MISSE-6.

6B-UV Power Distribution				
Power Slot	Experiment	Power Supplied	Wire /Fuse Continuity	Comments
Slot 1	ATEC A13	+5V, +15V	OK	
Slot 2	Chicago N6/N7	100V	OK	
Slot 3	Sandia S2	+5V, +100V	OK	
Slot 4	N/C			
Slot 5	USU U3	+/-5V, +15V	OK	
Slot 6	Glenn G4	+5V, -15V	OK	This experiment should have had +15V power. No +15 was present.
Slot 7	N/C			
Slot 8	N/C			

Figure A40: Results of continuity checks of power wiring and fuses for 6B-UV experiments.

3.4. 6B-AOUV Power Distribution

During de-integration each individual power line from the 6B-AOUV power distribution board was visually inspected, photographed, and labeled. The power wiring and the power distribution boards were removed and shipped back to the Boeing Radiation Effects Lab. Continuity checks were performed on all traces and fuses on the power distribution board and on all wiring. For 6B-AOUV the only anomalies discovered were confined to the AFRL A15 experiment. The +5V fuse for A15 was blown. A15 was fused with 2 fuses in parallel, one was 3A, the other 3/4A for a total of 3.75A. Detailed inspection of the power cable for A15 showed no opens or shorts. It is not known at this time the cause of the blown fuses. In addition to the blown +5V fuses a fuse that should have connected +15V to slot 3 was omitted. This oversight resulted in the AFRL experiment A15 flying without +15V power. The lack of the +15V fuse on slot 3 was not detected pre-flight because no functional checks of the A15 experiment was conducted after being integrated onto MISSE-6.

6B-AOUV Power Distribution				
Power Slot	Experiment	Power Supplied	Wire /Fuse Continuity	Comments
Slot 1	Chicago N8/N10/N11	+/-5V, +/-15V	Fuses OK	No power cable connected Slot 1 to the experiment.
Slot 2	GRC G3	+5V, +15V	OK	
Slot 3	AFRL A15	+5V, -15V	+5 Fuse is Blown	This experiment should have had +15V power. No +15V was present
Slot 4	Sandia S1	+5V, +100V	OK	
Slot 5	MSGC M4	+5V	OK	
Slot 6	Slides S10&S9	+/-5V, +15V	OK	
Slot 7	QCM Q1	+15V		
Slot 8	QCM Q2/Q4	+15V		
Hardwired	QCM Q3/Q5/S11	+15V		

Figure A414: 6B-AO/UV Power distributions.

4. Boeing Data Wiring, QCM wiring, and Rotor/Sensor wiring.

The data wiring for the Boeing experiments including QCMs and Rotor/Sensor were labeled, removed, and several of the wire bundles were shipped back to Boeing for post flight inspections. Inspections were conducted at Boeing on Data wiring for Q7, Q8, Q9 and the rotor-sensor. Results showed that Q7 and Q8 were properly wired to their data loggers.

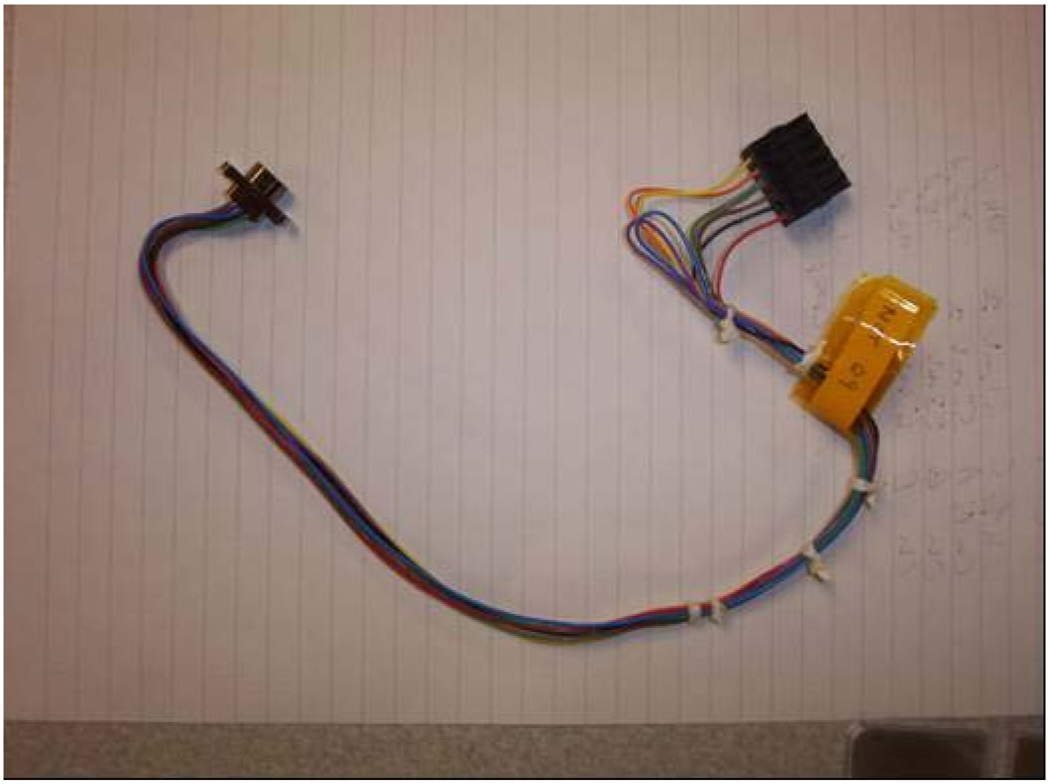


Figure A42: the properly wired data interface for a QCM

In addition, Q9 was properly wired into datalogger D8, and the rotor sensor was properly wired into datalogger D9. Datalogger D9 was a SP-4000-4CW, a current sensing datalogger, channel 1 of the data logger was connected through a 1kOhm resistor to the black data wire from the rotor. Channel 2 of D9 was unpopulated. Channel 3 was connected to the orange wire from the rotor. Channel 4 was connected through a 10KOhm resistor to the blue wire from the rotor connector.

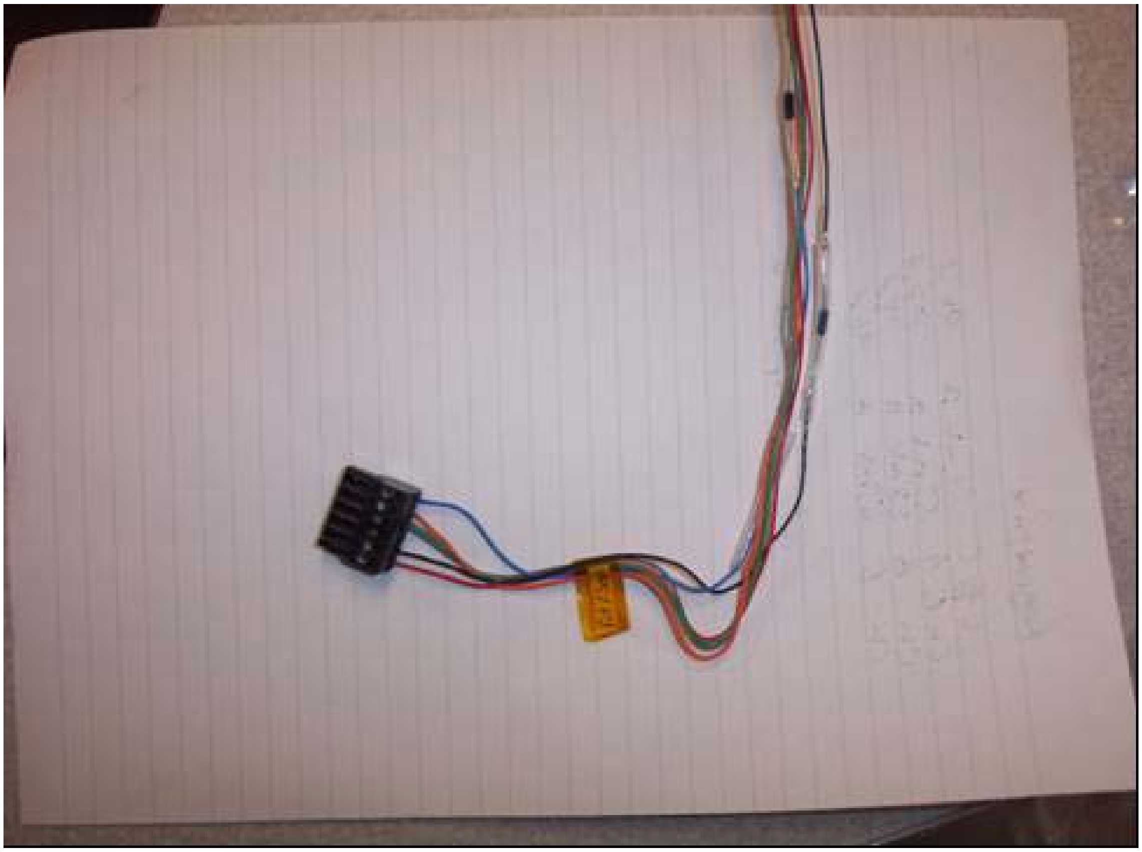


Figure A436: Rotor wiring to D9

Appendix B

Time-Temperature Results from Thermal Sensors distributed on MISSE-6A and MISSE-6B

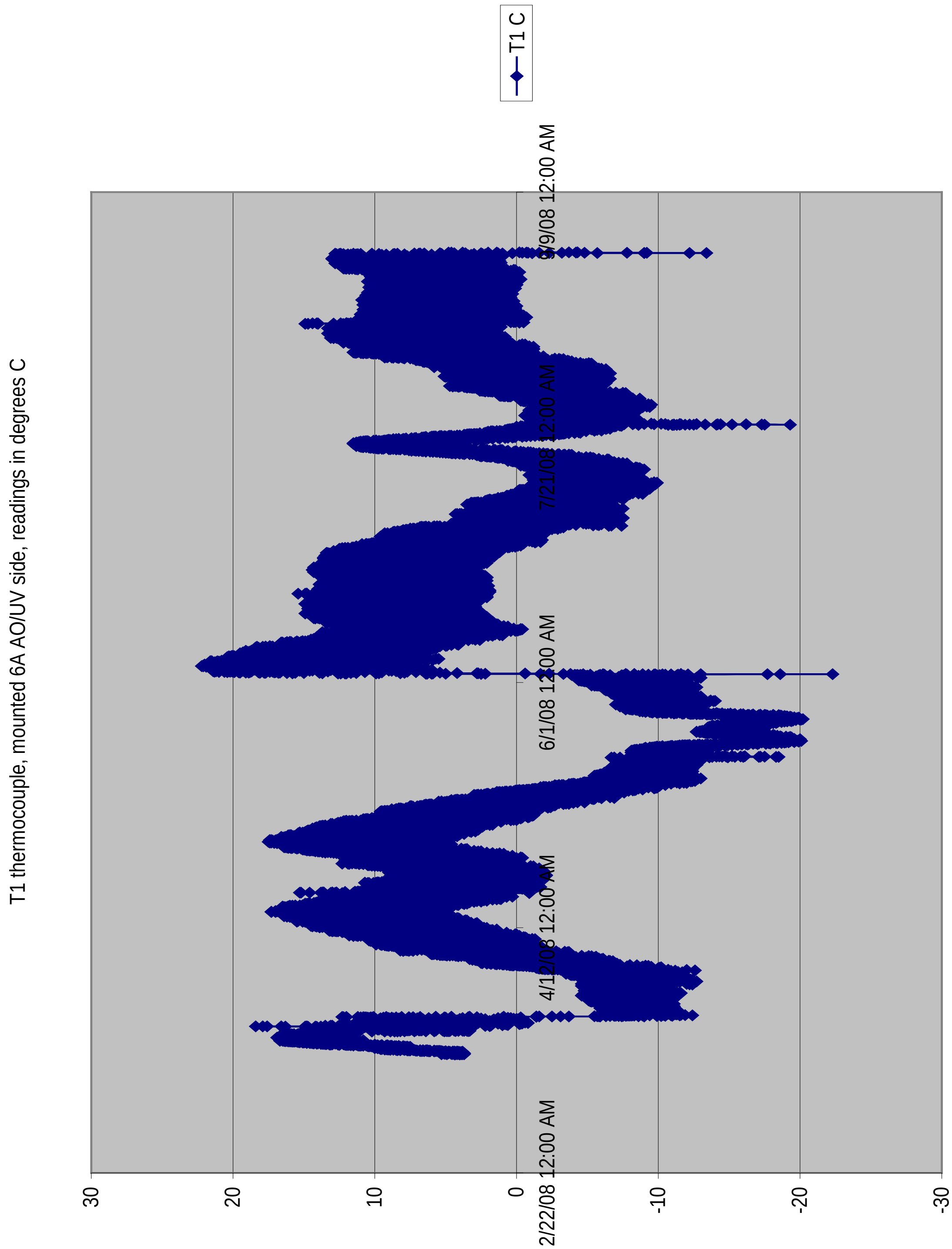


Figure B1 Time-Temperature profile for Thermocouple at T1.

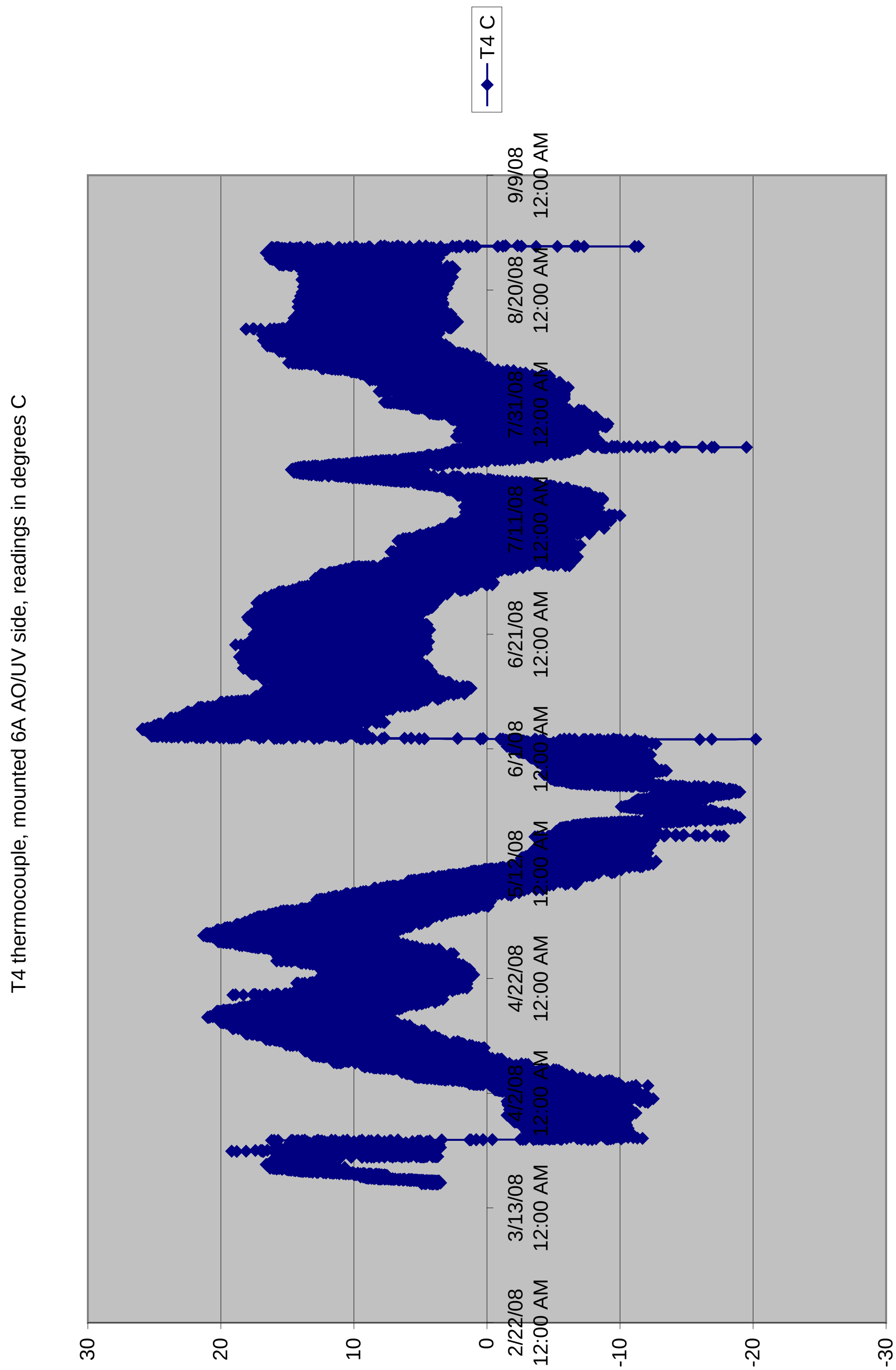


Figure B2 Time-Temperature profile for Thermocouple at T4.

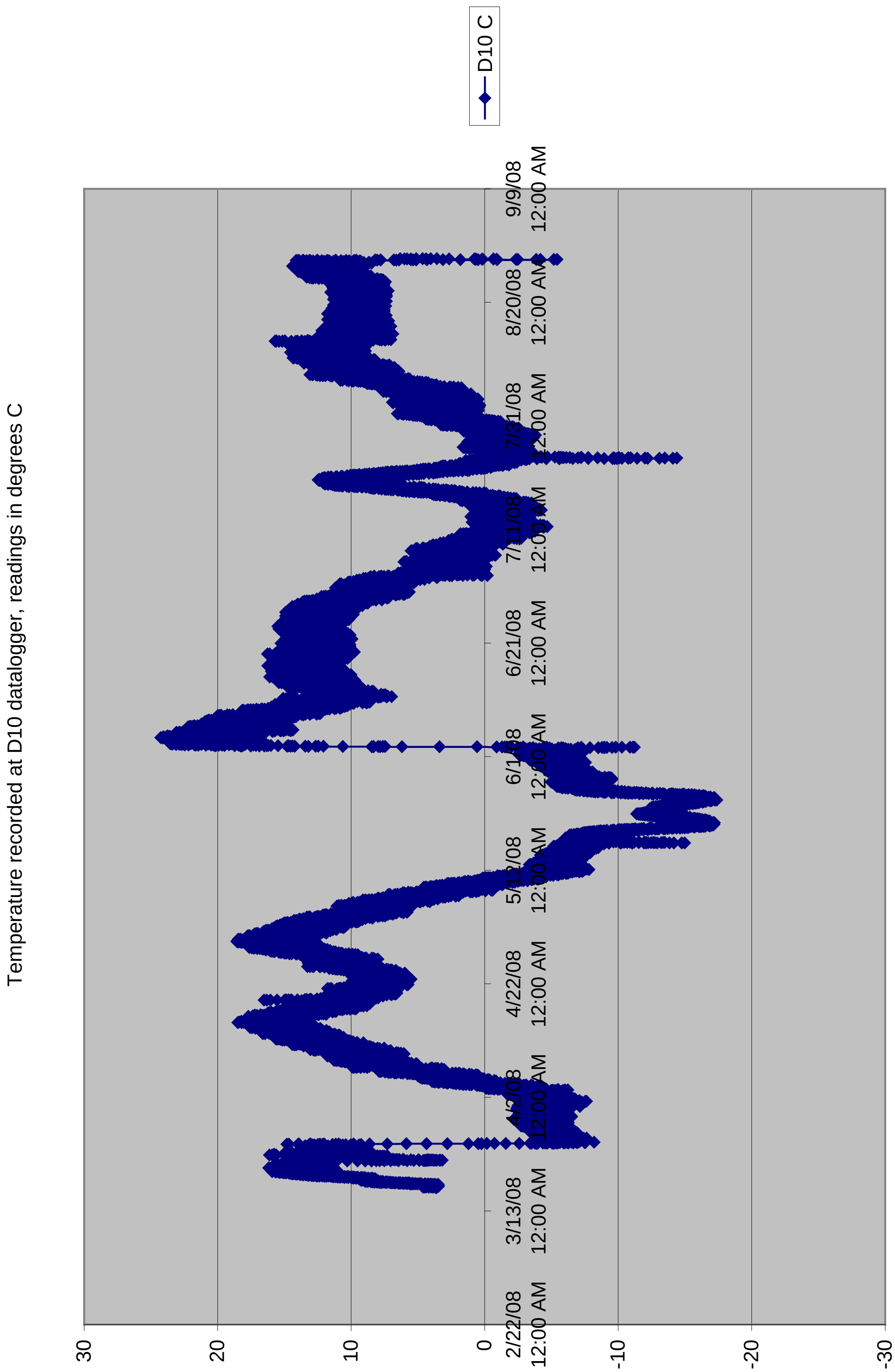


Figure B3 Temperature recorded at datalogger D10.

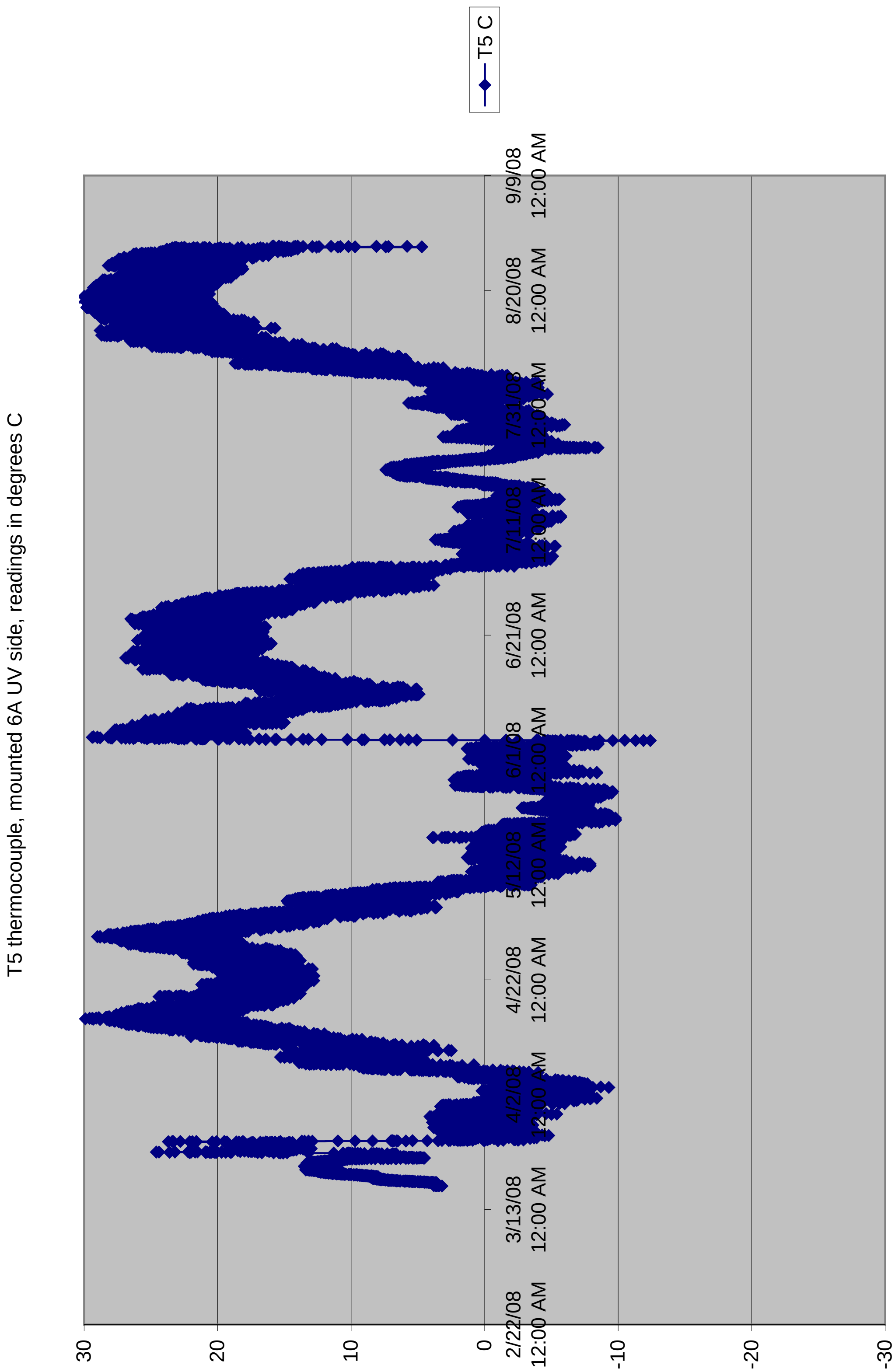


Figure B4 Time-Temperature profile for Thermocouple at T5.

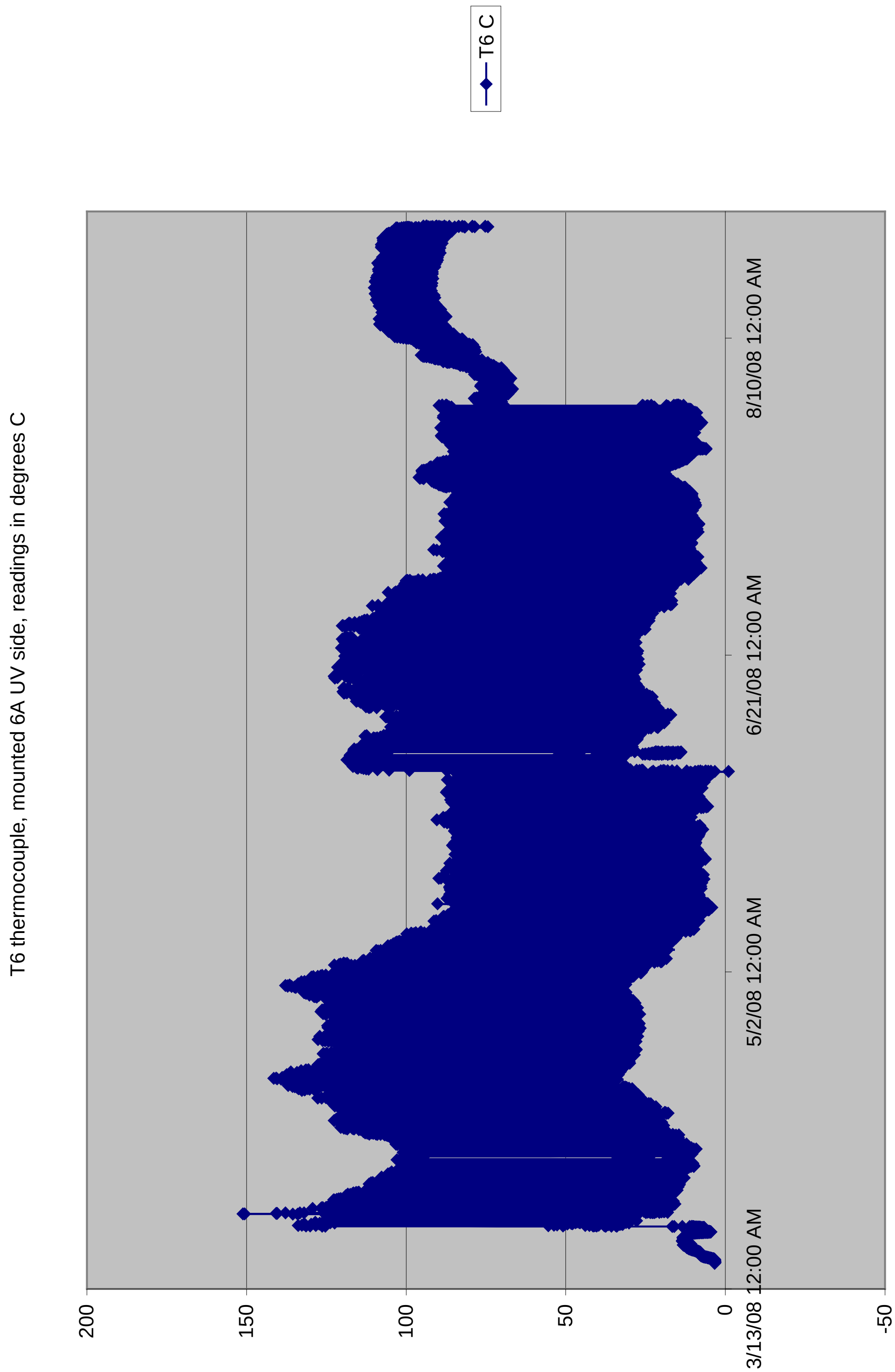


Figure B5 Time-Temperature profile for Thermocouple at T6.

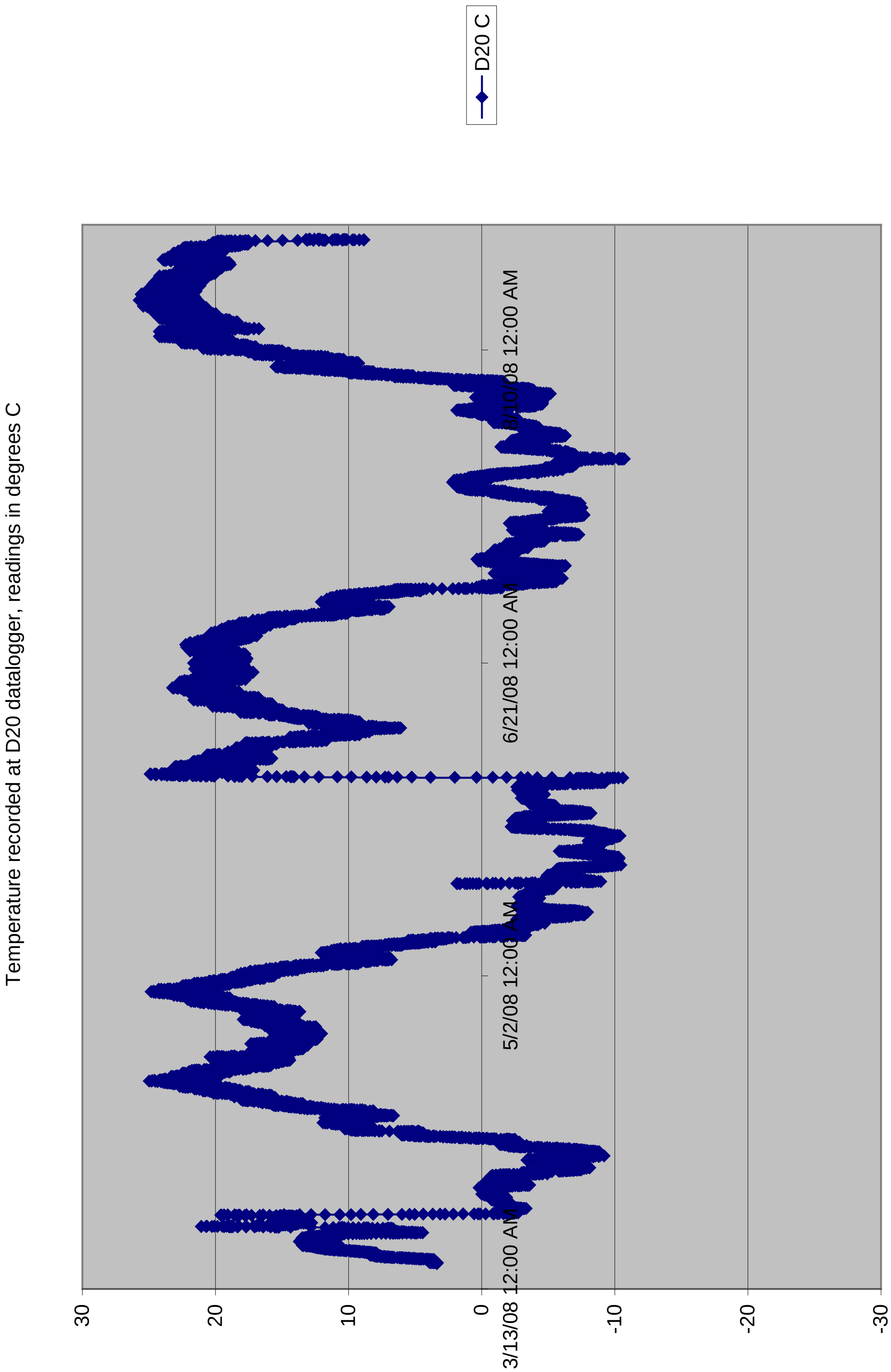


Figure B6. Temperature profile of datalogger D20

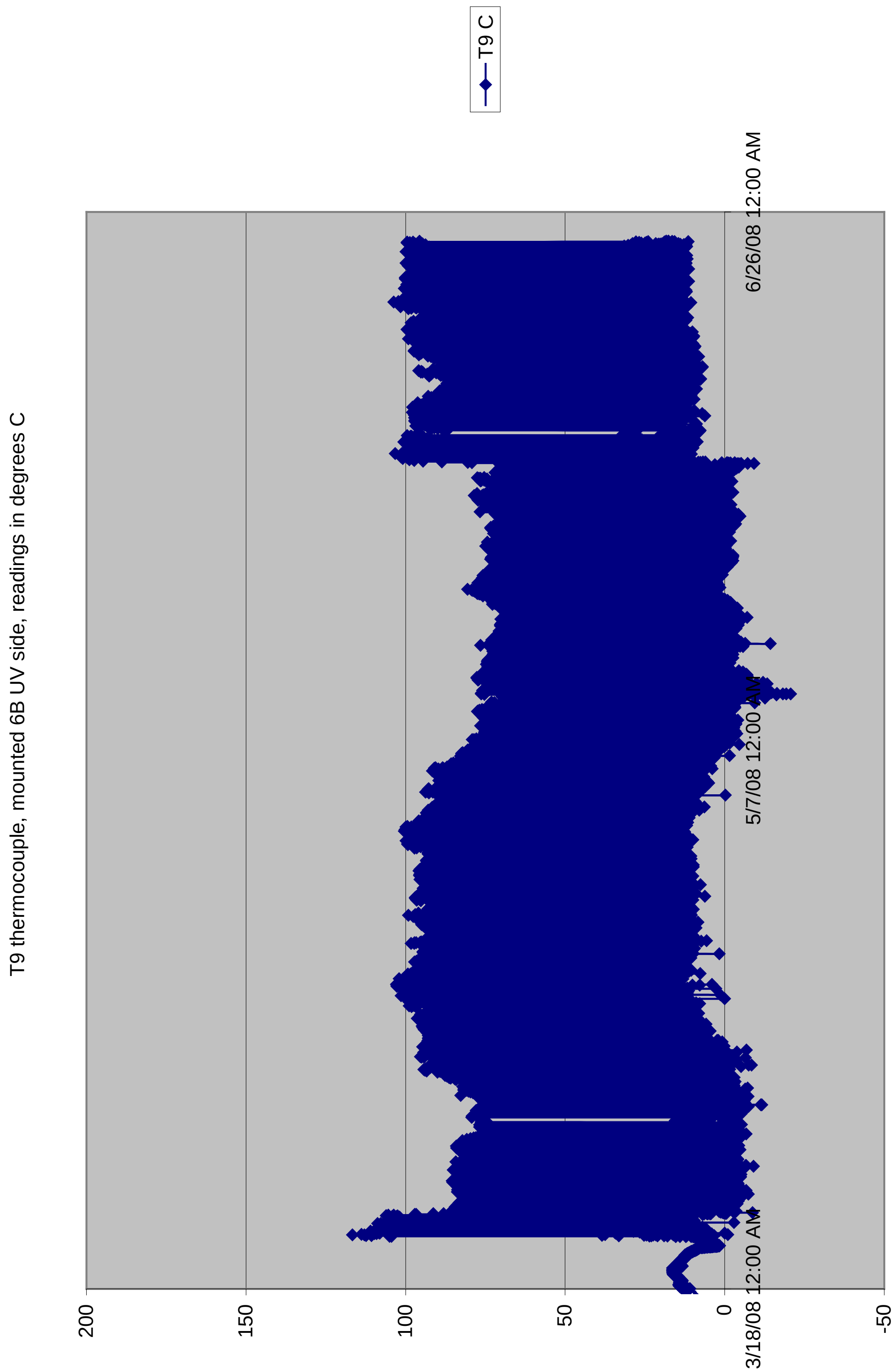


Figure B7 Time-Temperature profile for Thermocouple at T9.

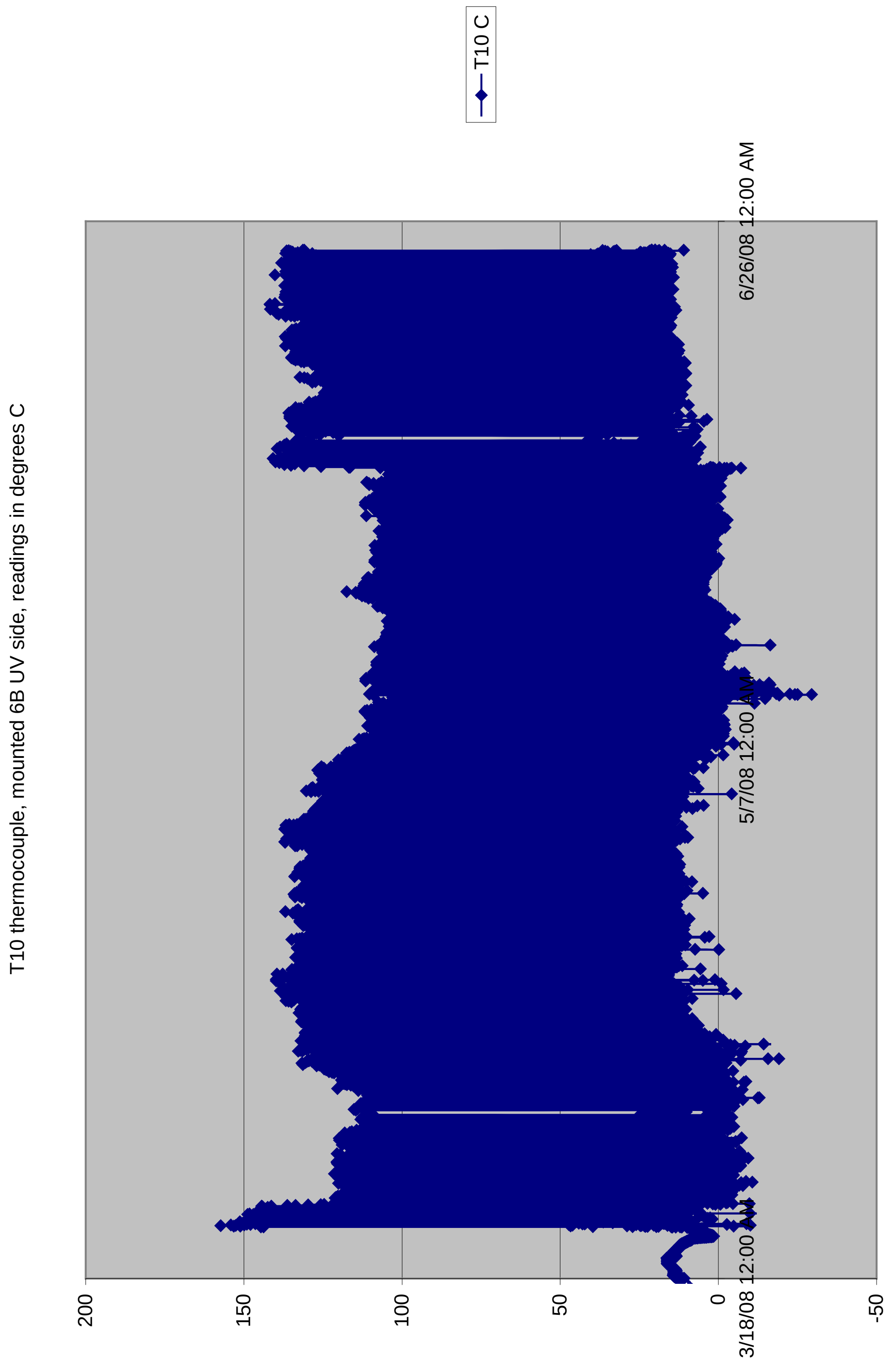


Figure B8 Time-Temperature profile for Thermocouple at T10.

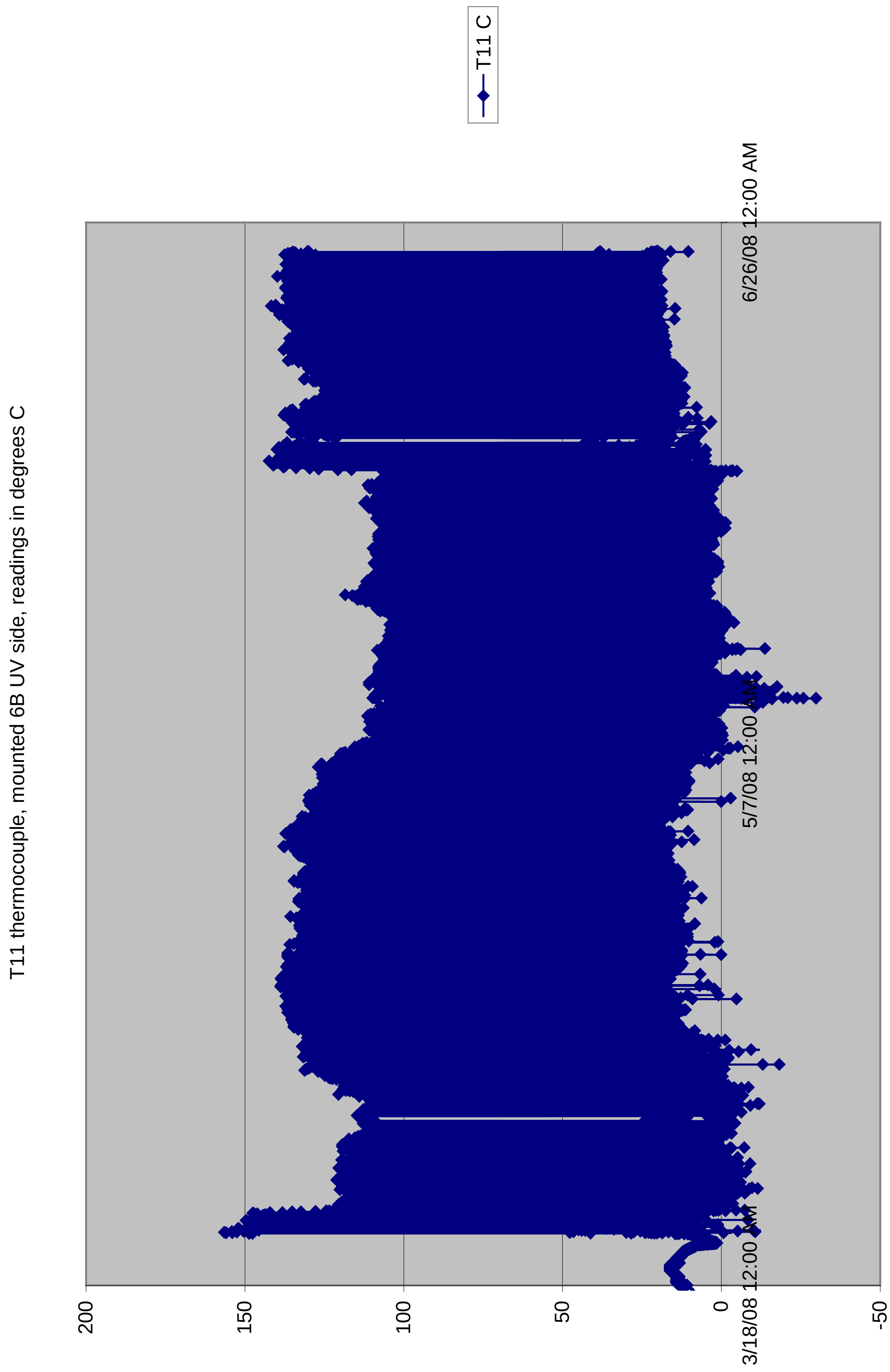


Figure B9 Time-Temperature profile for Thermocouple at T11.

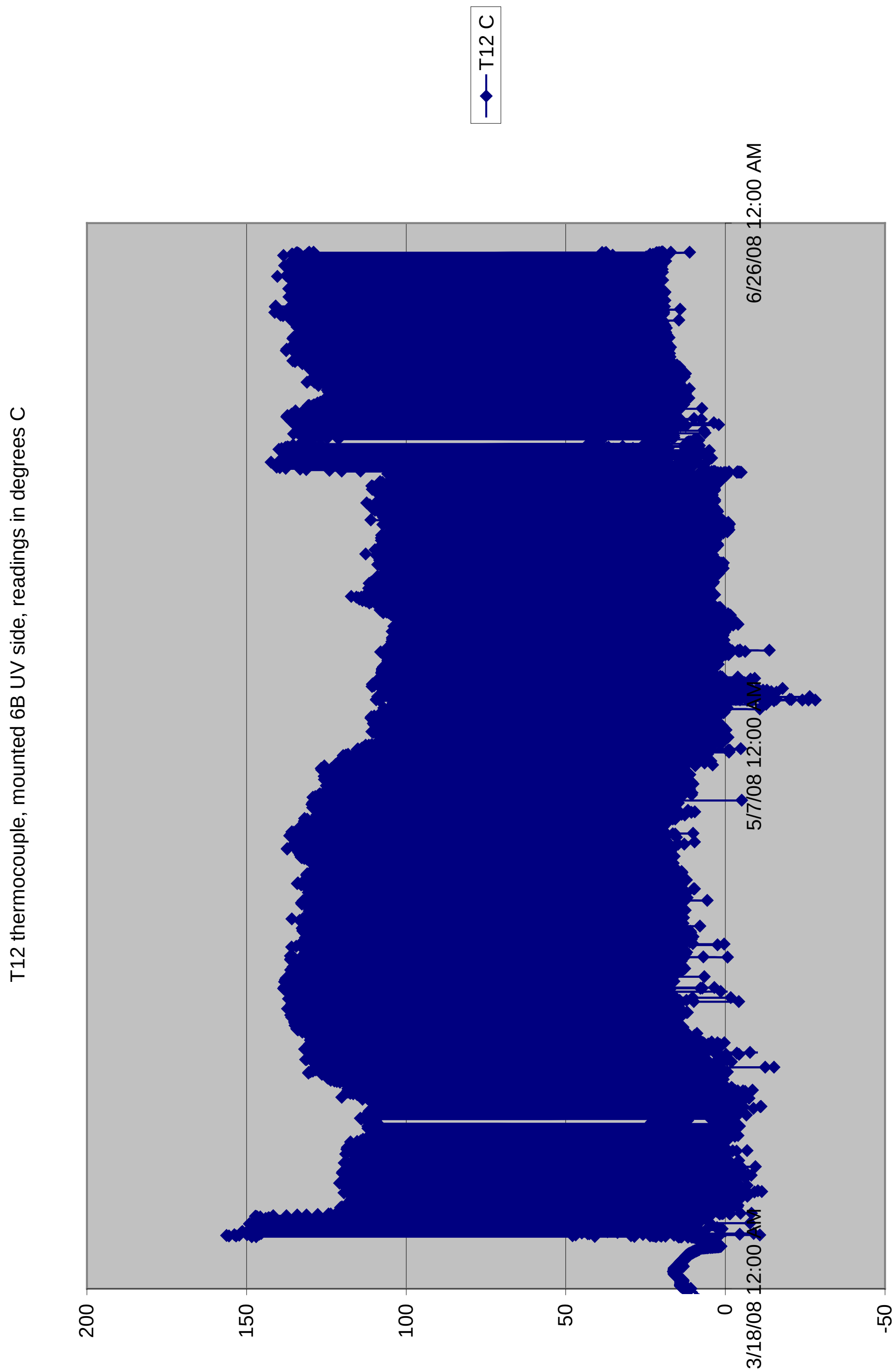


Figure B10 Time-Temperature profile for Thermocouple at T12.

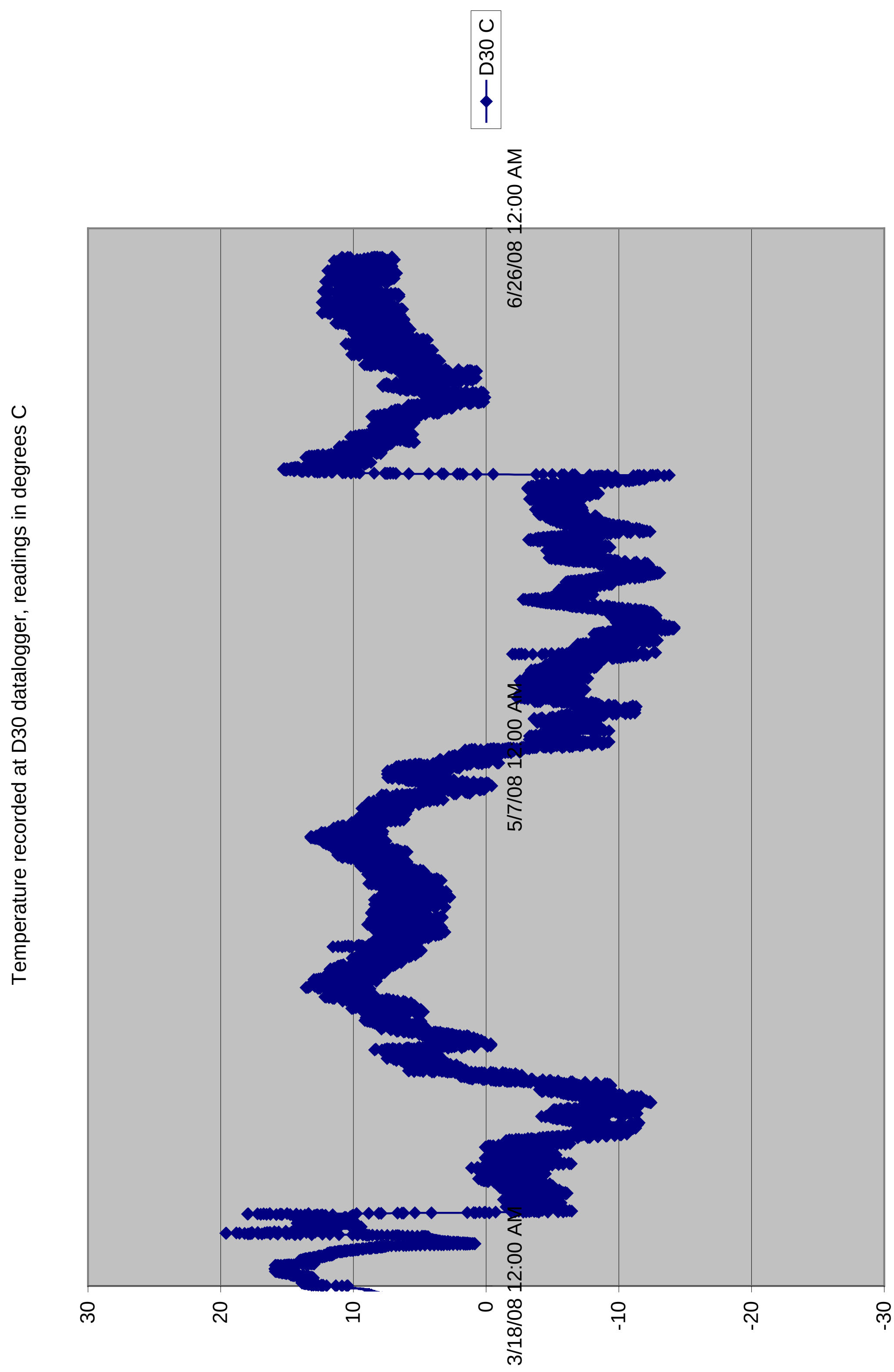


Figure B11. Temperature profile from datalogger D30

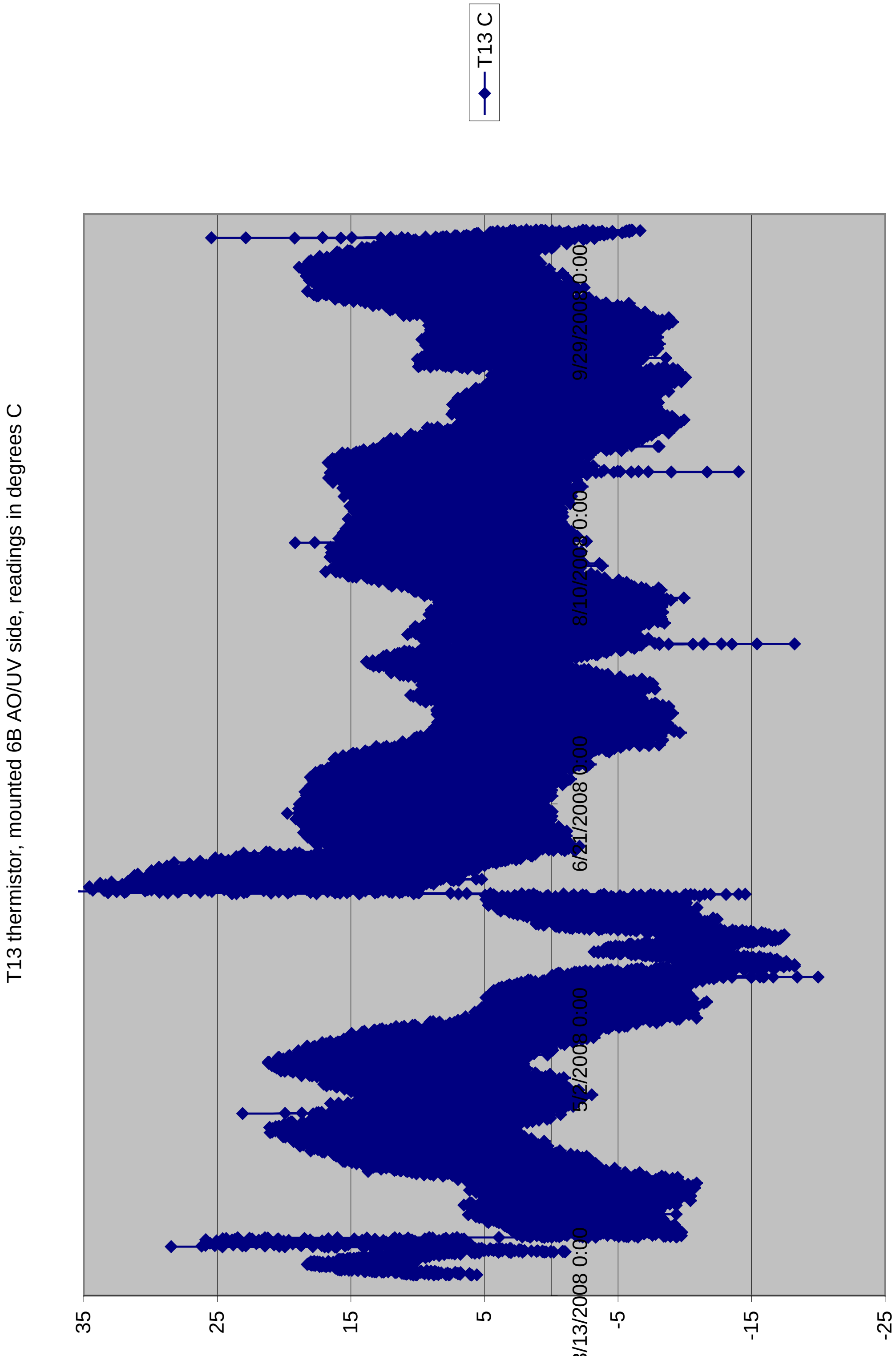


Figure B12 Time-Temperature profile for Thermocouple at T13.

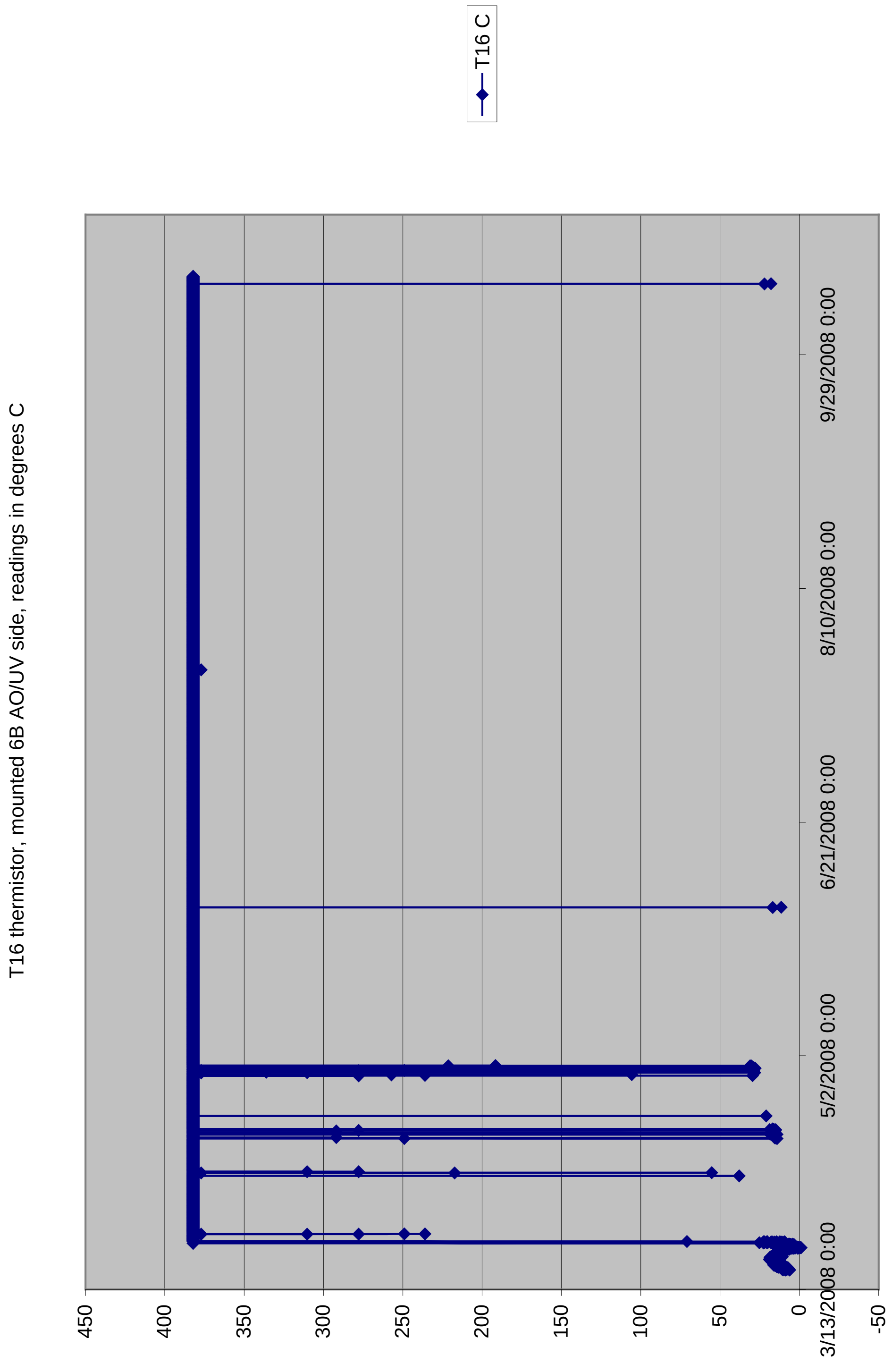


Figure B13 Time-Temperature profile for Thermocouple at T16.

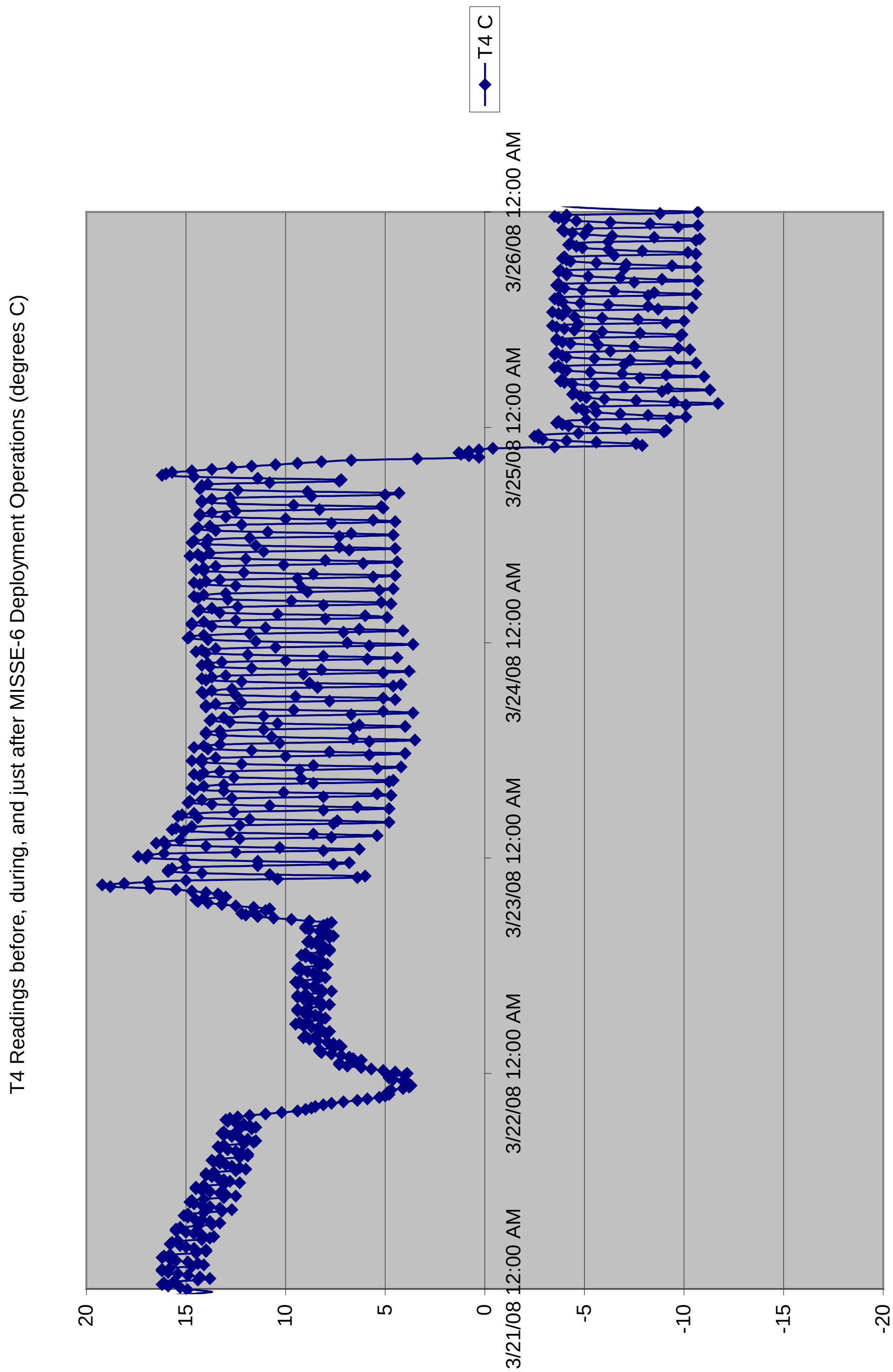


Figure B14 Time-Temperature profile for Thermocouple at T14 around the time of MISSE-6 deployment.

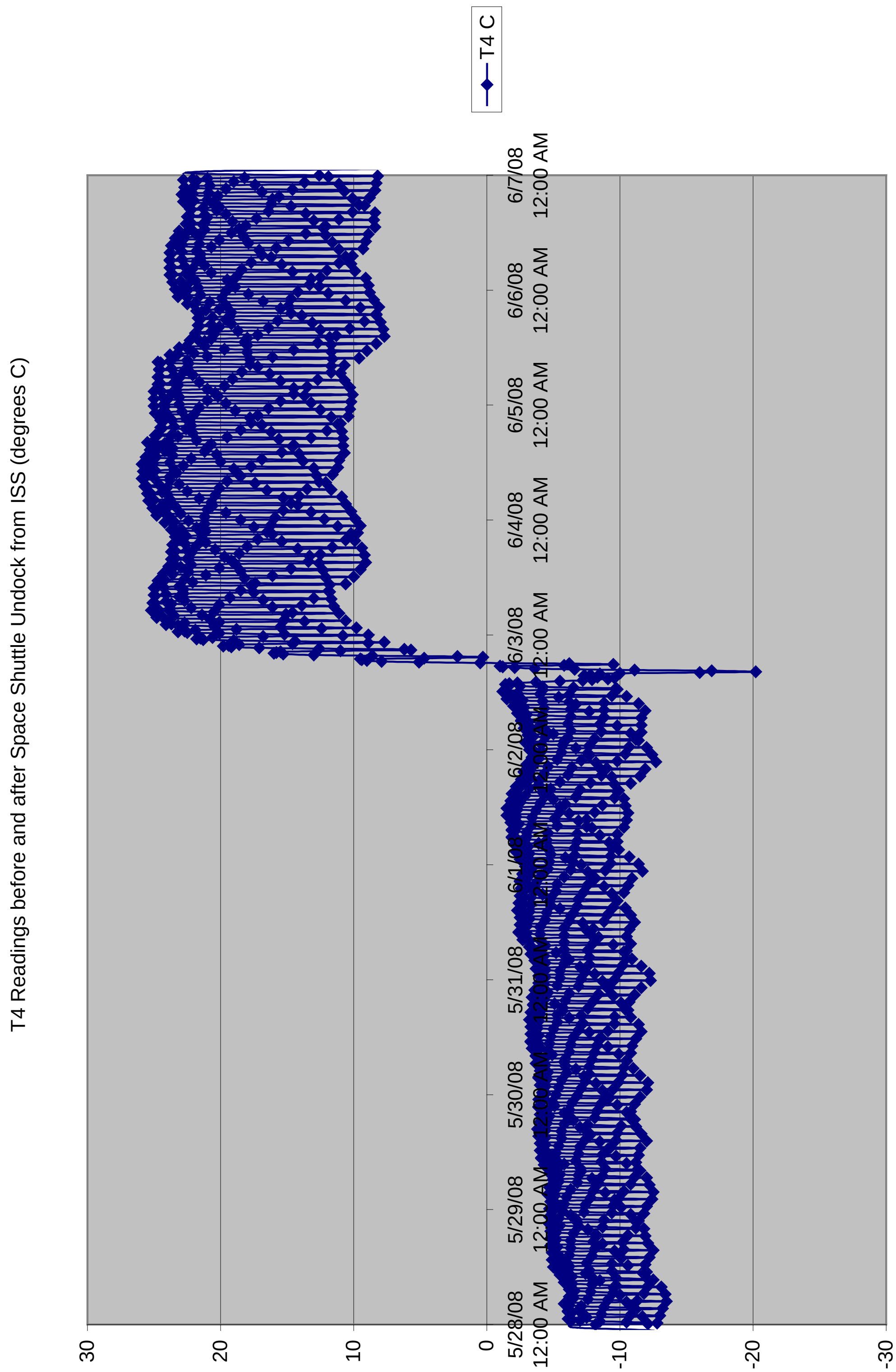


Figure B15 Time-Temperature profile for Thermocouple at T14 just before and just after Space shuttle undocking from ISS.

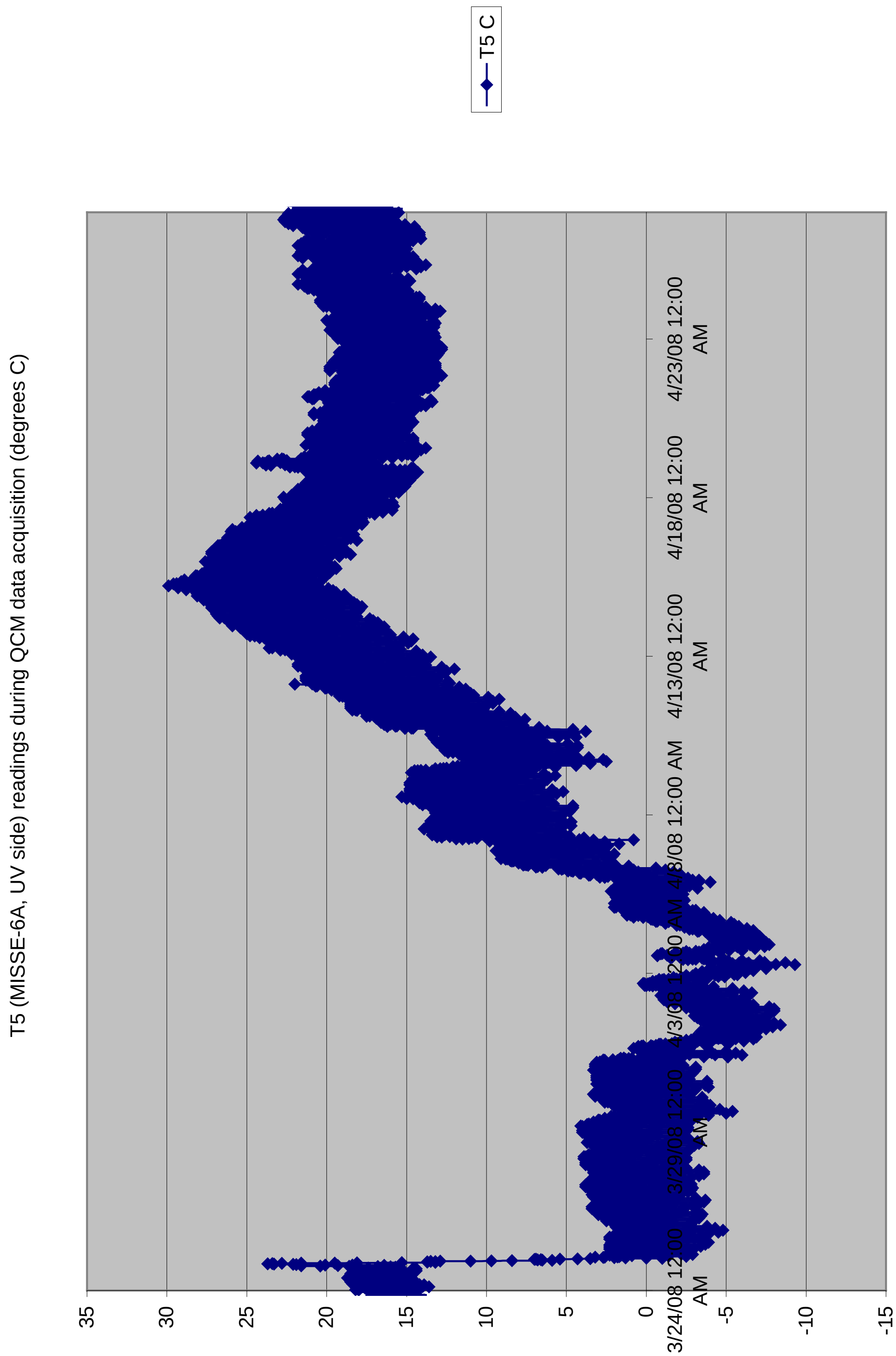


Figure B16 detailed Time-Temperature profile for Thermocouple at T5 during early period of MISSE-6A exposure.

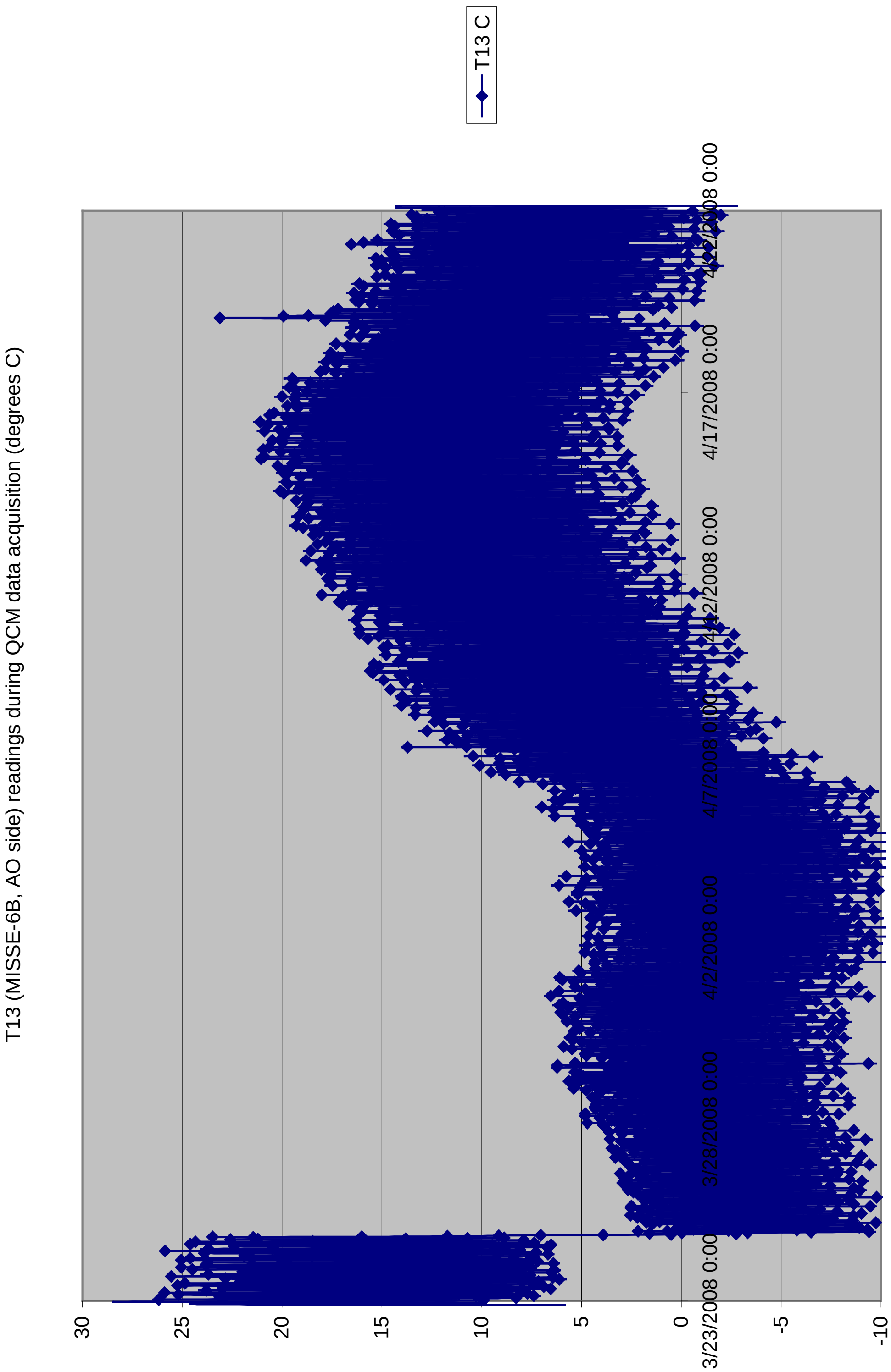


Figure B17 detailed Time-Temperature profile for MISSE-6B Thermocouple at T13.

Appendix C

Atomic Oxygen Calculation Results Summary

	Start dates & times - GMT					ambient AO fluence	Ram-side fluence	wake-side fluence	Shuttle shielding corrections
3	**22**	**2008**	82	21	0	1.92E+19	6.82E-08	1.13E+19	0.00E+00
3	**24**	**2008**	84	22	43	1.43E+20	1.43E+20	6.72E-09	6.72E-09
4	**7**	**2008**	98	8	17	6.77E+17	5.18E+17	5.85E-01	5.85E-01
4	**7**	**2008**	98	9	45	1.26E+20	1.26E+20	1.10E-08	1.10E-08
4	**19**	**2008**	110	4	31	1.08E+20	3.88E+18	3.90E+18	3.90E+18
4	**29**	**2008**	110	5	11	1.80E+20	1.80E+20	3.52E-08	3.52E-08
5	**16**	**2008**	137	19	20	9.14E+17	1.09E-07	8.61E+17	8.61E+17
5	**16**	**2008**	137	21	50	1.55E+20	1.55E+20	3.94E-08	3.94E-08
6	**2**	**2008**	154	18	29	6.69E+19	5.96E-07	6.46E+19	0.00E+00
6	**11**	**2008**	163	10	22	1.69E+20	1.69E+20	2.04E-08	2.04E-08
7	**2**	**2008**	185	0	25	1.08E+17	1.01E+17	1.63E-12	1.63E-12
7	**2**	**2008**	185	0	57	3.77E+20	3.77E+20	1.75E-08	1.75E-08
8	**27**	**2008**	240	14	0	7.28E+17	1.06E-10	7.23E+17	7.23E+17
8	**27**	**2008**	240	16	21	6.28E+19	6.27E+19	6.11E-09	6.11E-09
9	**1**	**2008**	245	19	13	2.30E+17	1.76E+17	1.49E-01	1.49E-01
9	**1**	**2008**	245	19	53	1.25E+20	1.24E+20	5.31E-09	5.31E-09
9	**17**	**2008**	261	16	20	8.91E+17	2.37E-07	8.39E+17	8.39E+17
9	**17**	**2008**	261	18	53	3.58E+20	3.58E+20	3.26E-08	3.26E-08
10	**23**	**2008**	297	23	43	2.90E+17	1.06E+16	1.04E+16	1.04E+16
10	**23**	**2008**	298	0	21	2.62E+20	2.61E+20	1.28E-07	1.28E-07
11	**16**	**2008**	321	23	1	1.14E+20	5.48E-04	1.06E+20	0.00E+00
11	**28**	**2008**	333	13	37	5.60E+20	5.60E+20	3.30E-05	3.30E-05
2	**6**	**2009**	37	3	38	2.40E+17	1.84E+17	1.15E+01	1.15E+01

2	**6**	**2009**	37	4	16	3.56E+20	3.56E+20	9.67E-07	9.67E-07
3	**17**	**2009**	76	21	47	2.53E+19	9.25E-06	2.53E+19	0.00E+00
3	**20**	**2009**	79	14	13	4.07E+18	1.63E+17	1.55E+17	1.55E+17
3	**20**	**2009**	79	0	18	1.76E+19	1.33E-06	1.67E+19	0.00E+00
3	**22**	**2009**	81	20	0	1.49E+18	1.49E+18	4.40E-10	4.40E-10
3	**22**	**2009**	81	23	35	2.79E+19	3.25E-06	2.64E+19	0.00E+00
3	**25**	**2009**	84	18	39	1.62E+20	1.62E+20	5.17E-07	5.17E-07
4	**8**	**2009**	98	3	22	3.25E+17	1.25E+16	1.25E+16	1.25E+16
4	**8**	**2009**	98	4	0	2.82E+20	2.82E+20	2.82E-06	2.82E-06
5	**6**	**2009**	126	14	45	3.27E+17	1.26E+16	1.26E+16	1.26E+16
5	**6**	**2009**	126	15	23	4.79E+20	4.79E+20	7.30E-06	7.30E-06
6	**30**	**2009**	181	17	57	1.88E+17	6.87E+15	6.70E+15	6.70E+15
6	**30**	**2009**	181	18	35	1.88E+18	1.88E+18	8.72E-09	8.72E-09
7	**1**	**2009**	0	0	0	1.71E+19	1.71E+19	8.01E-08	8.01E-08
7	**2**	**2009**	183	20	51	3.90E+17	3.66E+17	1.18E-06	1.18E-06
7	**2**	**2009**	183	21	48	7.56E+16	9.33E+15	3.01E+14	3.01E+14
7	**2**	**2009**	183	22	5	9.07E+19	9.07E+19	2.81E-07	2.81E-07
7	**12**	**2009**	193	15	0	9.03E+17	6.69E+16	1.26E+16	1.26E+16
7	**12**	**2009**	193	17	16	4.71E+19	4.71E+19	5.00E-08	5.00E-08
7	**17**	**2009**	198	18	15	1.04E+20	1.88E-05	9.86E+19	0.00E+00
7	**28**	**2009**	209	16	8	2.74E+20	2.74E+20	0.00E+00	0.00E+00
8	**18**	**2009**	230	5	11	2.62E+20	2.62E+20	3.32E-02	3.32E-02
9	**1**	**2009**	243	1	11	1.10E+19	1.40E+15	3.04E+18	0.00E+00
						5.00E+21	**4.49E+21**	**3.58E+20**	**6.53E+18**