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Self-contained, freely-drifting Swallow floats capable of recording very low frequency (VLF) ambient ocean noise are under development at the Marine Physical Laboratory, Scripps Institution of Oceanography, San Diego, California. The floats are ballasted to neutral buoyancy at midwater depth where they record the components of particle velocity from which sound pressure levels may be derived. A high frequency acoustic mutual interrogation system may be used to determine relative float positions. During an experiment conducted between 9 and 13 September 1985 approximately 150 miles southwest of San Diego, five Swallow float buoys were deployed to depths of 1100 to 3600 meters over a 48 hour period. This Technical Memorandum reports preliminary results of that experiment.

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MARINE PHYSICAL LABORATORY
of the Scripps Institution of Oceanography
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ABSTRACT

Self-contained, freely-drifting Swallow floats capable of recording very low frequency (VLF) ambient ocean noise are under development at the Marine Physical Laboratory, Scripps Institution of Oceanography, San Diego, California. The floats are ballasted to neutral buoyancy at midwater depth where they record the components of particle velocity from which sound pressure levels may be derived. A high frequency acoustic mutual interrogation system may be used to determine relative float positions. During an experiment conducted between 9 and 13 September 1985 approximately 150 miles southwest of San Diego, five Swallow float buoys were deployed to depths of 1100 to 3600 meters over a 48 hour period. This Technical Memorandum reports preliminary results of that experiment.

Introduction

Under Office of Naval Research sponsorship, the Marine Physical Laboratory has been involved in the design, fabrication and testing of prototype, self-contained Swallow floats which can record very low frequency (VLF) ambient ocean noise over extended periods of time. In operation, the floats may be ballasted to neutral buoyancy at a desired depth or deploy to the ocean bottom. Once deployed, the floats operate autonomously to measure and record the components of particle velocity in the 1 - 10 Hz band. They generate and receive high frequency acoustic signals which may be used to determine their relative positions. The deployment of several floats forms a freely drifting array of sensors.

The Swallow float design minimizes self-noise which can limit accurate ambient ocean noise measurements. The untethered floats do not experience flow noise or cable strumming. They measure particle velocity and are thus insensitive to variations in local pressure. Spectrum levels from one Swallow float deployed to 1400 meters 50 miles west of San Diego in July 1983 have been shown to agree closely with omni-directional hydrophone measurements acquired at 1200 meters near Eleutheria Island in 1980 and reported by R. H. Nichols.[1,2]

The Swallow float acoustic positioning system has been shown to provide an adequate means of estimating buoy depth and interbuoy ranges as functions of time.[3] System measurement error may be as low as ±0.75 meters once the buoys are at deployment depth and the interelement range is changing smoothly.

MPL has conducted Swallow float deployments annually since 1982. This technical memorandum reports preliminary results from the most recent deployment, made between 9 and 13 September 1985 approximately 150 miles southwest of San Diego, California (31°45′ N, 119°50′ W) in which three floats were deployed to about 1000 meters. Two other floats were deployed to the ocean bottom (3600 meters) to serve as reference points for the acoustical positioning system. Details of the floats operation and data recording have been published previously and are not repeated.[1,3,4]

Based upon these preliminary results, the Swallow floats appear to be operating generally well. Acoustic positioning system data seem reasonable and capable of being used to determine time varying float positions. Velocity sensor data seem to provide useful information about the ocean ambient noise field despite problems which include a dead y axis channel in float 2, y axis amplifier oscillation in most of the floats, and 1 Hz and harmonics self-noise evident in all floats whenever signal level is low. These problems are thought to have been solved since the September deployment.

I. Narrative Summary

On 9 September 1985, 6 MPL personnel and 6 Swallow floats embarked aboard the 109′ seismic survey vessel *Seamark*, leased from NEKTON, Inc., berthed at the University of California's Nimitz Marine Facility in San Diego. The intended deployment site, 31°45′ N, 119°50′ W, lay some 150 miles to the southwest, about 18 hours steaming for the *Seamark*. The trip was part of ongoing engineering development sponsored by the Office of Naval Research and directed at measuring ambient noise in the very low frequency (1 - 20 Hz) band. A brief narrative of events comprising the experiment is given below, and Figure 1.1 contains a summary of entries from the experiment logbook.

The group arrived on station early on 10 September to find 6′ seas and 10 kt winds. Water depth was about 3600 meters. As the floats were checked out prior to being put in the water, floats 0 and 2 were found to have problems. The remaining 4 floats, 1, 3, 4 and 5, checked out normally and were initialized synchronously at 1130.

Ballast had been attached to the floats before leaving San Diego. Four floats were ballasted to be neutrally buoyant at 1000 meters, while heavy weights were attached to 2 others so that they would deploy to the ocean bottom. Table 1.1 shows the depths for which particular floats were ballasted.

At about noon, deployment of the floats began. Within an hour, the four working floats were in the water and on their way to depth. Figure 1.2 shows the deployment area and indicates the positions at which floats were deployed and later recovered. Within a short time, float 1 inexplicably dropped its ballast weight and returned to the surface. The float was recovered, repaired and redeployed at 1440.

Float	Ballasted Depth (meters)
0	bottom
1	1000
2	1000
3	1000
4	bottom
5	1000

Table I.1: Ballast depth settings.

Next, problems with float 0 were isolated and repaired. The float was initiallized at 1806, exactly 396 minutes after the other 4 floats.* At 1811, float 0 was deployed.

Between 1950 and 2123 that evening, float positions were surveyed from the ship by sending out interrogation pulses which trigger the floats to respond with another pulse, and measuring the total elapsed time. Six seal bombs were exploded at known times and locations during the position survey. Soon after the survey started, float 1 was again detected on the surface and recovered. A decision was made to forego attempts to repair float 1 and instead

*The floats record data in 1.5 minute blocks, and the 6 floats take turns emitting an acoustic positioning pulse during each record. Float 4 was started (44 x 1.5 x 6 =) 396 minutes after the first four so that it would transpond at the right time.

concentrate on repairing float 2 and attempt to deploy it the next day. Float 1 therefore did not participate in the deployment and its short data record is not included in this report. MPL personnel set to work to repair float 2. The ship steamed through the night at 3 kts in the general vicinity of the deployed array.

The next morning, Wednesday, 11 September, seas were 6′ to 8′ and the winds were at 15 kts. Float 2 was initiallized at 0718, 1188 minutes after floats 3, 4 and 5 and deployed at 0833.** Two float position surveys were made later in the day and three seal bombs were exploded at known times and positions. During the night the ship steamed generally northwest of the deployed array at 3 kts.

On Thursday, 12 September, the group rose early to begin retrieving floats. Seas were observed at 8′ to 12′ with occasional sets to 16′. Winds were gusting to 25 kts. It was discovered that the tranducer suspended from the ship and used to communicate with the floats had broken loose and been lost during the night. Fortunately, a spare had been packed and was installed.

The day was spent recalling and recovering floats one at a time, beginning with the floats at 1000 meters. Ascent from 1000 meters took about 1.5 hours, and from the bottom, about 3 hours. By 1600 the last float was aboard and the ship got underway for San Diego.

Laboratory inspection revealed that all floats had maintained their watertight integrity. Data from the float tapes were transferred to another computer for analysis.

**Note that 132 x 1.5 x 6 = 1188.

Summary of Log Book Entries, 9 - 13 September 1985

9 September

0800-1200	Loaded equipment and supplies aboard the 109′ seismic survey vessell *Seamark*, leased from NEKTON, Inc., berthed at Nimitz Marine Facility pier, San Diego, Ca.
1300	Underway for intended deployment site, 31°45′ N, 119°50′ W, approximately 150 miles southwest of San Diego.

10 September

0800	Arrive on station. Seas 6′, wind 10 kts.
1130	Synchronize floats 1, 3, 4 and 5. Normal predeployment checks revealed problems with floats 0 and 2. Floats 1, 2, 3, and 5 were ballasted to be neutrally buoyant at about 100 meters depth. Floats 0 and 4 were ballasted to deploy to the ocean bottom.
1157	Float 1 deployed at 31°44.83′ N, 119°50.29′ W.
1218	Float 3 deployed at 31°44.70′ N, 119°49.94′ W.
1248	Float 4 deployed at 31°44.53′ N, 119°49.75′ W.
1308	Float 5 deployed at 31°44.38′ N, 119°50.26′ W.
1325	Float 1 detected on the surface and recovered.
1440	Float 1 redeployed with new ballast weights at 31°44.83′ N, 119°50.29′ W.
1713	Fathometer and propulsion noise from another ship detected. No sighting.
1806	Resynchronized float 0 396 minutes (264 records) after original synchronization.
1811	Float 0 deployed at 31°45.00′ N, 119°49.95′ W.
1950-2123	Surveyed float positions using active interrogation pulses at 16 second intervals.
2000	Seal bomb exploded at 31°44.02′ N, 119°49.49′ W.
2001	Seal bomb exploded at 31°44.02′ N, 119°49.49′ W.
2020	Float 1 detected on the surface and recovered.
2059	Seal bomb exploded at 31°44.87′ N, 119°49.45′ W.
2102	Seal bomb exploded at 31°45.03′ N, 119°49.45′ W.
2125	Seal bomb exploded at 31°44.64′ N, 119°50.74′ W.
2136	Seal bomb exploded at 31°43.46′ N, 119°50.76′ W.
2300	Position: 31°43.42′ N, 119°50.48′ W. Underway throughout the night in the general vicinity of the array. Shaft rate: 1000 RPM. Propeller has 4 blades.

11 September

0702	Position: 31°45.68′ N, 119°52.78′ W Seas 6′ to 8′, wind 15 kts.
0718	Resynchronized float 2 1188 minutes (792 records) after original synchronization.
0740-0758	Support ship speed increased.
0746-0839	Surveyed float positions using active interrogation pulses at 16 second intervals.
0833	Float 2 deployed at 31°43.66′ N, 119°50.14′ W.

Figure I.1

1249-1512	Surveyed float positions using active interrogation pulses at 16 second intervals.
1427	Seal bomb exploded at 31°44.29′ N, 119°47.06′ W.
1428	Seal bomb exploded at 31°44.43′ N, 119°47.07′ W.
1452	Seal bomb exploded at 31°44.85′ N, 119°48.62′ W.
1500	Underway throughout the night, remaining generally northwest of the array.

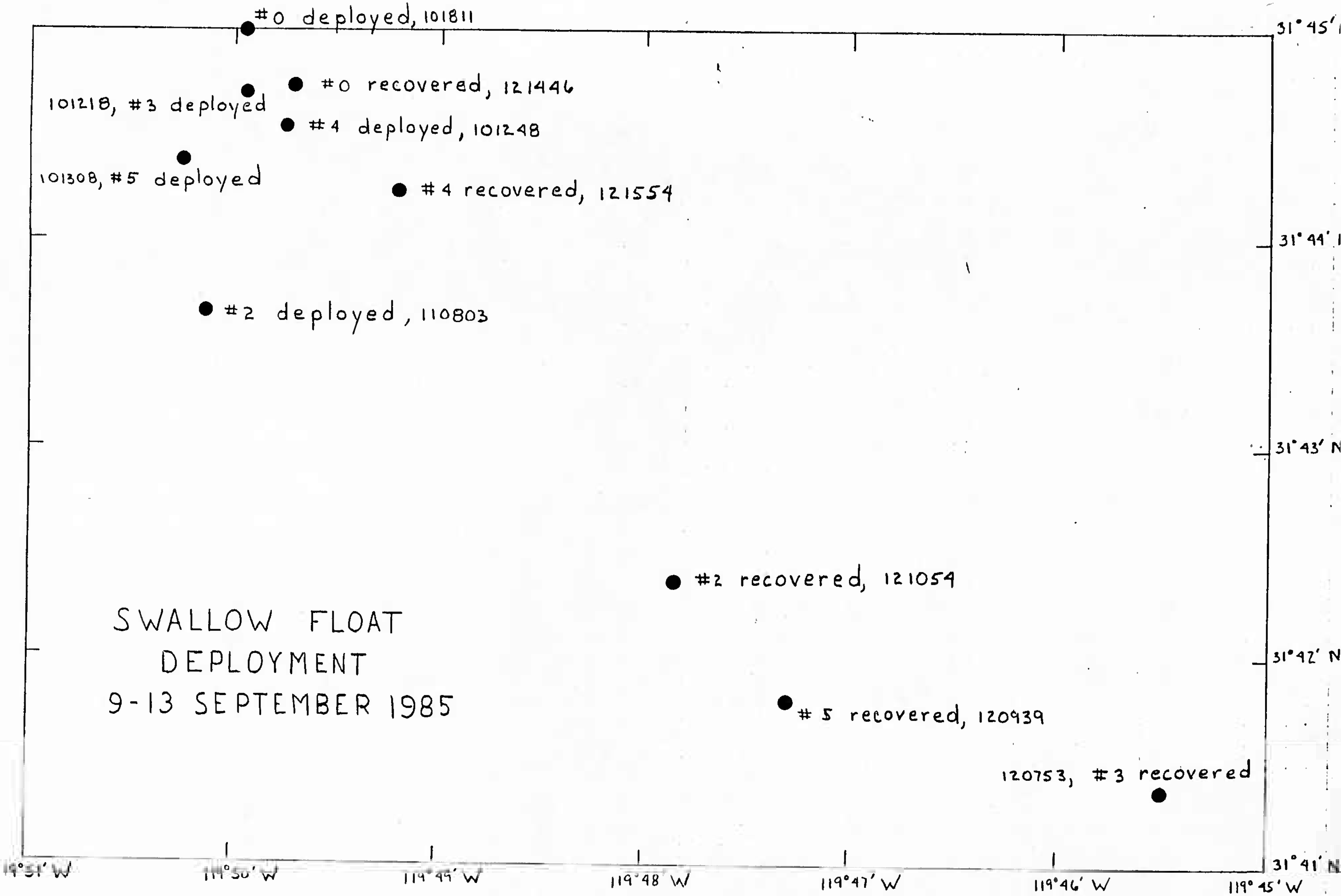
12 September

0415	Position: 31°46.58′ N, 119°46.01′ W. Seas 8′ to 12′, with occassional sets to 16′. Wind gusts to 25 kts. Discovered that the acoustic transponder had broken loose during the night and was lost.
0530	Spare transducer installed and operational.
0604-1544	Manuevering to recover floats. Surveying float positions using active interrogation pulses at 16 second intervals.
0627	Position: 31°41.44′ N, 119°45.81′ W. Float 3 commanded to release its ballast.
0753	Float 3 recovered at 31°41.37′ N, 119°45.50′ W.
0814	Float 5 commanded to release its ballast.
0939	Float 5 recovered at 31°41.79′ N, 119°47.30′ W.
0950	Float 2 commanded to release its ballast.
1054	Float 2 recovered at 31°42.36′ N, 119°47.86′ W.
1136	Float 0 commanded to release its ballast.
1236	Float 4 commanded to release its ballast.
1446	Float 0 recovered at 31°44.73′ N, 119°49.71′ W.
1544	Float 4 recovered at 31°44.23′ N, 119°49.29′ W.
1600	Underway for San Diego.

13 September

1000	Arrive San Diego.

Figure I.1



#0 deployed, 101811
#0 recovered, 121446
101218, #3 deployed
#4 deployed, 101248
101308, #5 deployed
#4 recovered, 121554
#2 deployed, 110803
#2 recovered, 121054
SWALLOW FLOAT
DEPLOYMENT
9-13 SEPTEMBER 1985
#5 recovered, 120939
120753, #3 recovered
31°44'
31°43' N
31°42' N
31°41' N
119°49' W
119°48' W
119°47' W
119°46' W
119°45' W

Figure I.2

II. General Indication of Data Integrity

Tape quality may be assessed in a general way by inspecting each 1.5 minute record for the presence of resync characters and verifying checksums. Figure II.1 shows record format. The first nine bytes form the header subrecord, which may be verified with a checksum. The range subrecord which follows starts with a 3 byte resync character. The remainder of the range subrecord may be verified with a checksum located at bytes 524 and 525. The remaining 7120 bytes in the record comprise the acoustic subrecord and include 89 resync characters and checksums.

Table II.1 shows the number of records on each of the Swallow float tapes. The first 263 records on float 0's tape relate to its resynchronization at 1806 on 10 September and should be ignored. The other floats have 1 to 3 records at the front which were used during checkout and should be ignored. In each case, the last record marks the end of the useable data segment.

Float	# of records on tape	ignore first how many?	last good record
0	2031	263	2001
2	1113	3	1112
3	1814	1	1813
4	1969	1	1955
5	1848	2	1847

Table II.1: Swallow float tape length

Figures II.2 through II.6 list those records on each float tape which are missing resync characters or which contain checksum errors. The internal record number is taken from the the first two bytes of the record (see Figure II.1). The number of bytes written indicates how many bytes were read from the Swallow float tape. The first missing resync will be 0 if all 90 are present. All records will have at least 1 failed acoustic checksum because transferring data from the Swallow float tape removes the last 4 bytes, 2 of which are data and 2 of which are a checksum. Trailing records with 0 bytes written were also added during the data transfer and are of no consequence.

Information in Figures II.2 through II.6 can be combined with information in table II.1 to determine data quality. For example, the float 0 tape contains useable data in records 264 to 2001 (table II.1), of which all but 429 and 430 passed all checksum tests (Figure II.2). Tapes 0, 2, 4 and 5 look very good, their useable data sections containing only 2 or 3 bad records. Tape 3 contains many bad records, apparently due to the capstan slippage problem reported earlier.[1]

0	RECORD # (LB)	H
	RECORD # (HB)	E
	AGC CODE	A
	COMPASS	D
	BUOY ID	E
	BATTERY	R
	SPARE	
	CHECKSUM (LB)	
	CHECKSUM (HB)	
9	RESYNC (AA)	
	RESYNC (AA)	
	RESYNC (01)	
12	RANGE INDEX 1	R
	DETECTION	A
	TIME (LB)	N
	TIME (HB)	G
	DETECTION	E
	TIME (LB)	
	TIME (HB)	P
	|	U
	|	L
	DETECTION	S
	TIME (LB)	E
	TIME (HB)	
268	RANGE INDEX 2	D
	DETECTION	A
	TIME (LB)	T
	TIME (HB)	A
	DETECTION	
	TIME (LB)	
	TIME (HB)	
	|	
	|	
	DETECTION	
	TIME (LB)	
	TIME (HB)	
	CHKSUM (LB)	
525	CHKSUM (HB)	

526	RESYNC (AA)	V
	RESYNC (AA)	L
	RESYNC (01)	F
	CHAN X	
	CHAN Y	A
	CHAN Z	C
	CHAN X	O
	CHAN Y	U
	CHAN Z	S
	|	T
	|	I
	CHECKSUM (LB)	C
	CHECKSUM (HB)	
606	RESYNC (AA)	D
	RESYNC (AA)	A
	RESYNC (01)	T
	CHAN X	A
	CHAN Y	
	CHAN Z	
	|	
	|	
	CHECKSUM (LB)	
7645	CHECKSUM (HB)	
		G
		A
		P
0	RECORD # (LB)	
	|	N
	|	E
	|	X
	|	T
	|	
	|	R
	|	E
	|	C
	|	O
	|	R
	|	D

Figure II-1

Results of screening sf0.dat

record number	internal record number	# of bytes written	first missing resync	pass header checksum?	pass range checksum?	# of failed acoustic checksum?
1	****	5404	1	no	no	61
3	****	7676	1	no	no	89
7	200	4324	1	no	no	49
429	165	6764	0	yes	yes	1
430	****	180	1	no	no	1
2002	1736	0	0	yes	yes	1
2003	1736	0	0	yes	yes	1
2004	1736	0	0	yes	yes	1
2005	1736	0	0	yes	yes	1
2006	1736	0	0	yes	yes	1
2007	1736	0	0	yes	yes	1
2008	1736	0	0	yes	yes	1
2009	1736	0	0	yes	yes	1
2010	1736	0	0	yes	yes	1
2011	1736	0	0	yes	yes	1
2012	1736	0	0	yes	yes	1
2013	1736	0	0	yes	yes	1
2014	1736	0	0	yes	yes	1
2015	1736	0	0	yes	yes	1
2016	1736	0	0	yes	yes	1
2017	1736	0	0	yes	yes	1
2018	1736	0	0	yes	yes	1
2019	1736	0	0	yes	yes	1
2020	1736	0	0	yes	yes	1
2021	1736	0	0	yes	yes	1
2022	1736	0	0	yes	yes	1
2023	1736	0	0	yes	yes	1
2024	1736	0	0	yes	yes	1
2025	1736	0	0	yes	yes	1
2026	1736	0	0	yes	yes	1
2027	1736	0	0	yes	yes	1
2028	1736	0	0	yes	yes	1
2029	1736	0	0	yes	yes	1
2030	1736	0	0	yes	yes	1
2031	1736	0	0	yes	yes	1

Figure II.2

Results of screening sf2.dat

record number	internal record number	# of bytes written	first missing resync	pass header checksum?	pass range checksum?	# of failed acoustic checksum?
693	689	7642	17	yes	yes	73
890	886	6308	0	yes	yes	2
891	****	834	1	no	no	6
1113	1107	0	0	yes	yes	1

Figure II.3

Results of screening sf3.dat

record number	internal record number	# of bytes written	first missing resync	pass header checksum?	pass range checksum?	# of failed acoustic checksum?
437	435	7642	0	yes	no	89
442	440	7642	75	yes	yes	15
467	465	1694	0	yes	yes	2
468	****	1232	1	no	no	11
469	****	16	1	no	no	11
470	****	108	1	no	no	11
471	****	0	1	no	no	11
472	****	60	1	no	no	11
473	0	144	1	no	no	11
474	466	1388	0	yes	yes	3
475	****	7676	1	no	no	89
476	467	1402	11	yes	no	80
477	****	7384	1	no	no	89
478	468	1780	2	yes	no	89
479	****	5462	1	no	no	89
480	469	1414	12	yes	no	78
481	-389	1174	1	no	no	87
482	4159	3666	1	no	no	89
483	470	1410	0	yes	no	89
484	-651	1954	1	no	no	89
485	-3	838	1	no	no	89
486	****	1232	1	no	no	89
487	471	132	0	yes	no	89
488	****	746	1	no	no	89
489	****	7676	1	no	no	89
490	472	114	0	yes	no	89
491	****	562	1	no	no	89
492	****	1462	1	no	no	89
493	-19	4748	1	no	no	89
494	473	98	0	yes	no	89
495	****	870	1	no	no	89
496	****	7486	1	no	no	89
497	****	128	1	no	no	89
498	****	542	1	no	no	89
499	****	312	1	no	no	89
500	****	4342	1	no	no	89
501	475	124	0	yes	no	89
502	-324	648	1	no	no	89
503	****	5448	1	no	no	89
504	476	128	0	yes	no	89

Figure II.4

505	-518	604	1	no	no	89
506	****	5376	1	no	no	89
507	477	142	0	yes	no	89
508	****	7676	1	no	no	89
510	480	7642	0	yes	no	89
523	493	2852	0	yes	yes	2
524	****	5920	1	no	no	69
989	958	5592	0	yes	yes	2
990	1594	1366	1	no	no	13
1044	1012	1842	0	yes	yes	2
1045	1012	0	0	yes	yes	2
1046	****	4364	1	no	no	49
1249	1215	5914	0	yes	yes	2
1250	****	1356	1	no	no	13
1366	1331	6780	0	yes	yes	2
1367	4468	92	1	no	no	2
1461	1425	7642	0	yes	yes	2
1462	1426	652	0	yes	yes	3
1463	****	6240	1	no	no	73
1490	1453	2894	0	yes	yes	2
1491	****	4070	1	no	no	46
1814	1775	0	0	yes	yes	1

Figure II.4 (Cont)

Results of screening sf4.dat

record number	internal record number	# of bytes written	first missing resync	pass header checksum?	pass range checksum?	# of failed acoustic checksum?
469	467	7642	64	yes	yes	26
978	****	7644	1	no	no	89
1956	1953	0	0	yes	yes	1
1957	1953	0	0	yes	yes	1
1958	1953	0	0	yes	yes	1
1959	1953	0	0	yes	yes	1
1960	1953	0	0	yes	yes	1
1961	1953	0	0	yes	yes	1
1962	1953	0	0	yes	yes	1
1963	1953	0	0	yes	yes	1
1964	1953	0	0	yes	yes	1
1965	1953	0	0	yes	yes	1
1966	1953	0	0	yes	yes	1
1967	1953	0	0	yes	yes	1
1968	1953	0	0	yes	yes	1
1969	1953	0	0	yes	yes	1

Figure II.5

Results of screening sf5.dat

record number	internal record number	# of bytes written	first missing resync	pass header checksum?	pass range checksum?	# of failed acoustic checksum?
457	454	7642	62	yes	yes	28
986	0	7646	1	no	no	89
1848	1845	0	0	yes	yes	1

Figure II.6

III. Surface Echo Data

Proper functioning of each float's acoustic positioning system may be evaluated from its record of receiving its own pulses reflected from the ocean surface. Surface echo data also indicate actual float depth. The scale on the x axis may be converted to record number using the record length (1.5 minutes). Thus there are 40 records per hour, and 3 hours corresponds to 120 records, etc.

Figures III.1 and III.2 contain surface echo data for the two floats deployed to the ocean bottom, and Figures III.3 through III.5 pertain to the 3 floats deployed to 1000 meters depth. The sampling interval is 9 minutes. The actual depths reached and descent times are summarized in Table III.1.

Float	Depth reached (meters)	Descent time (hours)
0	3640	6
4	3670	5
2	1130	8
3	1200	8
5	1120	8

Table III.1: Depths reached and descent times.

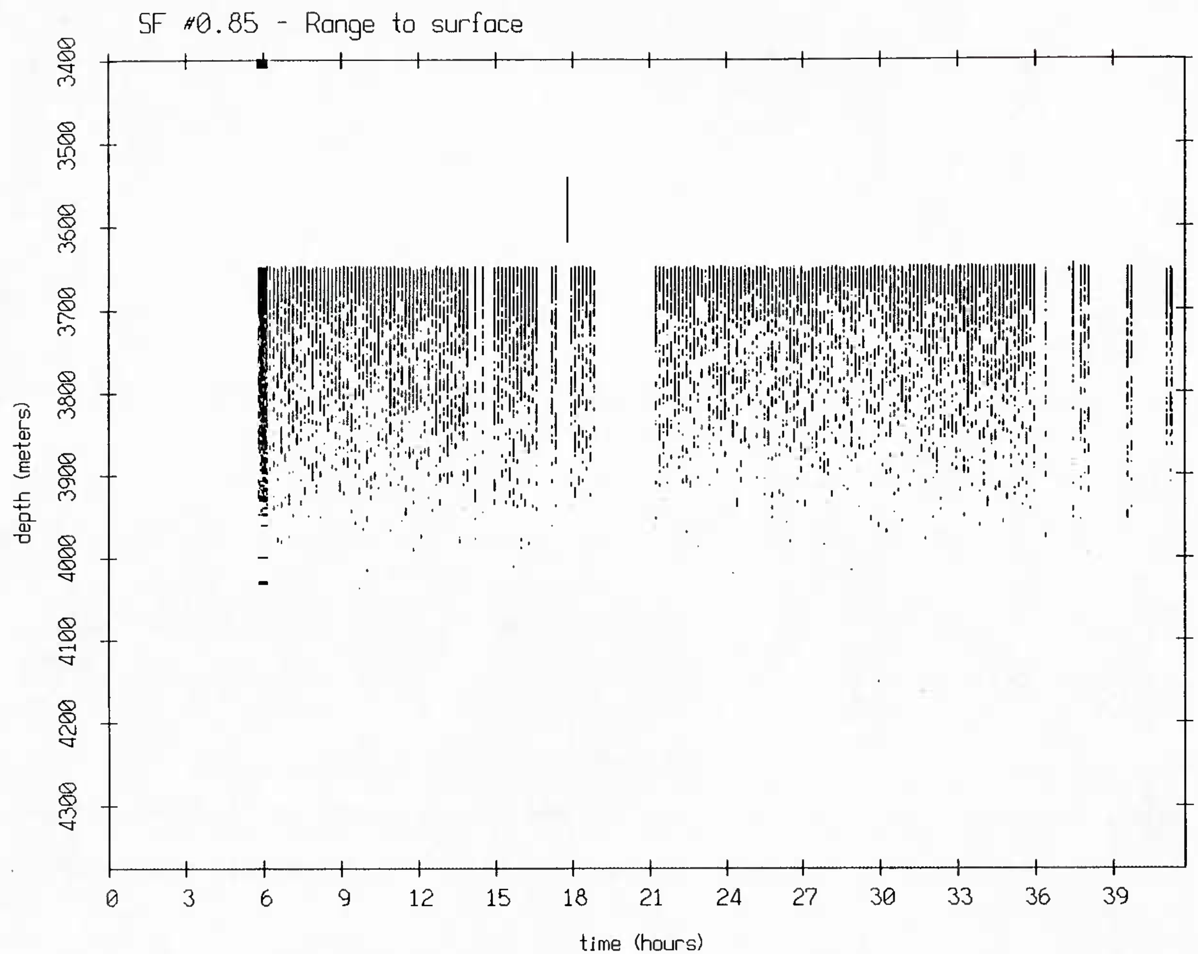
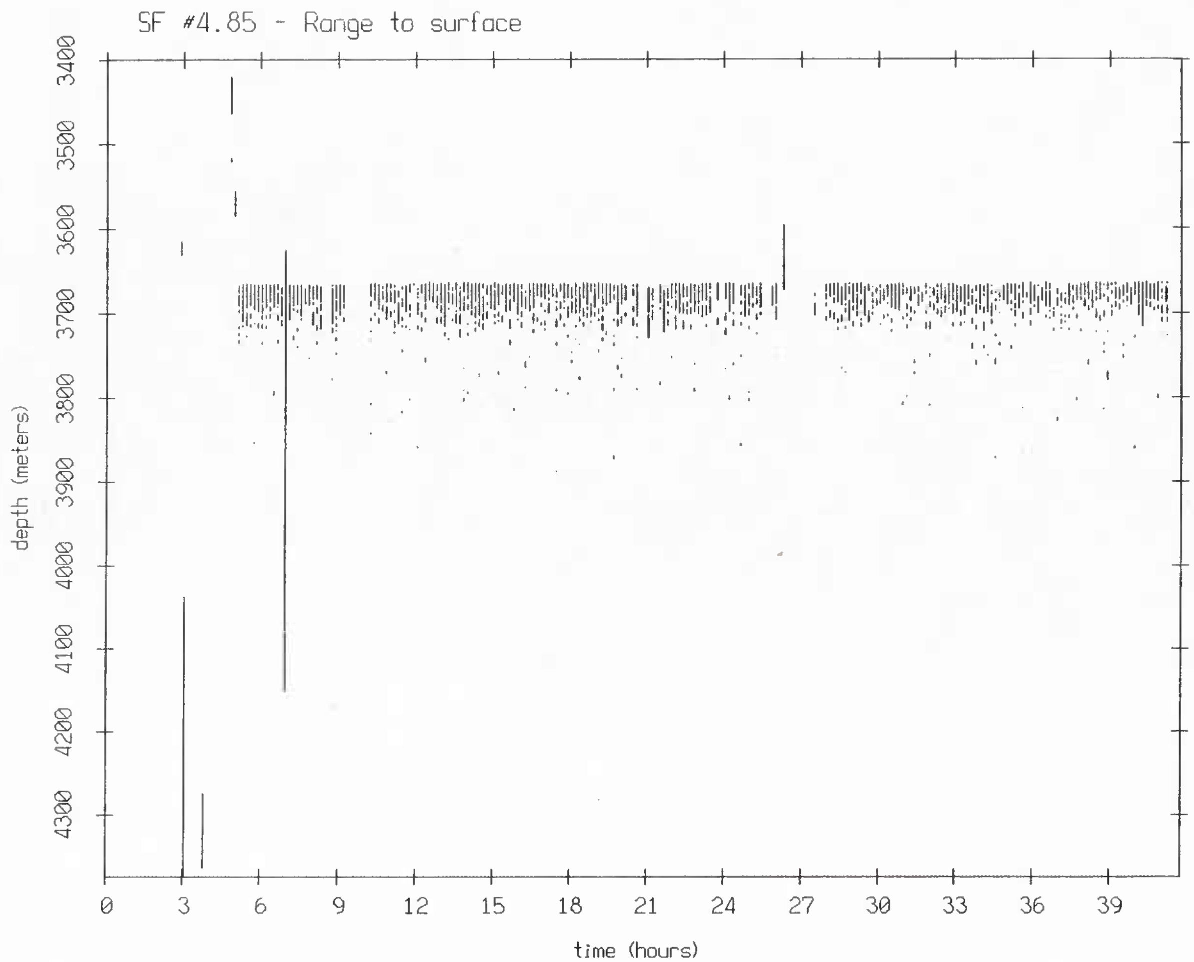

SF #0.85 - Range to surface
depth (meters)
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
0
3
6
9
12
15
18
21
24
27
30
33
36
39
time (hours)

Figure III.1



SF #4.85 - Range to surface
depth (meters)
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
0
3
6
9
12
15
18
21
24
27
30
33
36
39
time (hours)

Figure III.2

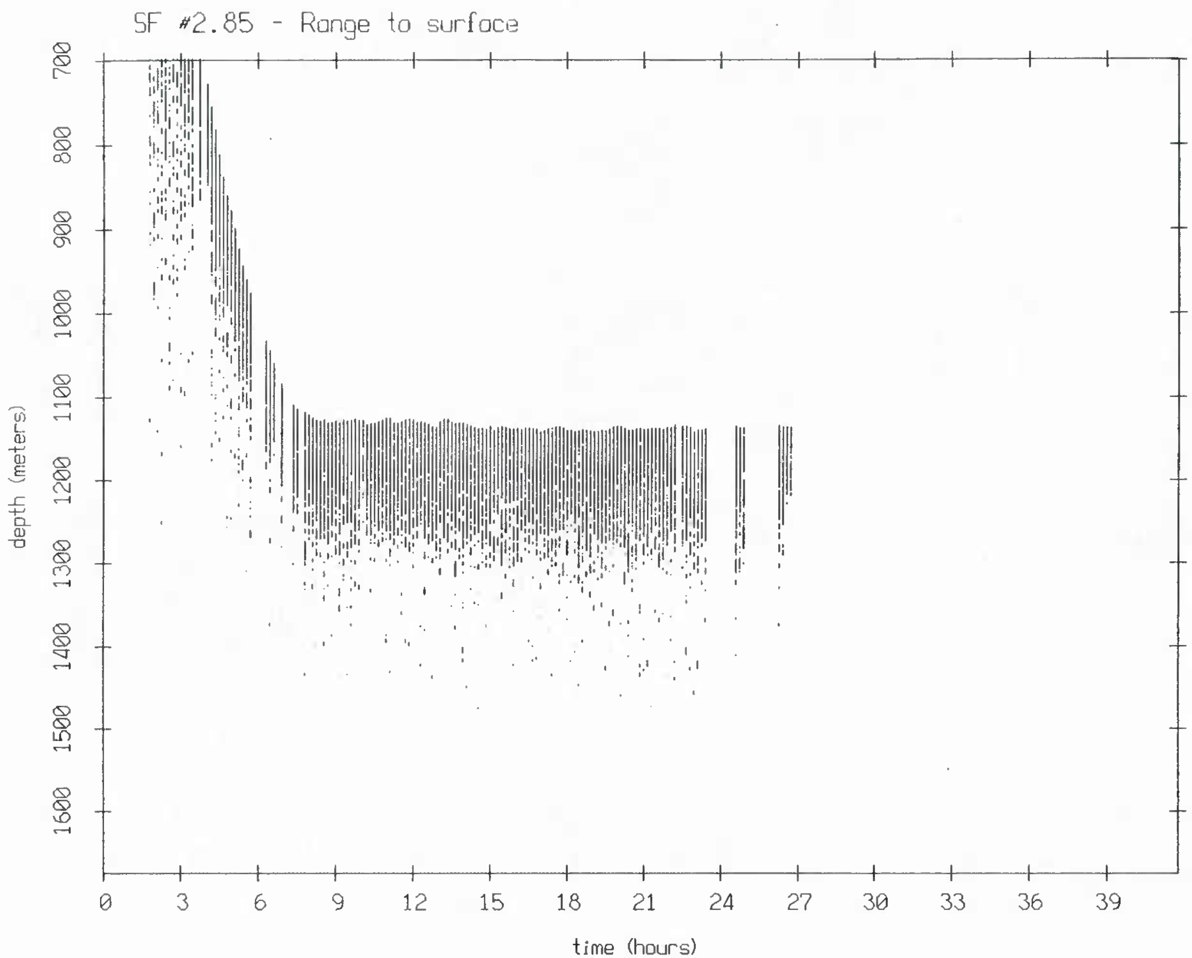

SF #2.85 - Range to surface
depth (meters)
700
800
900
1000
1100
1200
1300
1400
1500
1600
0
3
6
9
12
15
18
21
24
27
30
33
36
39
time (hours)

Figure III.3

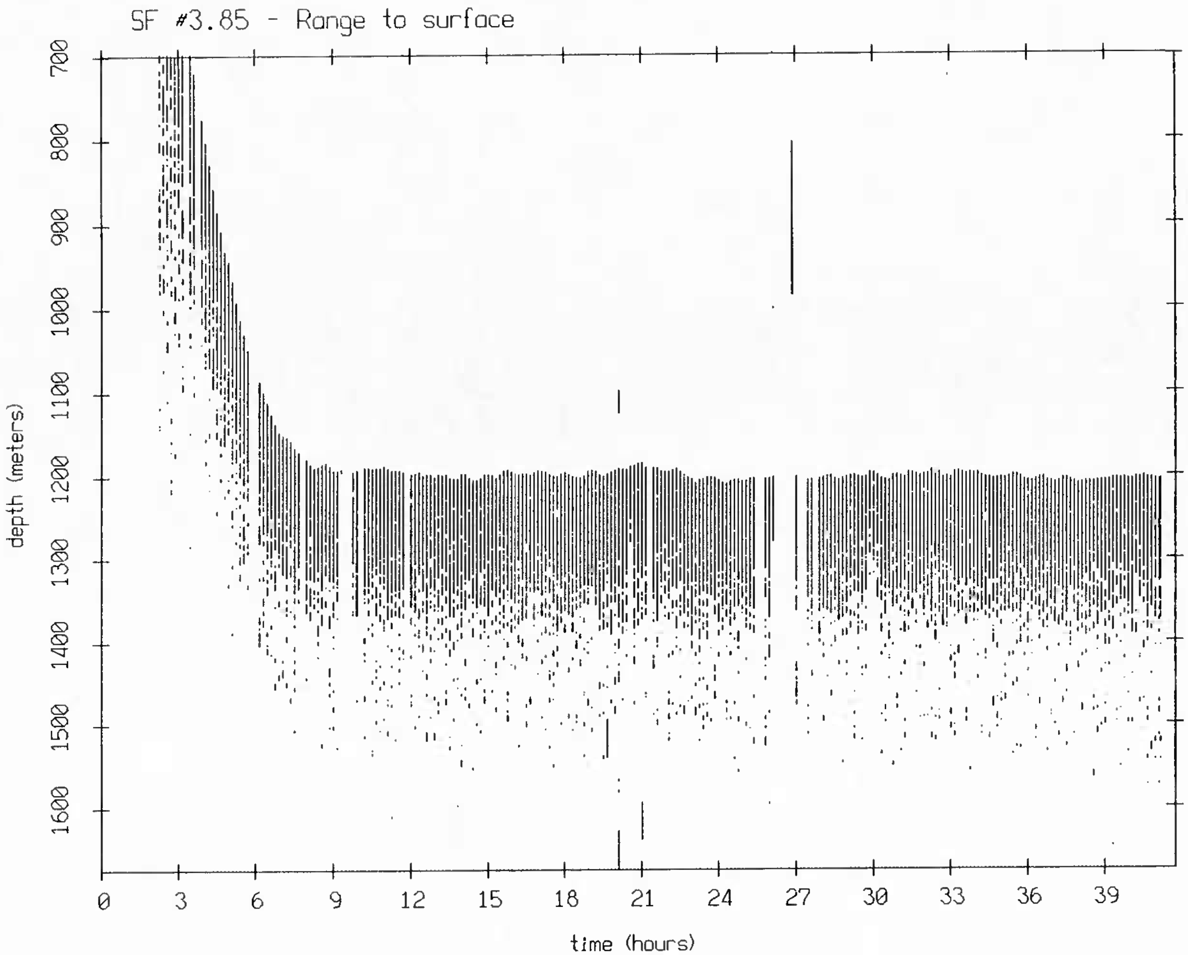

SF #3.85 - Range to surface
depth (meters)
700
800
900
1000
1100
1200
1300
1400
1500
1600
0
3
6
9
12
15
18
21
24
27
30
33
36
39
time (hours)

Figure III.4

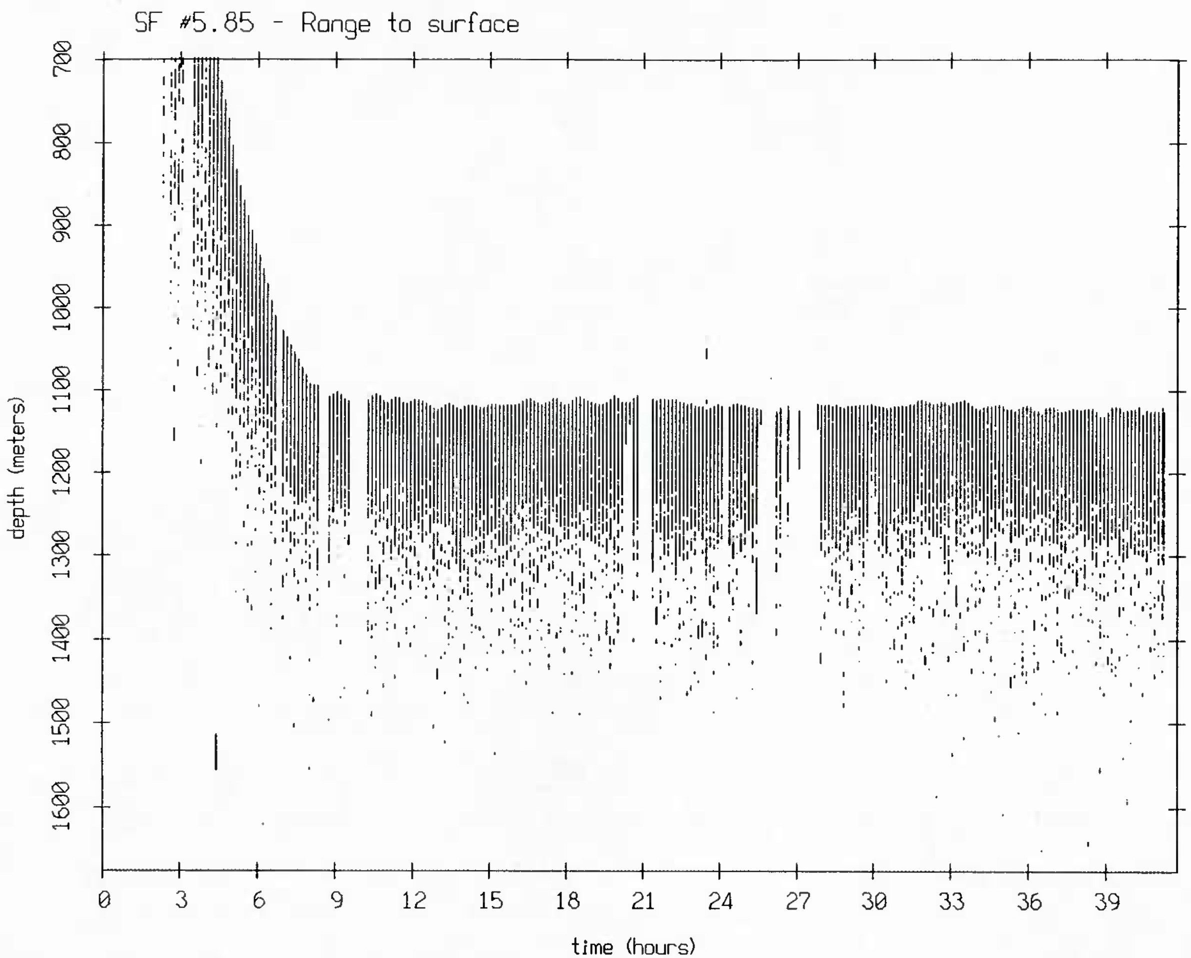

SF #5.85 - Range to surface
depth (meters)
700
800
900
1000
1100
1200
1300
1400
1500
1600
0
3
6
9
12
15
18
21
24
27
30
33
36
39
time (hours)

Figure III.5

IV. AGC Level and Float Heading

Particle velocity data recorded by each float may be evaluated from the level of an automatic gain control (AGC) circuit which optimizes use of the analog to digital converter (ADC) dynamic range. AGC level is increased by the float's microprocessor when the velocity signal decreases and is therefore useful as a general indicator of signal level. AGC level does not change during a record and is constrained to change by no more than 0.5 dB between records.

Figures IV.1 and IV.2 depict AGC level, compass heading and battery voltage for floats 0 and 4 which went to the bottom. These floats were bottomed to provide references for the acoustic positioning system and their particle velocity data are useful only to verify proper float functioning. Float 0's origin corresponds to float 4's record 264 because of its later start. AGC level in both floats is generally low, probably as a result of tether strumming. The irregularly spaced peaks in AGC level appear to be correlated with changes in compass heading and may be attributed to changes in mooring line tension and flow noise due to tidal forces.

Figures IV.3 through IV.5 pertain to the 3 floats deployed to about 1200 meters. Float 2's origin corresponds to record 792 in floats 3 and 5. AGC levels are low during the floats' descent and increase once they reach depth and their motion is reduced. The flat top appearance to the AGC level plots, particularly evident in floats 2 and 3, is thought to be caused by y axis amplifier oscillation whenever the AGC reaches 18.0 dB, increasing signal level and thereby decreasing AGC level. Dips in AGC level correspond to increased signal level, caused in some cases by acoustic interrogation pulses from the support ship. Float headings fluctuate randomly while they are deployed, but their rate of fluctuation slows considerably once they reach depth.

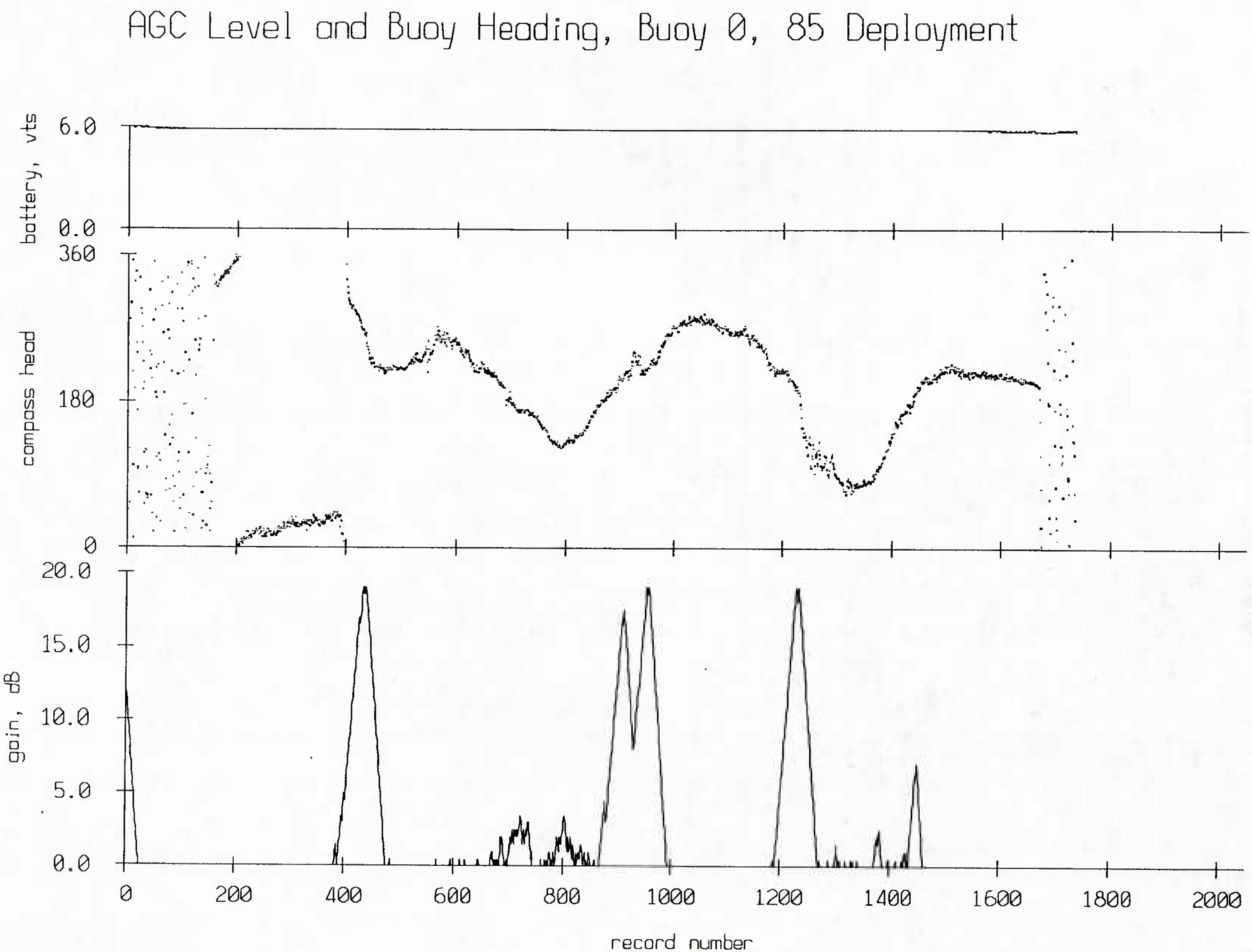

AGC Level and Buoy Heading, Buoy 0, 85 Deployment
battery, vts
6.0
0.0
compass head
360
180
0
gain, dB
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
record number

Figure IV.1

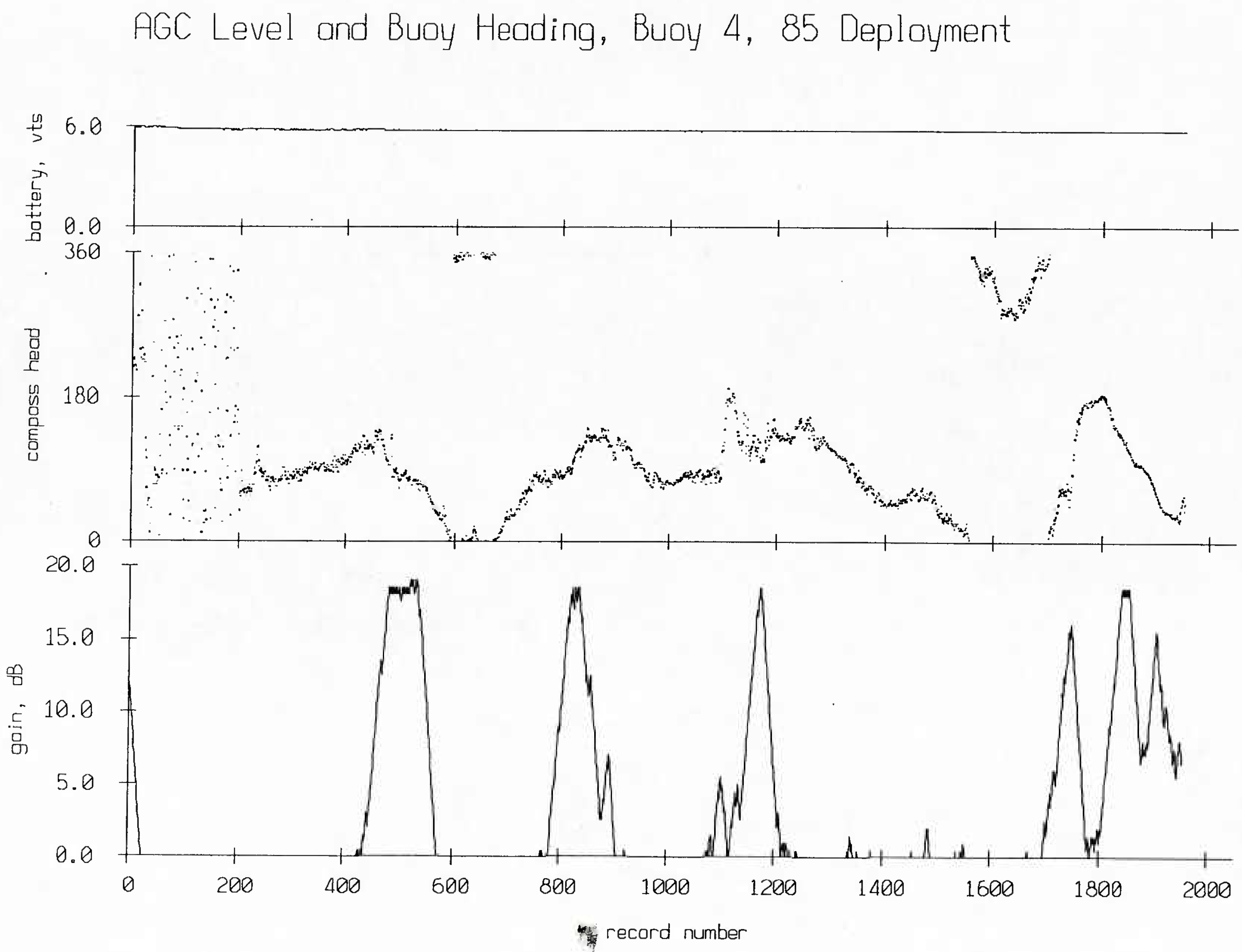

AGC Level and Buoy Heading, Buoy 4, 85 Deployment
battery, vts
6.0
0.0
compass head
360
180
0
gain, dB
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
record number

Figure IV.2

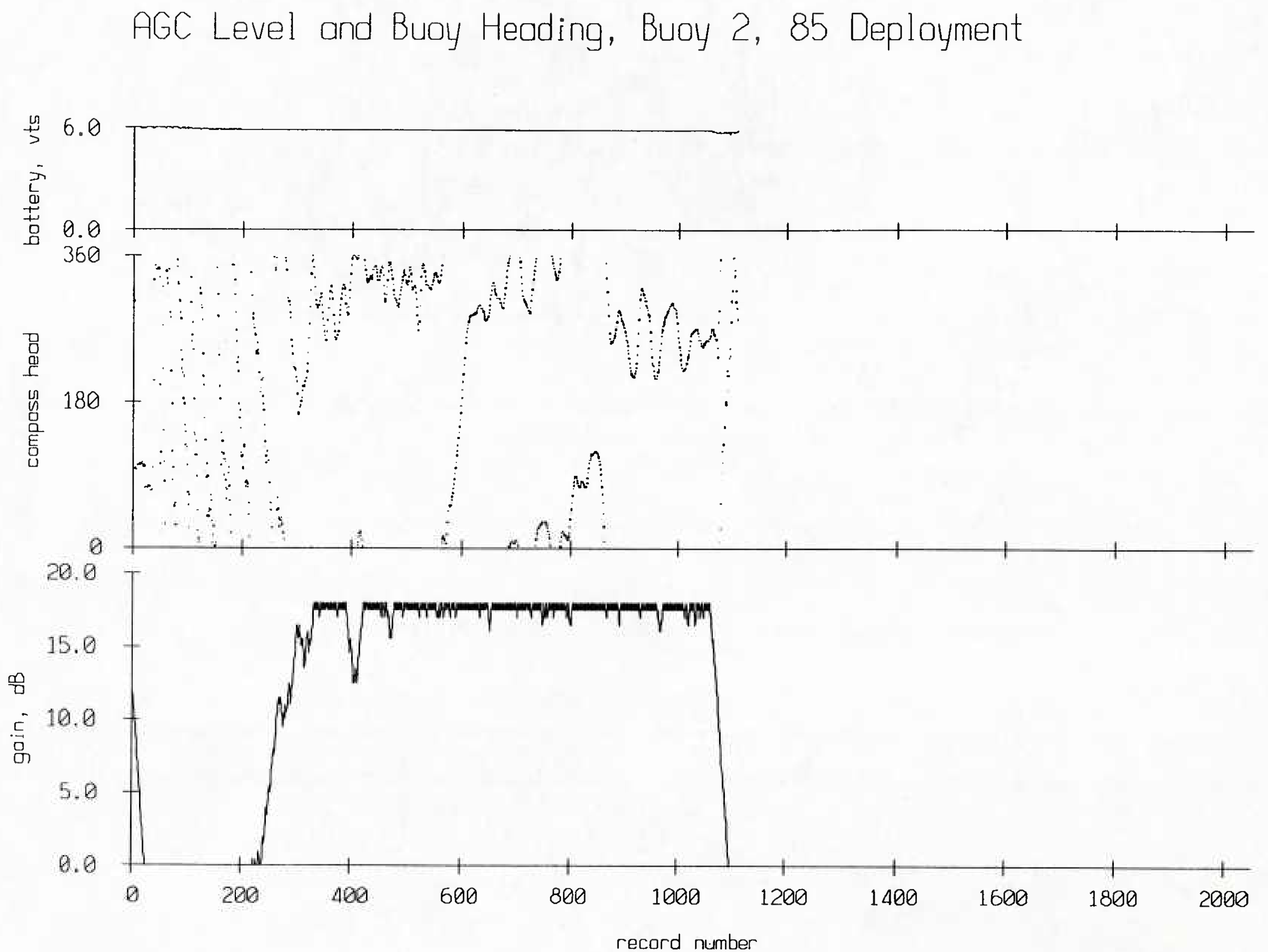

AGC Level and Buoy Heading, Buoy 2, 85 Deployment
battery, vts
6.0
0.0
compass head
360
180
0
gain, dB
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
record number

Figure IV.3

AGC Level and Buoy Heading, Buoy 3, 85 Deployment

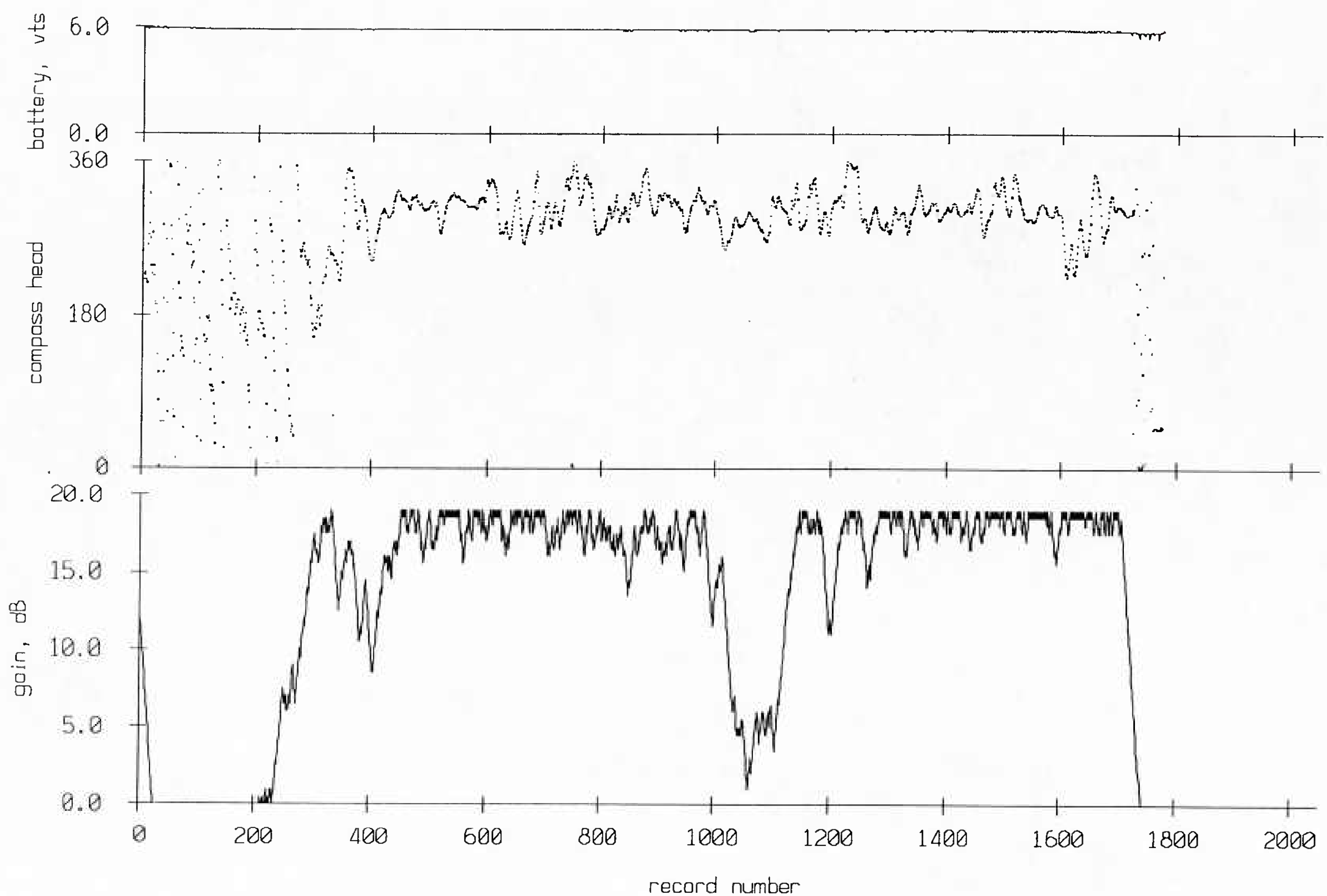


Figure IV.4

AGC Level and Buoy Heading, Buoy 5, 85 Deployment

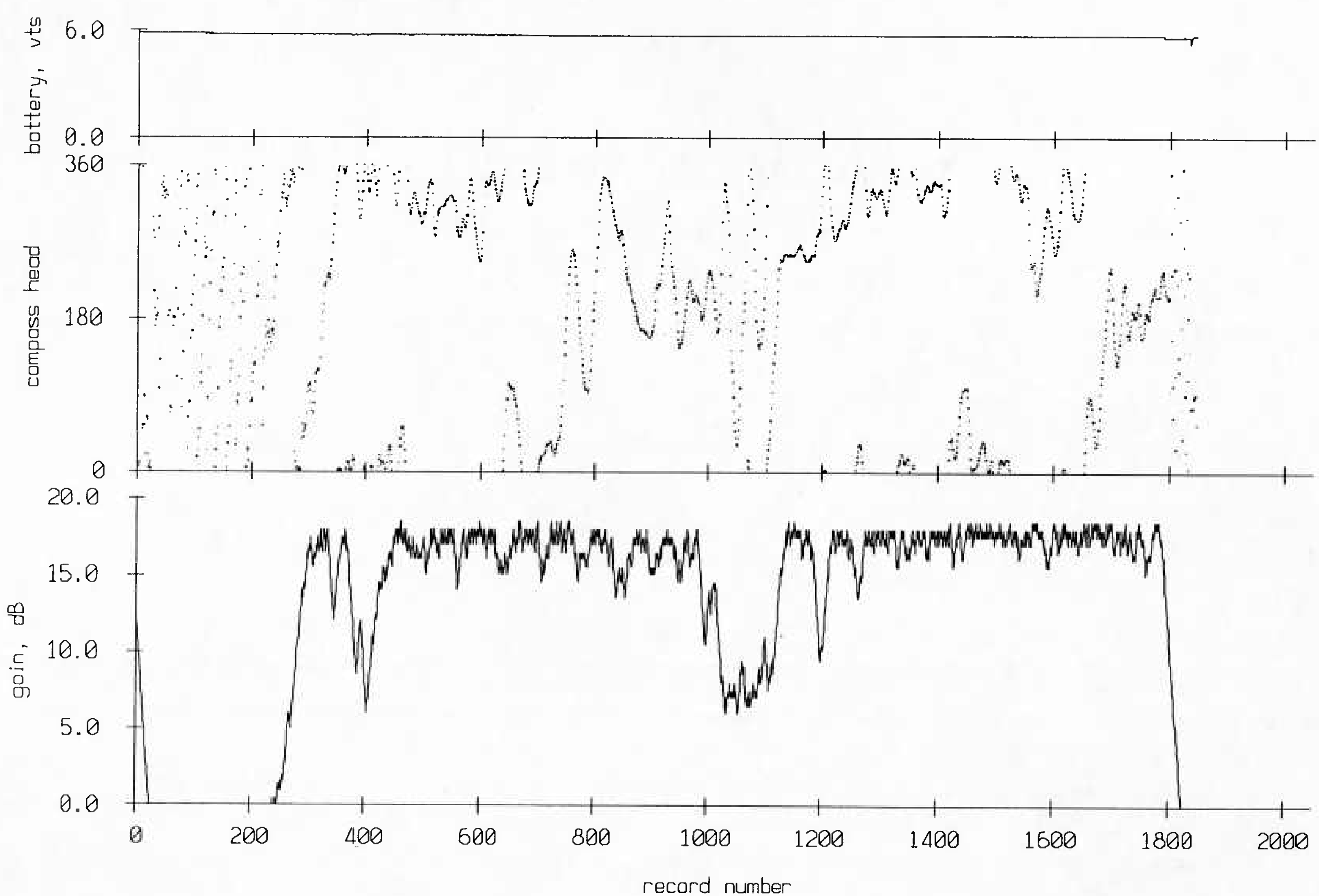


Figure IV.5

V. Root Mean Square Velocity

A more detailed evaluation of particle velocity data may be obtained by looking at root mean square (rms) signal level. Figures V.1 and V.2 contain rms signal level for the two bottomed floats, 0 and 4. The averaging period is 10 seconds, and the vertical axis has units of volts rms, with full scale being either 2.5 or 1.0 volts rms.

Signal levels in the x and y axis (horizontal direction) channels are comparable, with the z axis (vertical) channel level on the average considerably lower for both floats. Spikes seen in z axis data at 6 record intervals correspond to acoustic positioning pulses emitted by the float. Levels in all 3 directions of float 0 drop substantially between 390 and 450, 870 and 960, and 1190 and 1230. These intervals correspond to AGC level peaks seen in Figure IV.1. Similar drops in signal level of float 4 are seen between 435 and 560, 780 and 900, 1140 and 1200, and 1700 and 1875, corresponding to peaks in AGC level (see Figure IV.2). During most of these low signal level periods, some clipping can be seen in the y axis channel (e.g. float 0, records 435-445, 950-955, 1227-1230; float 4, records 480-535, 824-840, 1172-1175, 1840-1860). The clipping is thought to be caused by amplifier oscillation.*

All 3 channels of float 0 become saturated at about record 1590 when the float was commanded to drop its ballast and began its ascent. Float 4 ran out of tape before receiving the command to drop its ballast. Note that record 979 of float 4 does not contain good data which matches Figure II.5.

Figures V.3 through V.5 display rms signal level for the three floats deployed to about 1200 meters depth. Y axis channel clipping prominent in floats 2 and 3 is evident to a lesser degree in float 5. The y axis channel of float 2 appears to contain no data (i.e. is dead) when it is not clipped. Float 2's x and z axis levels decrease and stabilize by about record 260, corresponding to when its depth began to stabilize. Levels appear reasonable until record 1070, when it was commanded to release its ballast and begin its ascent.

Float 3's levels decreased and stabilized by about record 265 corresponding to when its depth stabilized (Figure III.4). Signal level is relatively stable until record 1725 when the command to drop ballast was received, except that they are elevated between records 1025 and 1115. Float 5's average velocity levels decrease and stabilize at about record 275 as its depth stabilizes(Figure III.5) and start to rise again at record 1790 as it begins its ascent, except that they are also elevated between records 1025 and 1115. Dips in both floats' AGC level also occur during this period (Figures IV.4 and IV.5). These elevated signal levels are thought to have been caused by the acoustic positioning survey conducted between 1249 and 1512 on 11 September (Figure I.2, pg. 2). Another short period of elevated levels is evident in both floats between records 1180 and 1210, which may correspond to a float position survey conducted later that day but not logged. The effect of an acoustic positioning survey on velocity signal level probably depends on the proximity of the ship to the floats.

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*When AGC level is raised to 18.0 dB (between records), y axis clipping occurs during the subsequent record. The microprocessor reacts to the clipping by reducing AGC level to 17.5 dB for the next record. If signal level is low during that record, AGC level is increased to 18.0 dB for the following record, which results in clipping. This accounts for alternate records being clipped (Figures V.1 through V.4) and for the AGC level's flat top appearance (Figures IV.1 through IV.5).

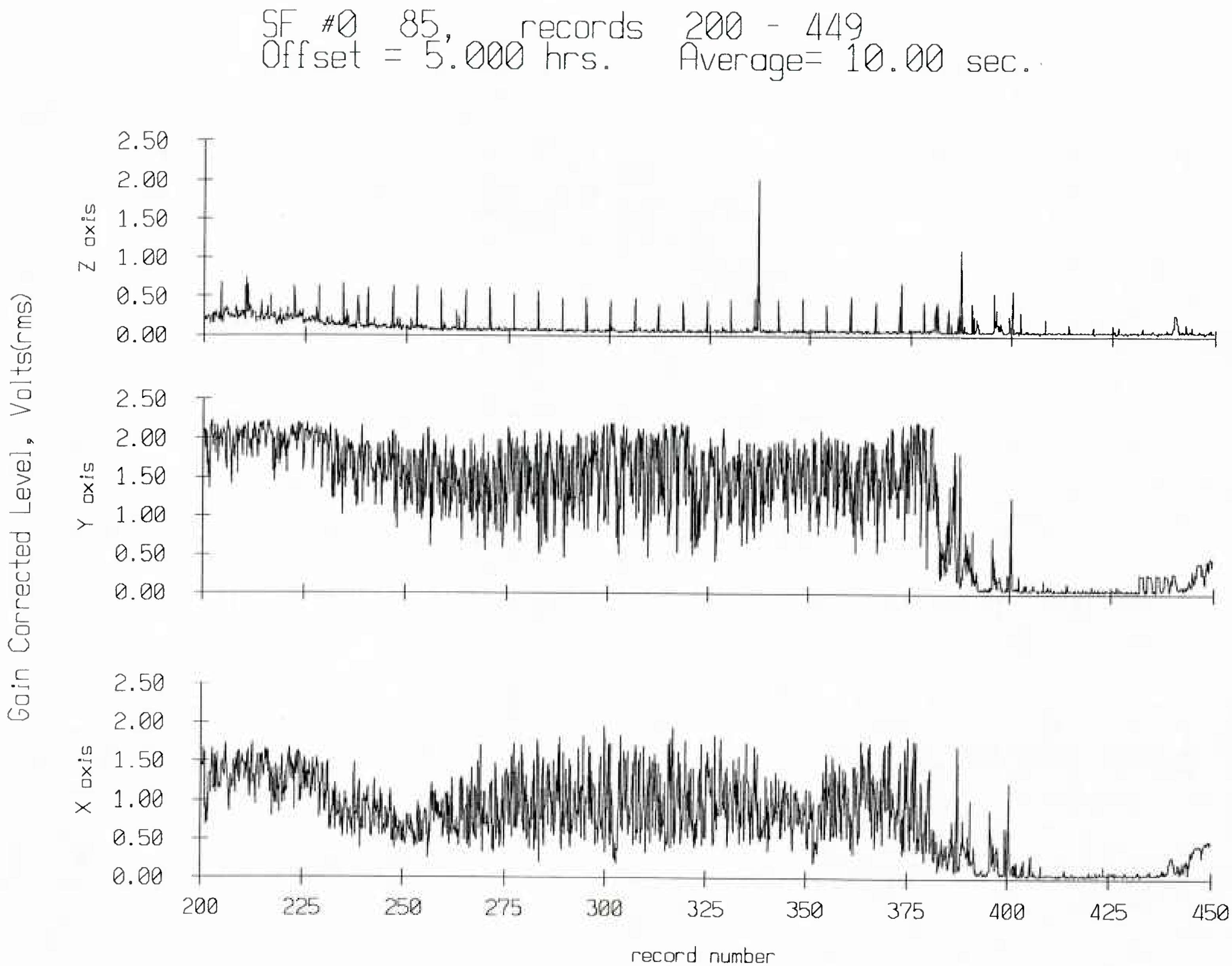
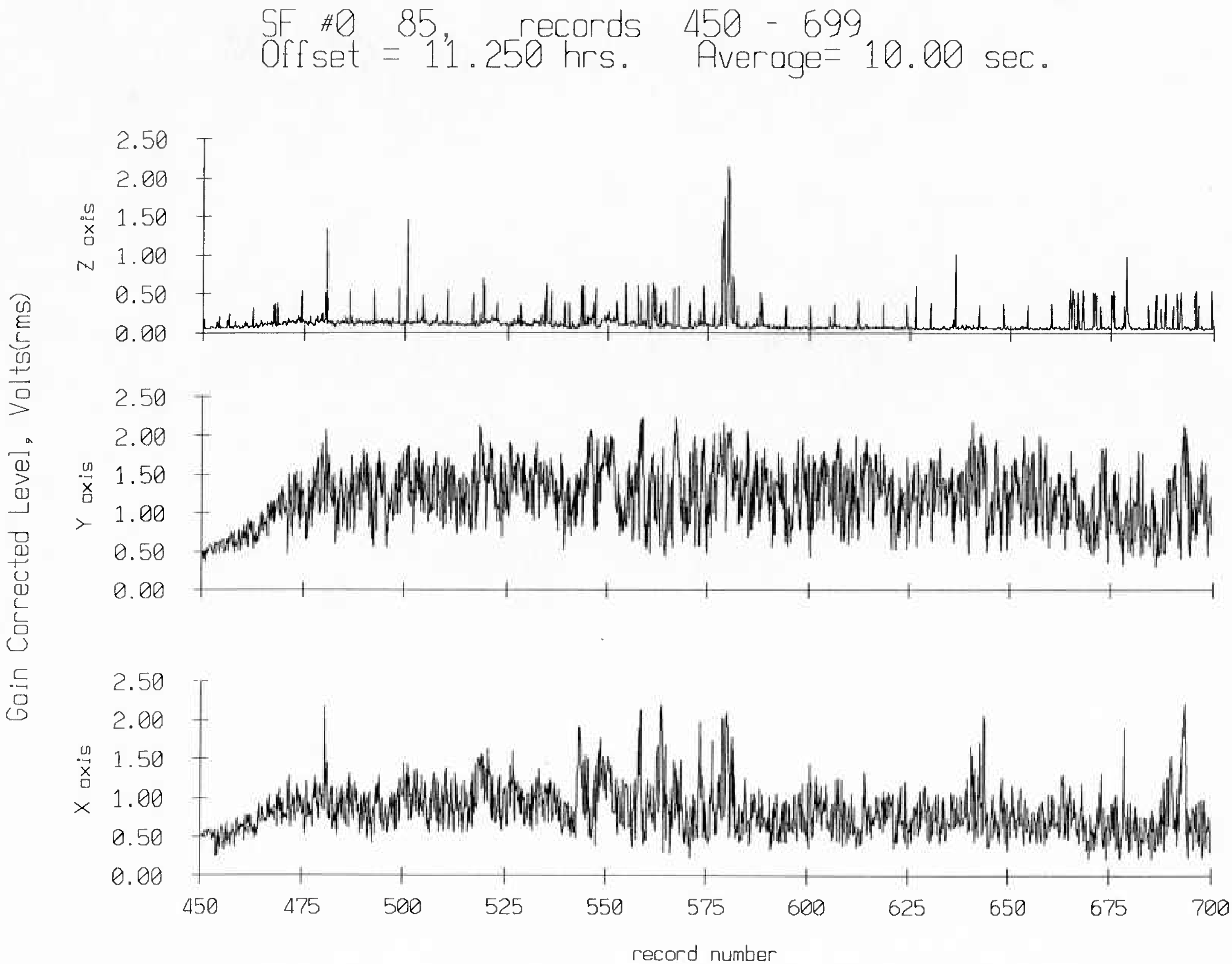

SF #0 85, records 200 - 449
Offset = 5.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
0.00
0.50
1.00
1.50
2.00
2.50
200
225
250
275
300
325
350
375
400
425
450
record number

Figure V.1a



SF #0 85, records 450 - 699
Offset = 11.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
450
475
500
525
550
575
600
625
650
675
700
record number

Figure V.1b

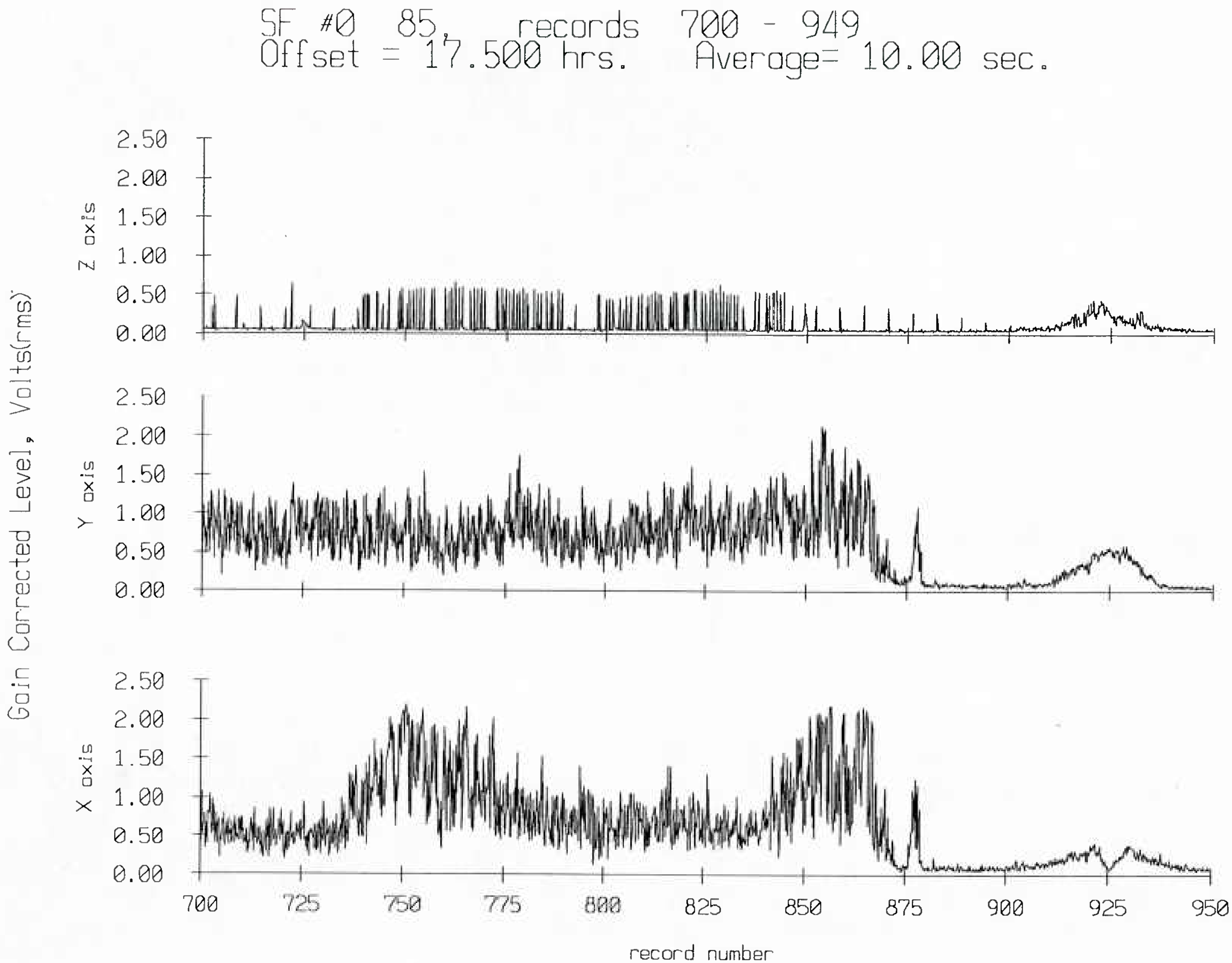
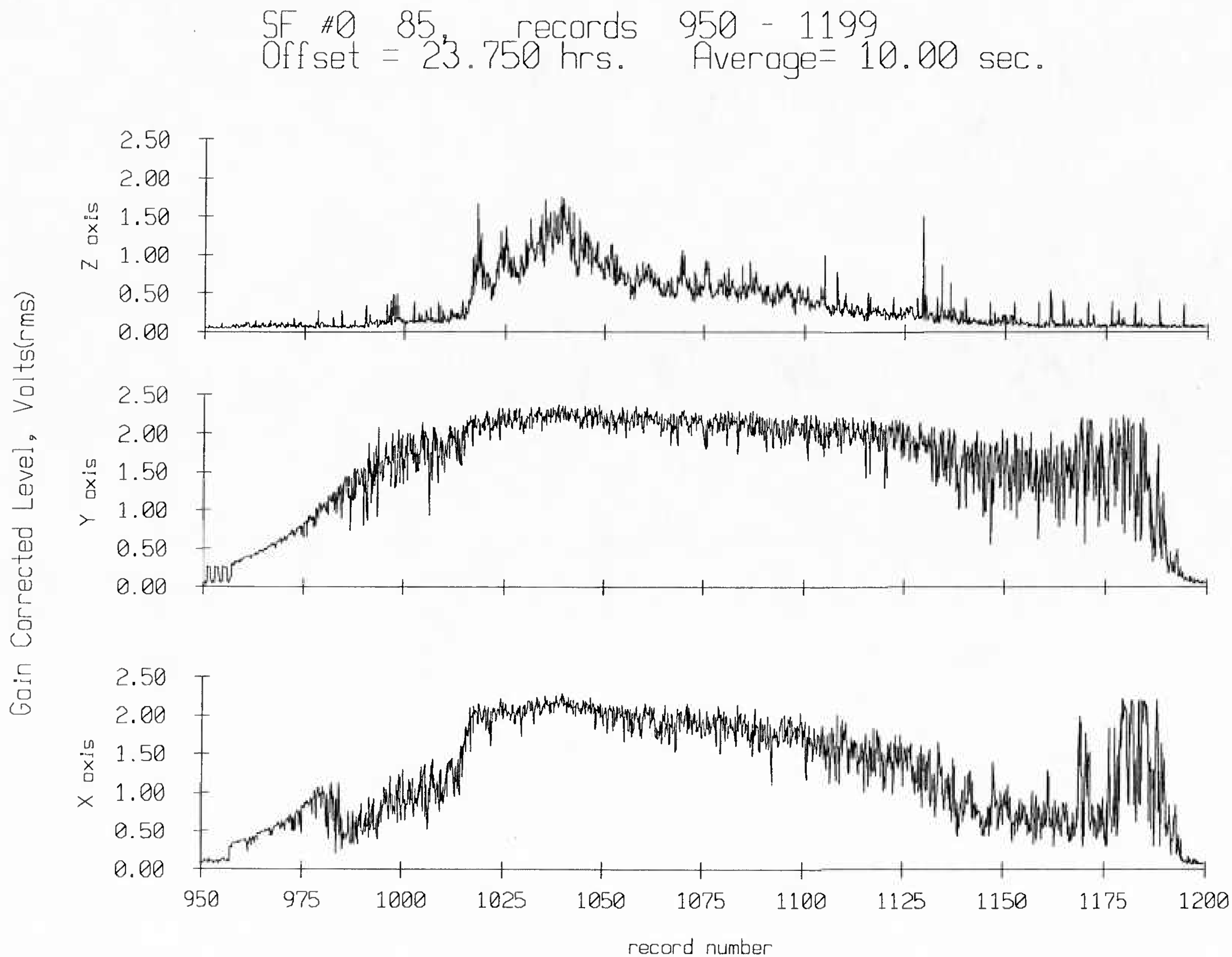
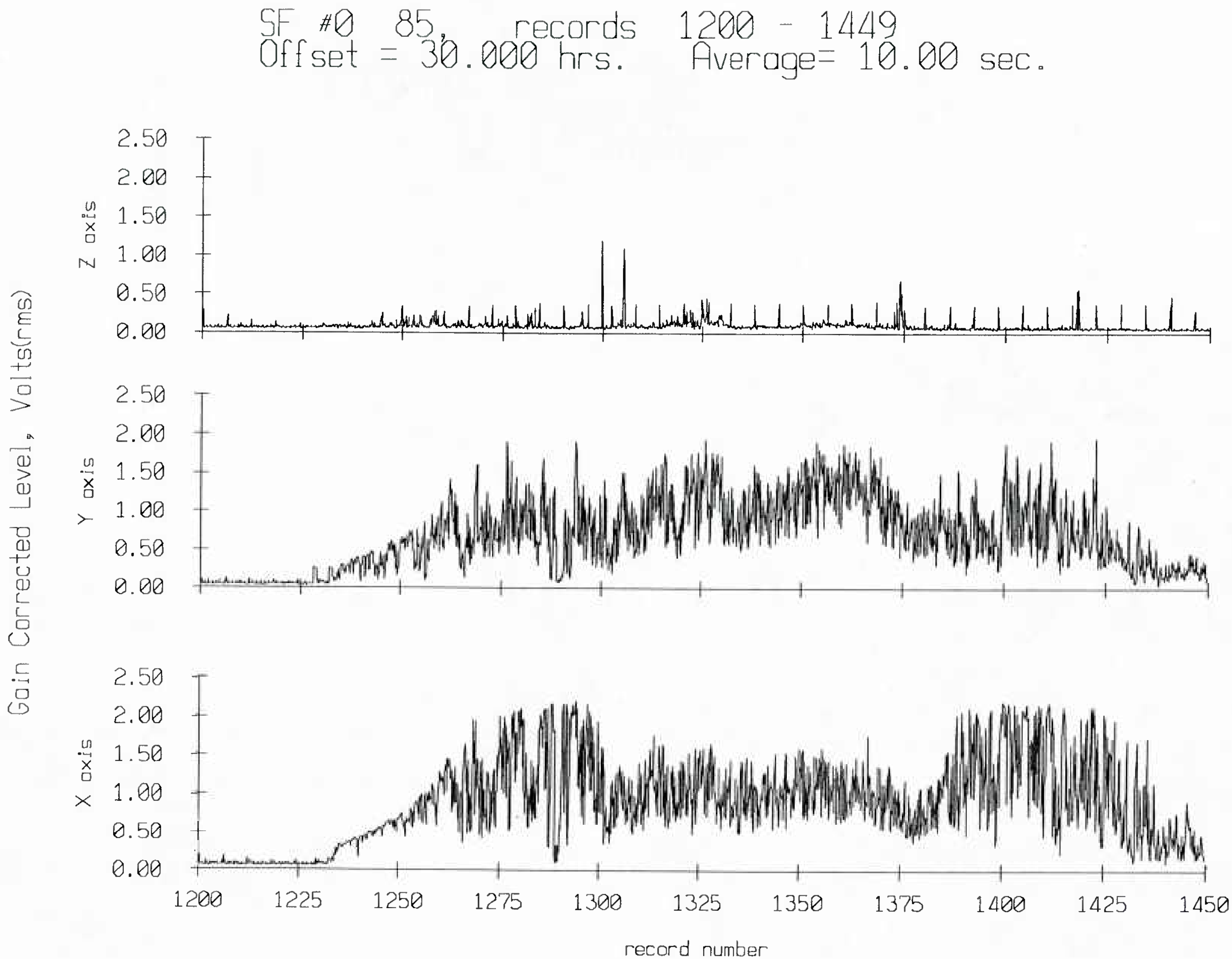

SF #0 85, records 700 - 949
Offset = 17.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
700
725
750
775
800
825
850
875
900
925
950
record number

Figure V.1c



SF #0 85, records 950 - 1199
Offset = 23.750 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
950
975
1000
1025
1050
1075
1100
1125
1150
1175
1200
record number

Figure V.1d



SF #0 85, records 1200 - 1449
Offset = 30.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
1200
1225
1250
1275
1300
1325
1350
1375
1400
1425
1450
record number

Figure V.1e

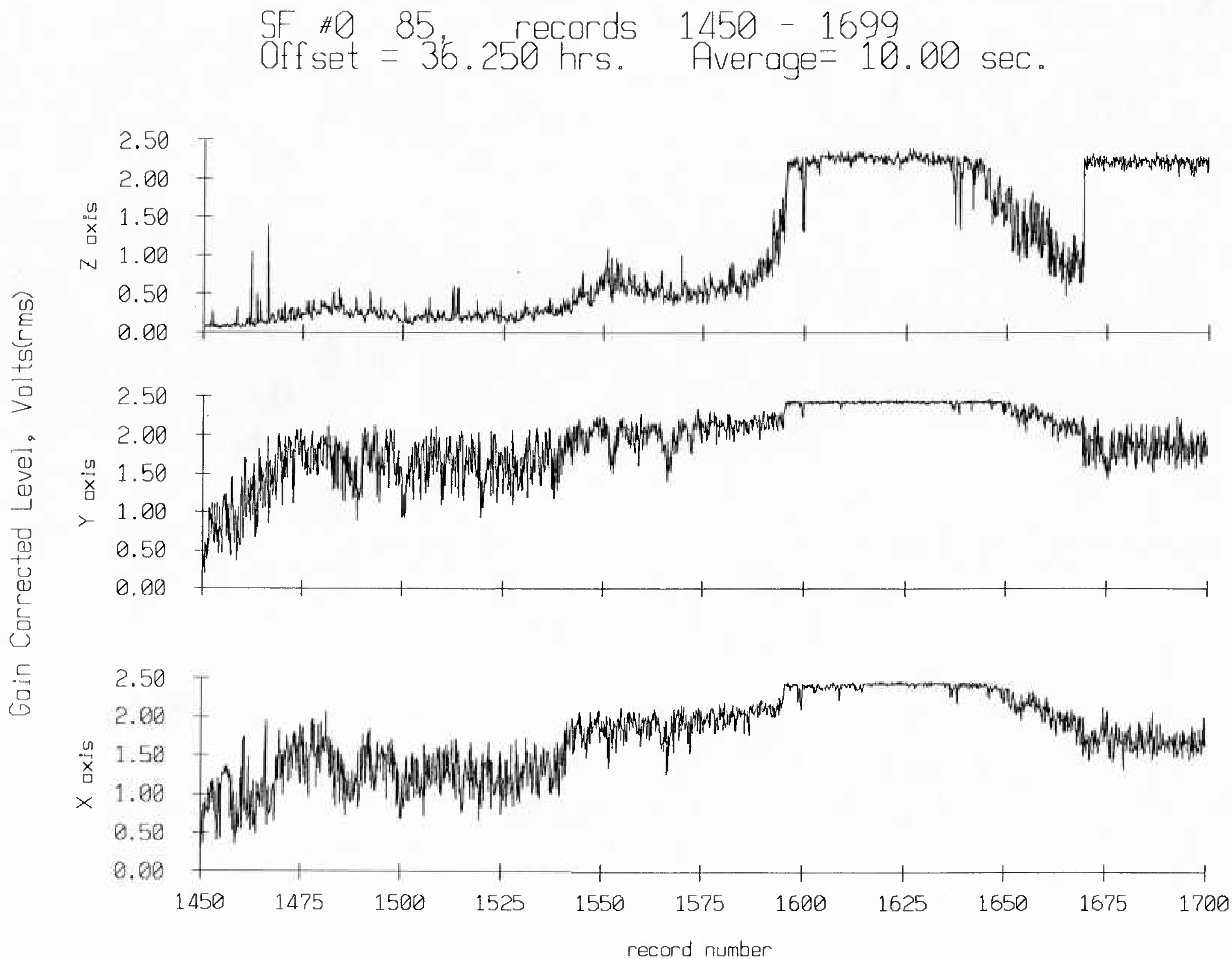

SF #0 85, records 1450 - 1699
Offset = 36.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
1450
1475
1500
1525
1550
1575
1600
1625
1650
1675
1700
record number

Figure V.1f

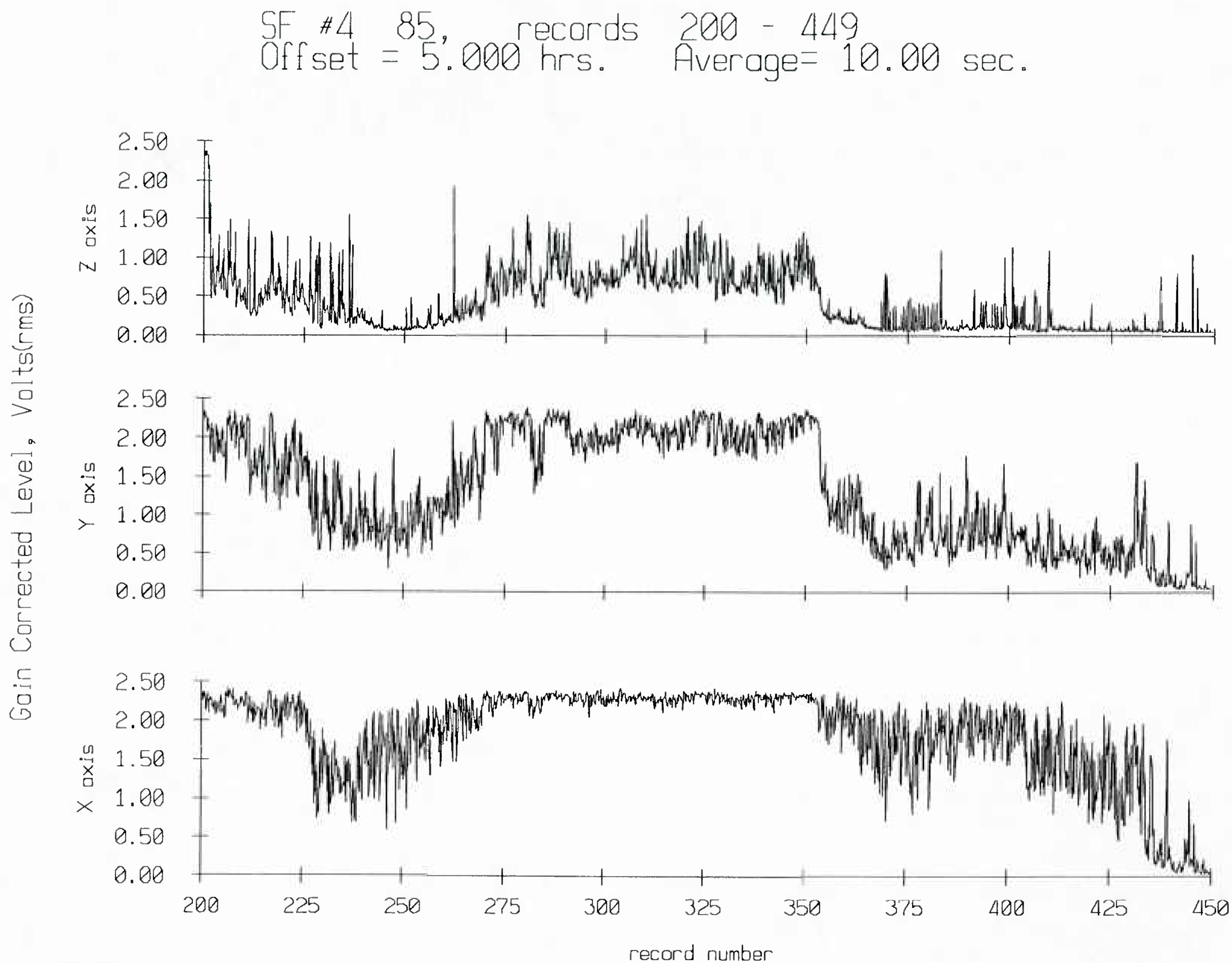

SF #4 85, records 200 - 449
Offset = 5.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
200
225
250
275
300
325
350
375
400
425
450
record number

Figure V.2a

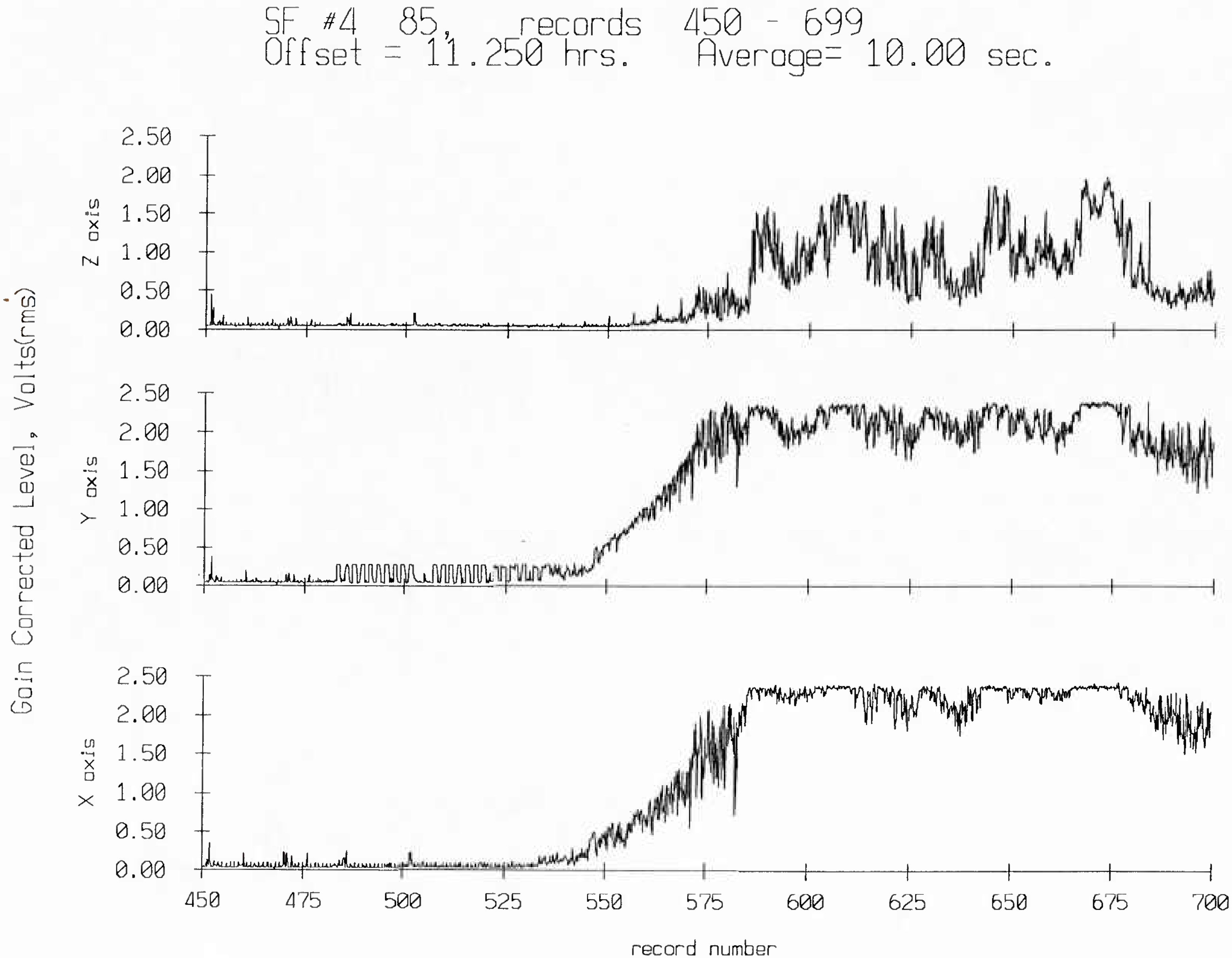

SF #4 85, records 450 - 699
Offset = 11.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
450
475
500
525
550
575
600
625
650
675
700
record number

Figure V.2b

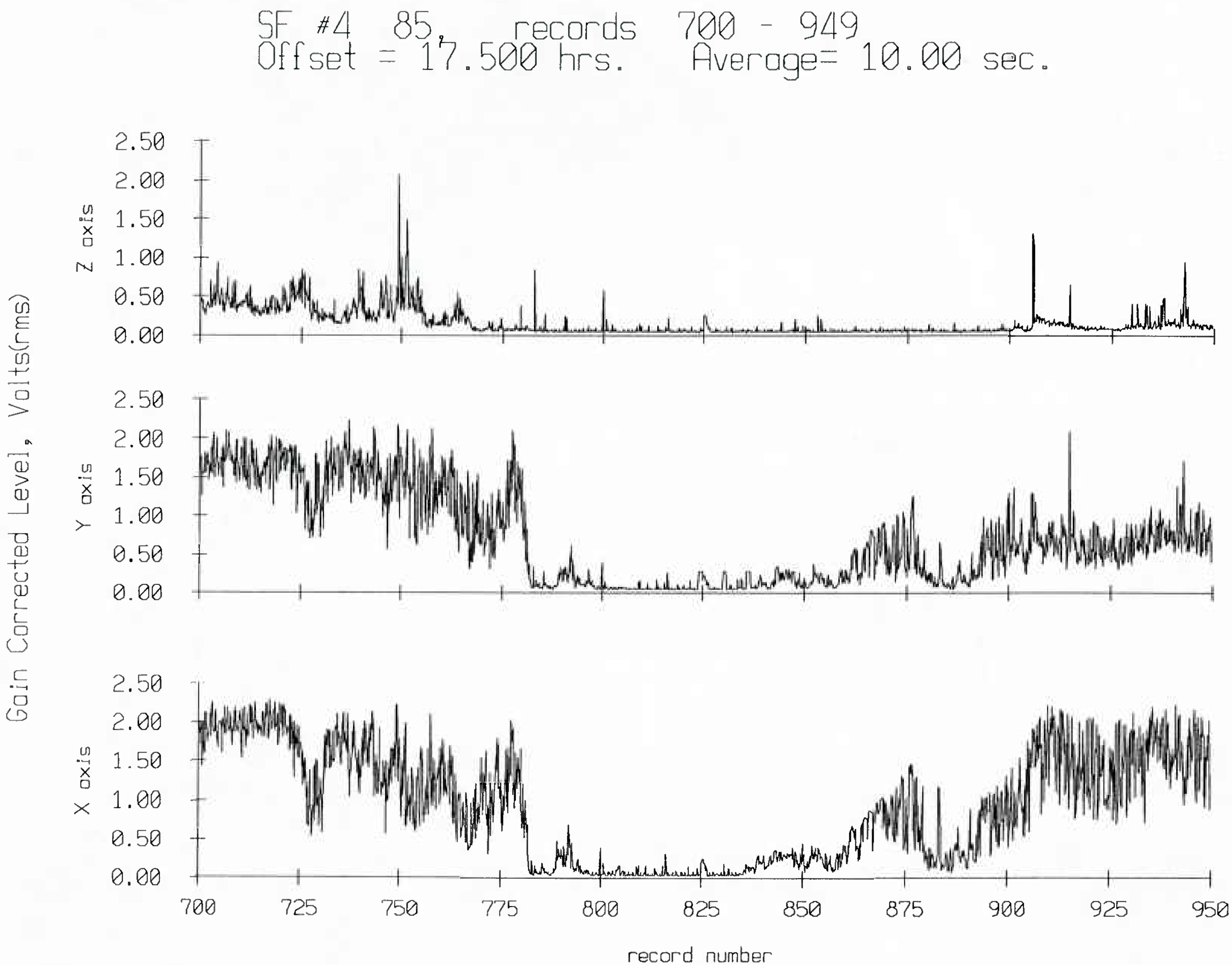

SF #4 85, records 700 - 949
Offset = 17.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
700
725
750
775
800
825
850
875
900
925
950
record number

Figure V.2c

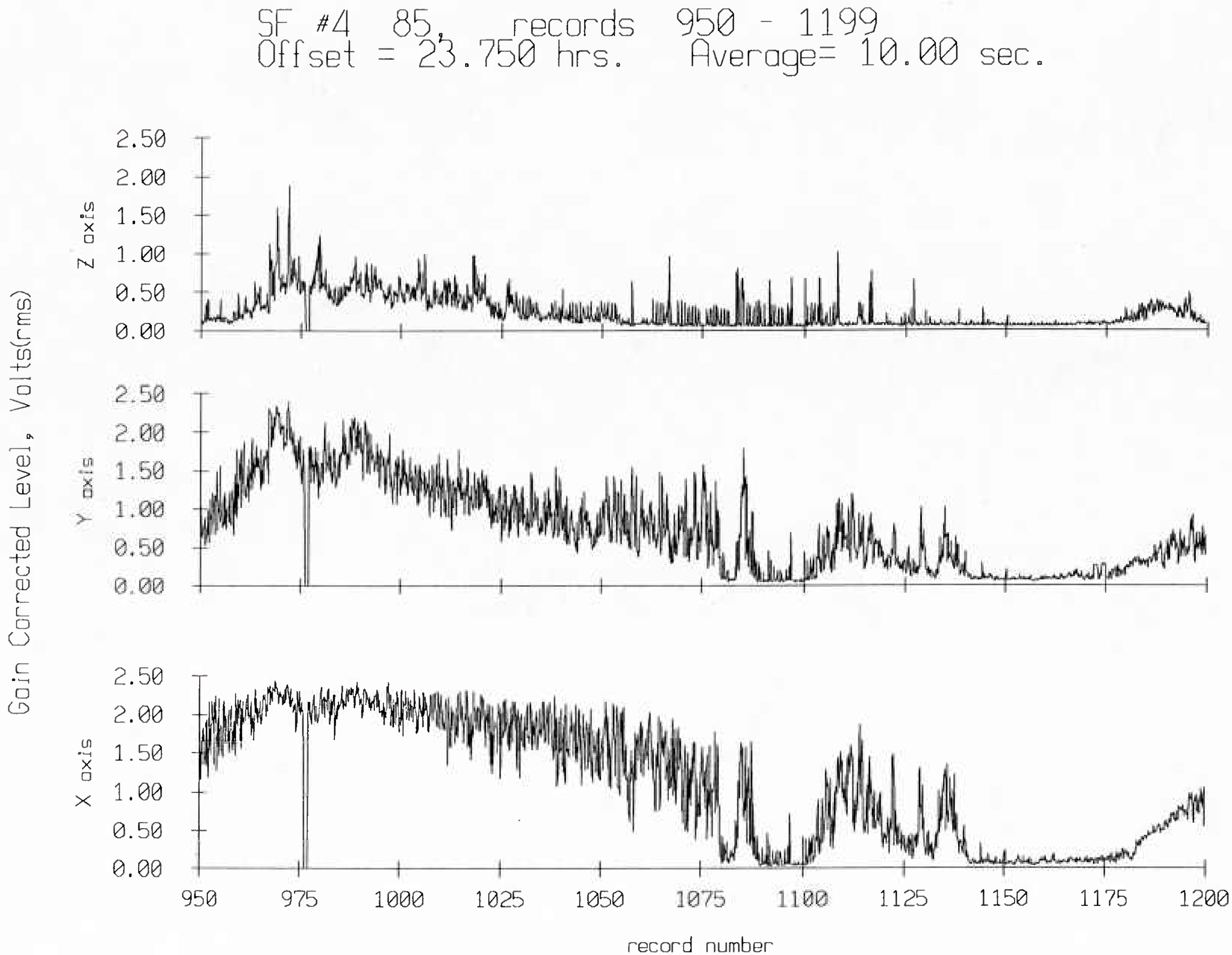

SF #4 85, records 950 - 1199
Offset = 23.750 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
950
975
1000
1025
1050
1075
1100
1125
1150
1175
1200
record number

Figure V.2d

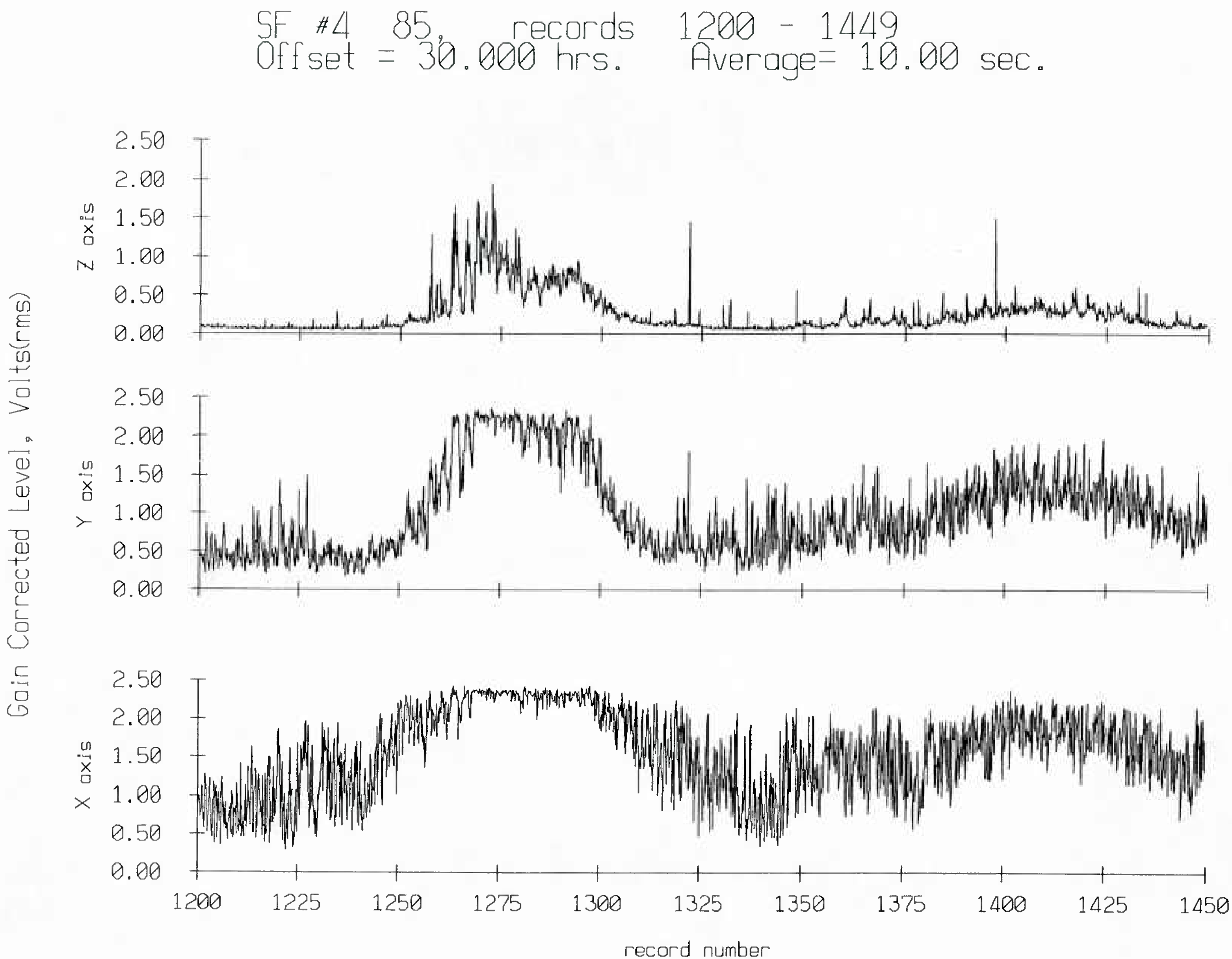

SF #4 85, records 1200 - 1449
Offset = 30.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
1200
1225
1250
1275
1300
1325
1350
1375
1400
1425
1450
record number

Figure V.2e

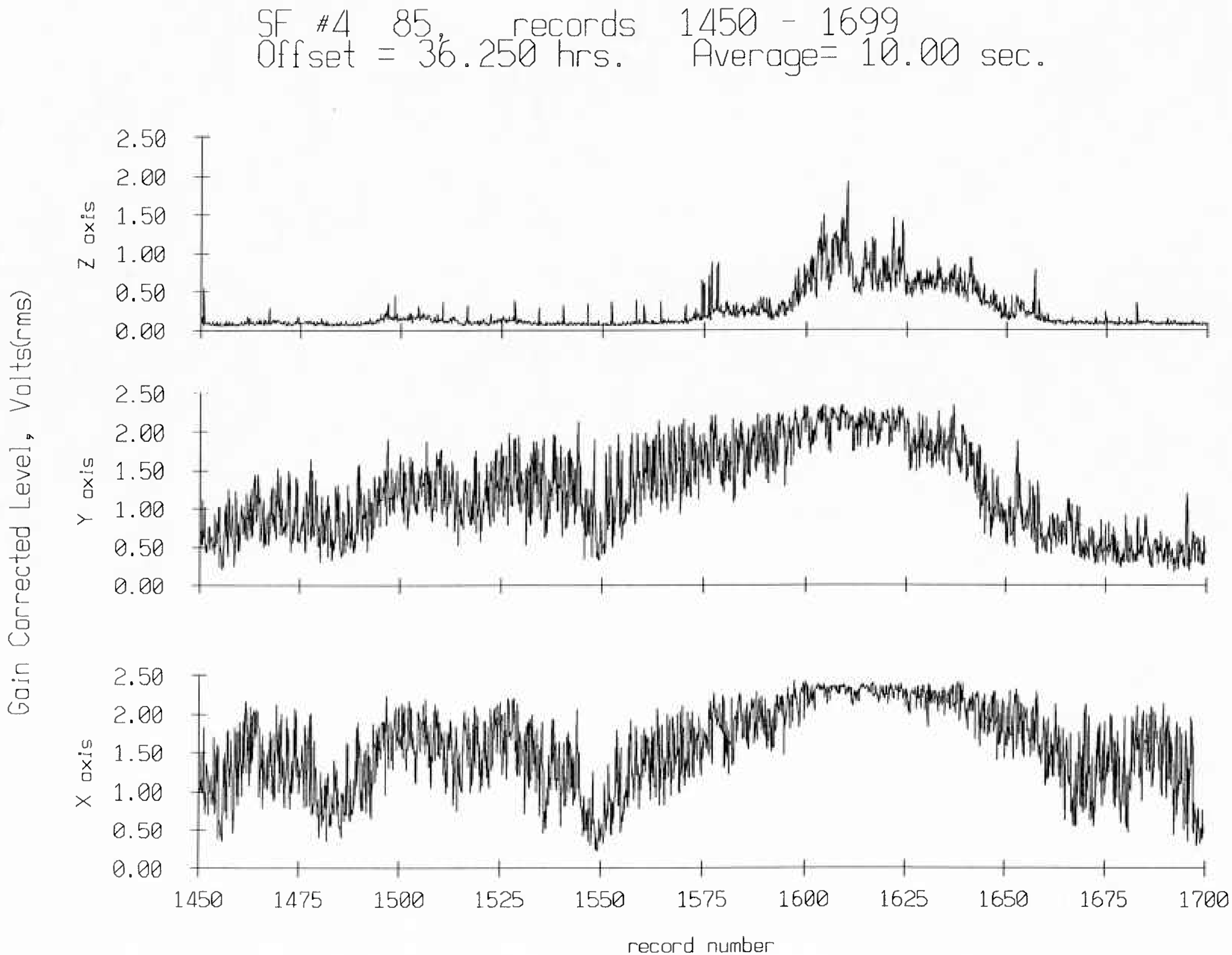

SF #4 85, records 1450 - 1699
Offset = 36.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
1450
1475
1500
1525
1550
1575
1600
1625
1650
1675
1700
record number

Figure V.2f

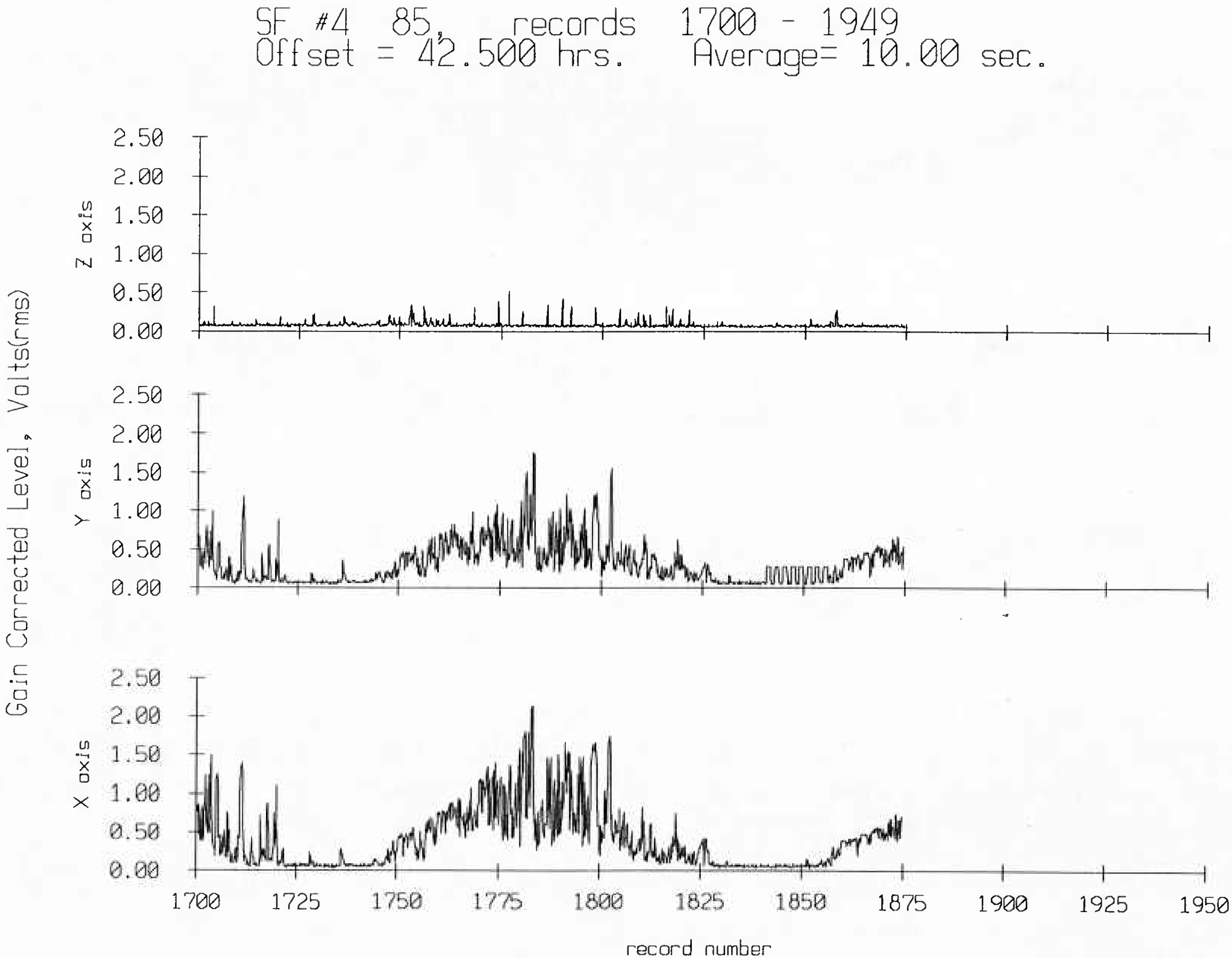

SF #4 85, records 1700 - 1949
Offset = 42.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
1700
1725
1750
1775
1800
1825
1850
1875
1900
1925
1950
record number

Figure V.2g

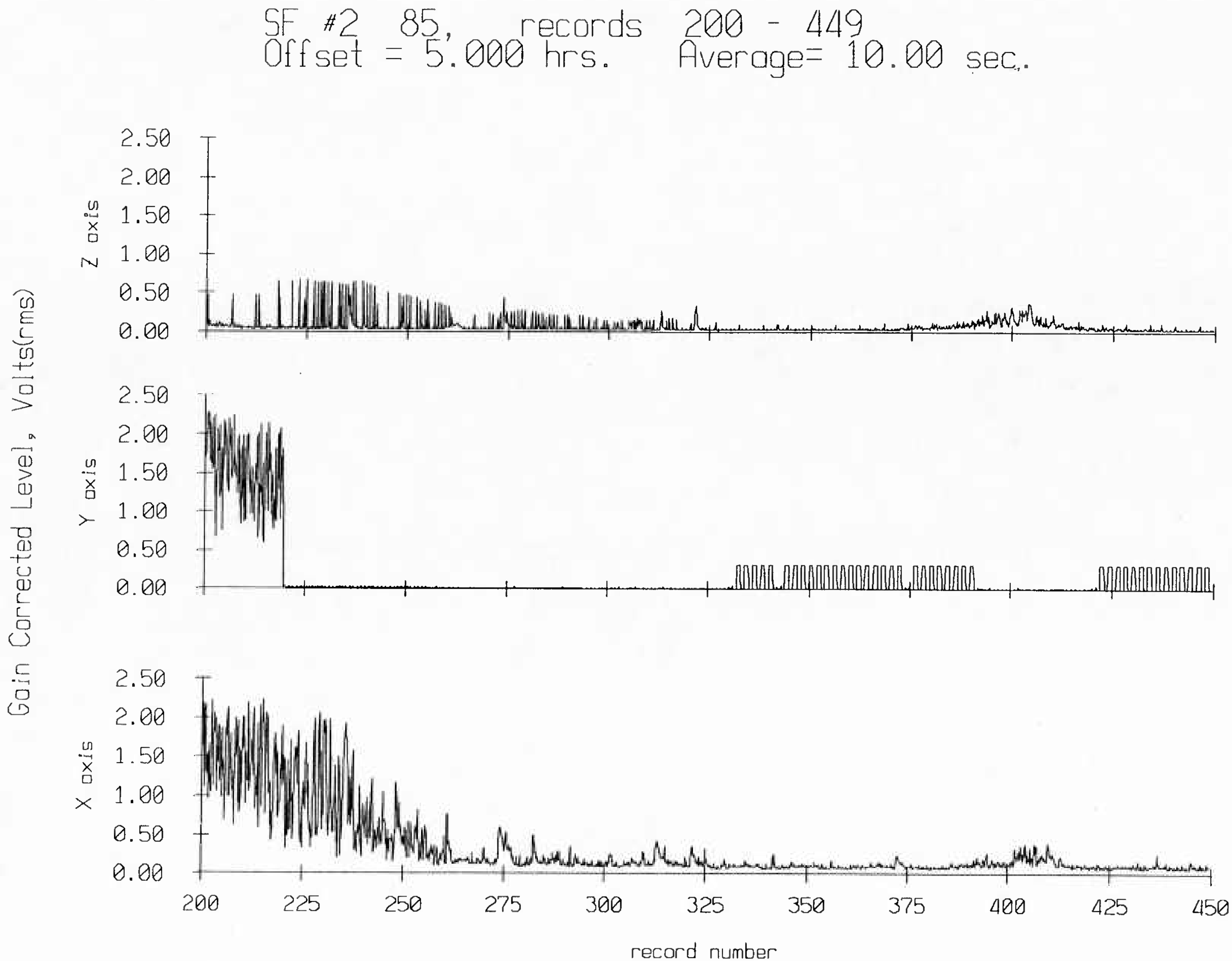
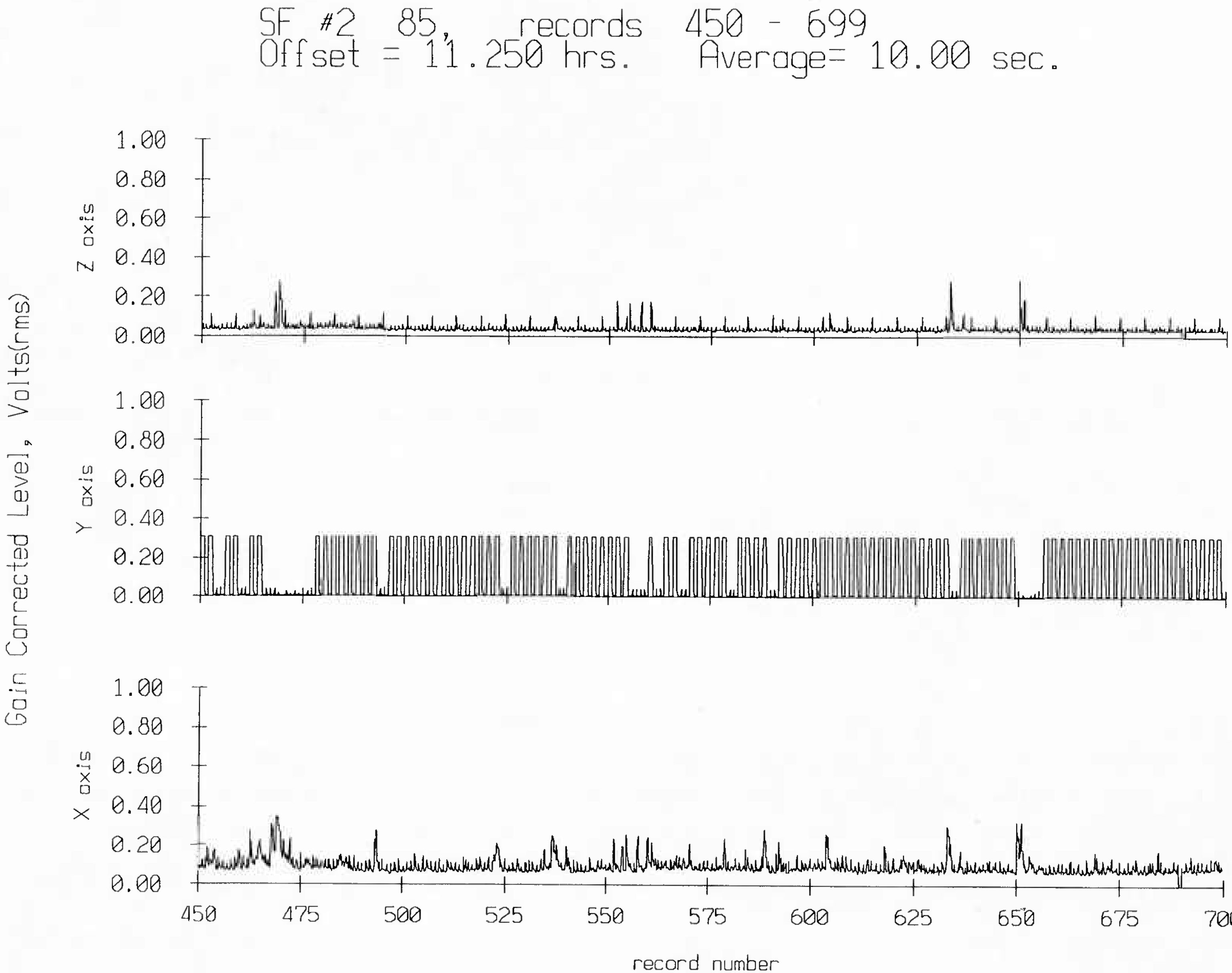

SF #2 85, records 200 - 449
Offset = 5.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
200
225
250
275
300
325
350
375
400
425
450
record number

Figure V.3a



SF #2 85, records 450 - 699
Offset = 11.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
450
475
500
525
550
575
600
625
650
675
700
record number

Figure V.3b

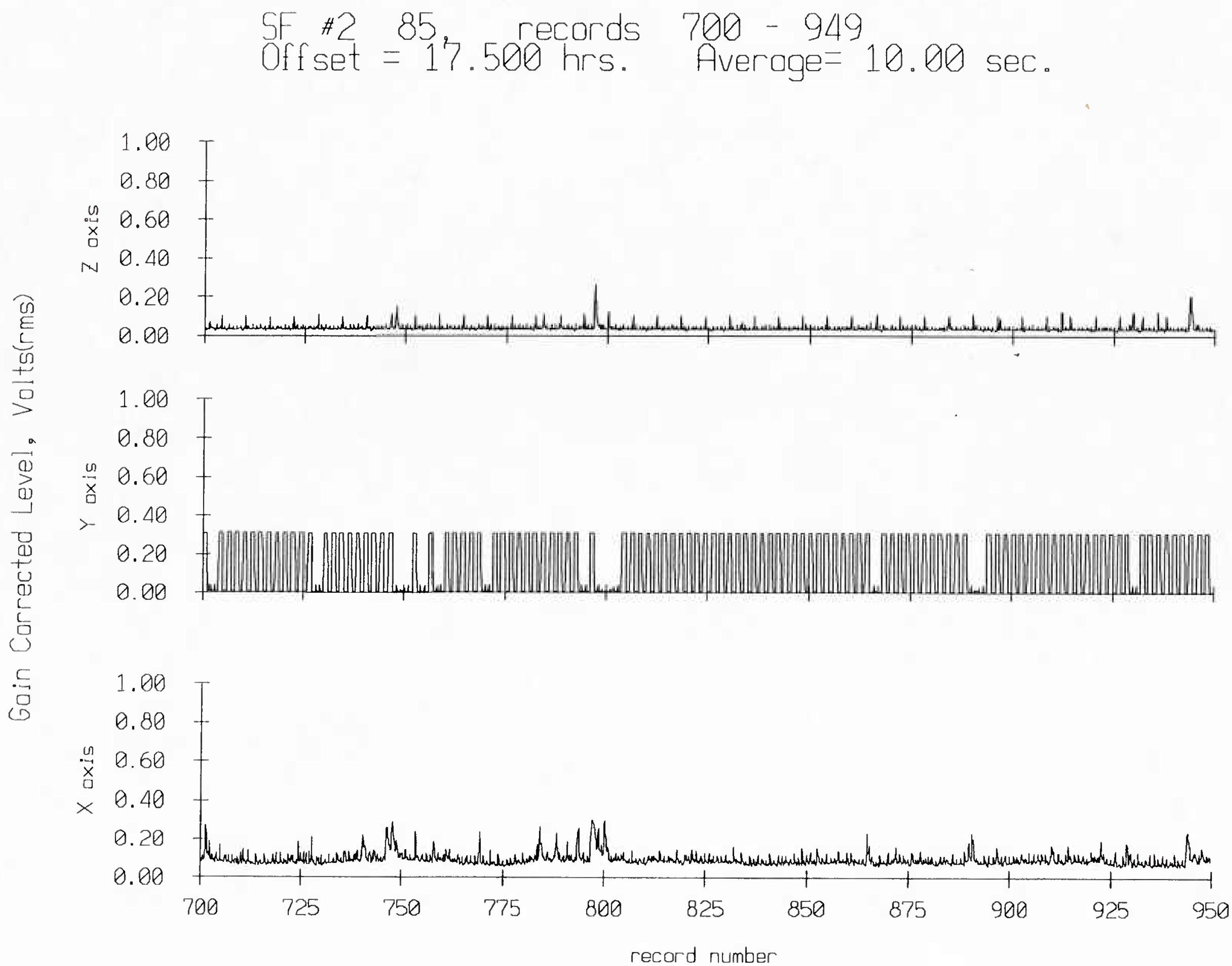

SF #2 85, records 700 - 949
Offset = 17.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
700
725
750
775
800
825
850
875
900
925
950
record number

Figure V.3c

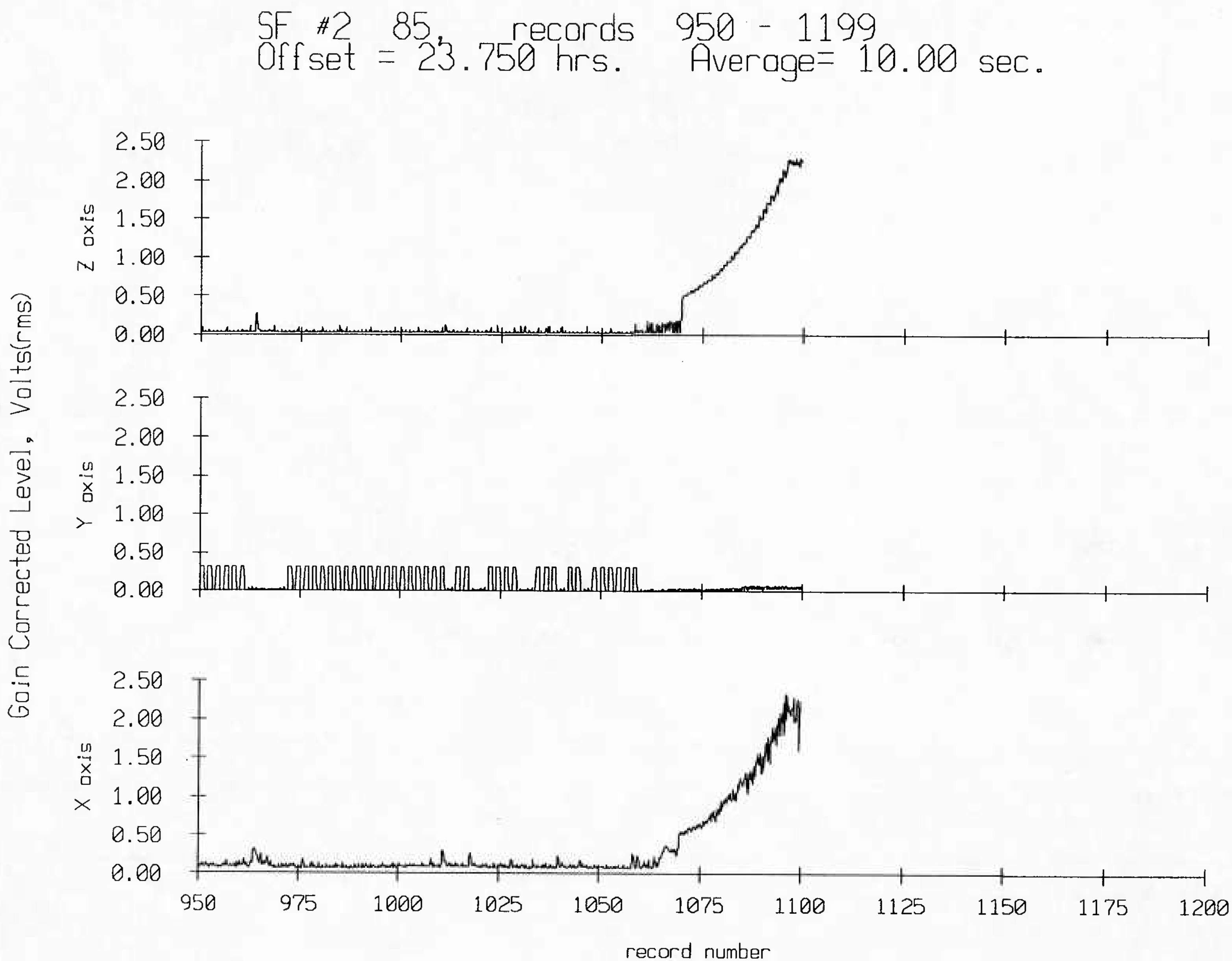

SF #2 85, records 950 - 1199
Offset = 23.750 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
950
975
1000
1025
1050
1075
1100
1125
1150
1175
1200
record number

Figure V.3d

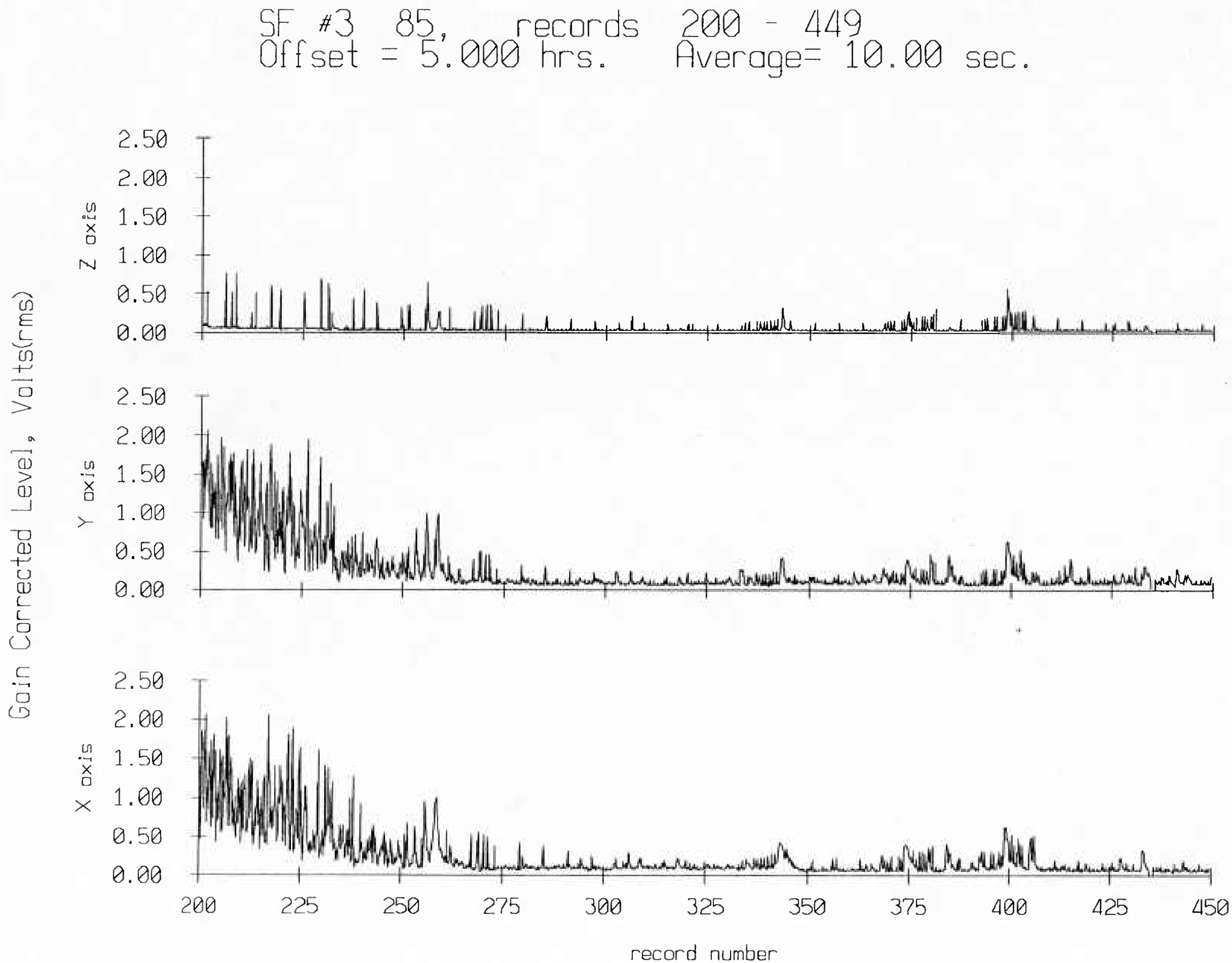

SF #3 85, records 200 - 449
Offset = 5.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
200
225
250
275
300
325
350
375
400
425
450
record number

Figure V.4a

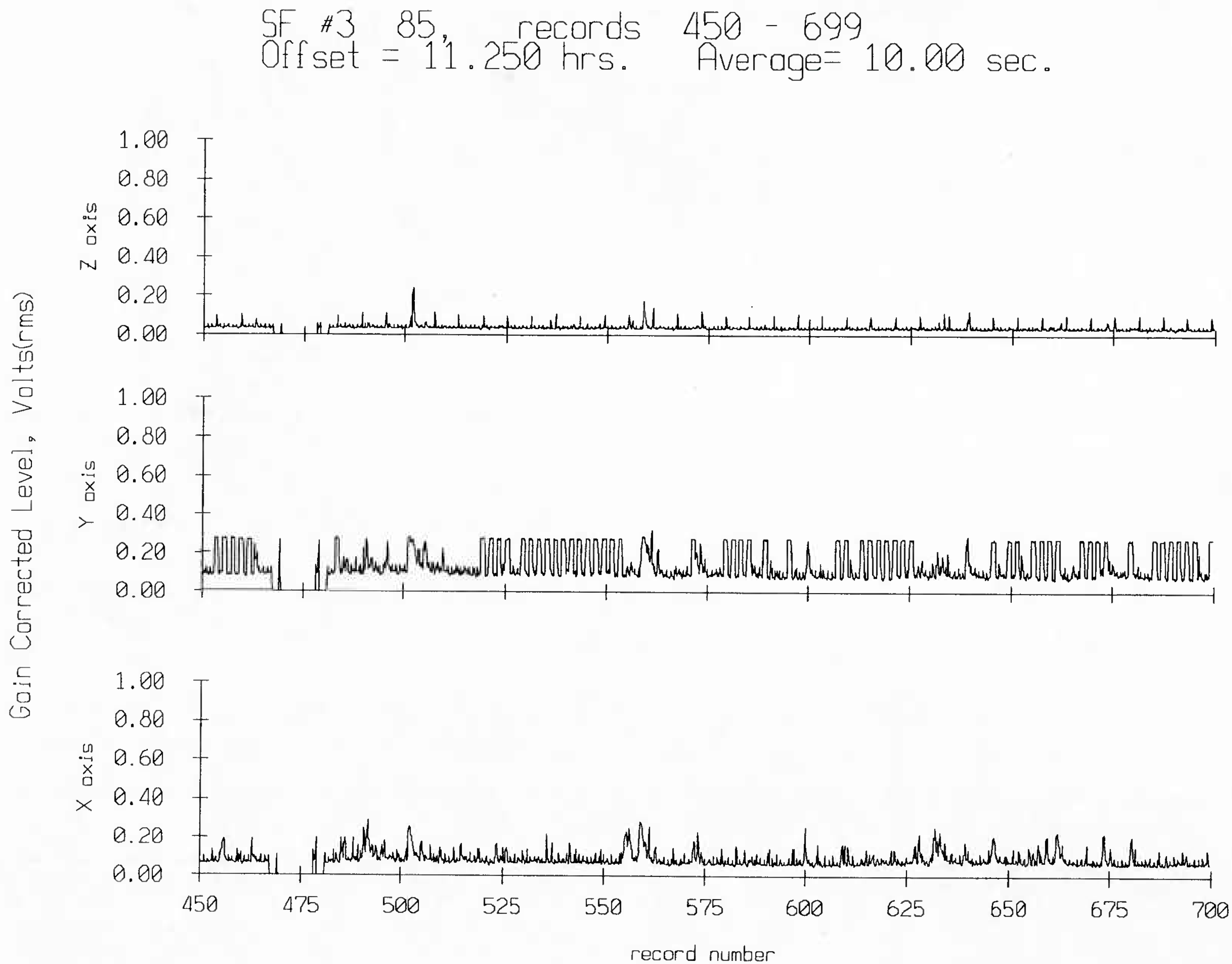

SF #3 85, records 450 - 699
Offset = 11.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
450
475
500
525
550
575
600
625
650
675
700
record number

Figure V.4b

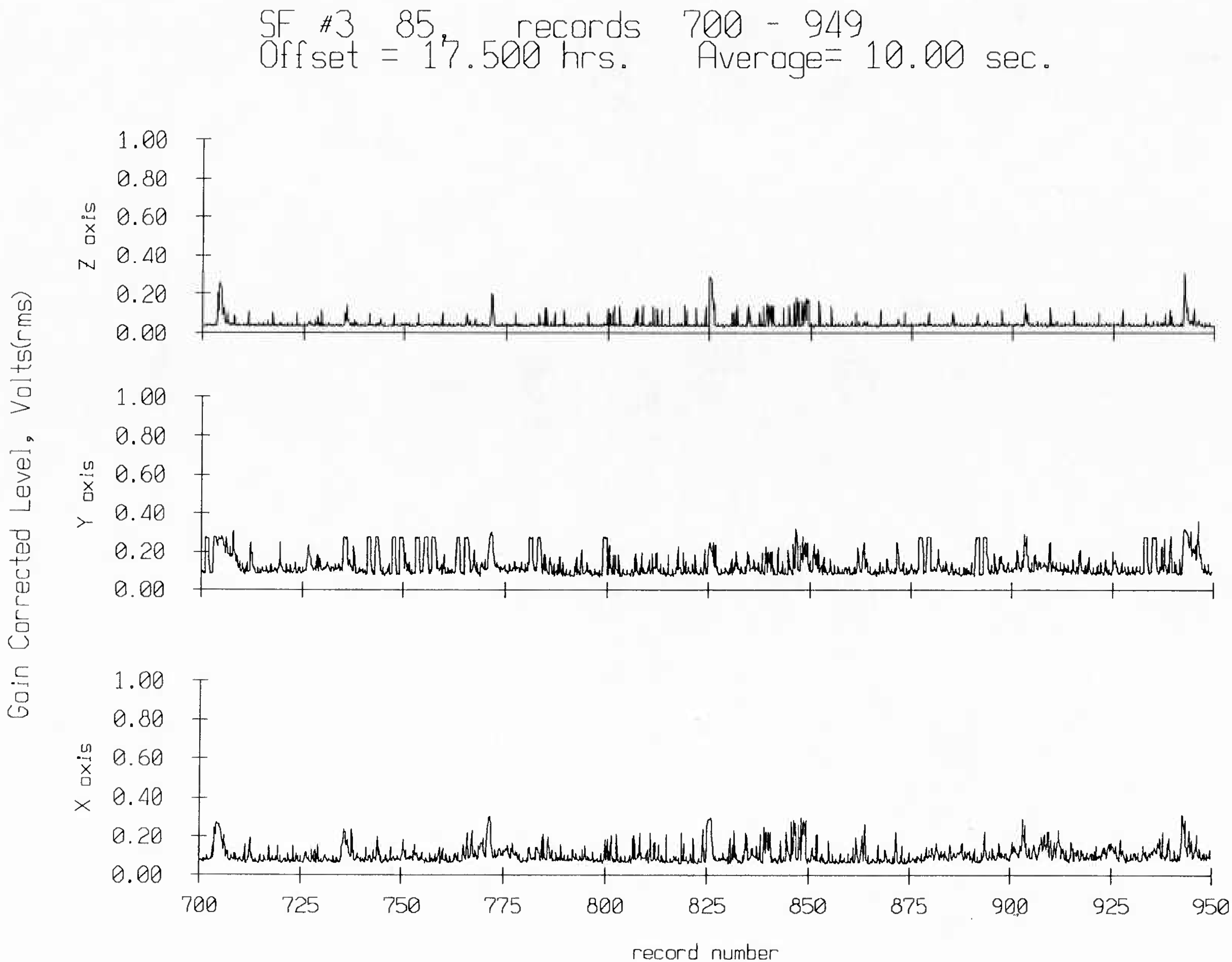

SF #3 85, records 700 - 949
Offset = 17.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
700
725
750
775
800
825
850
875
900
925
950
record number

Figure V.4c

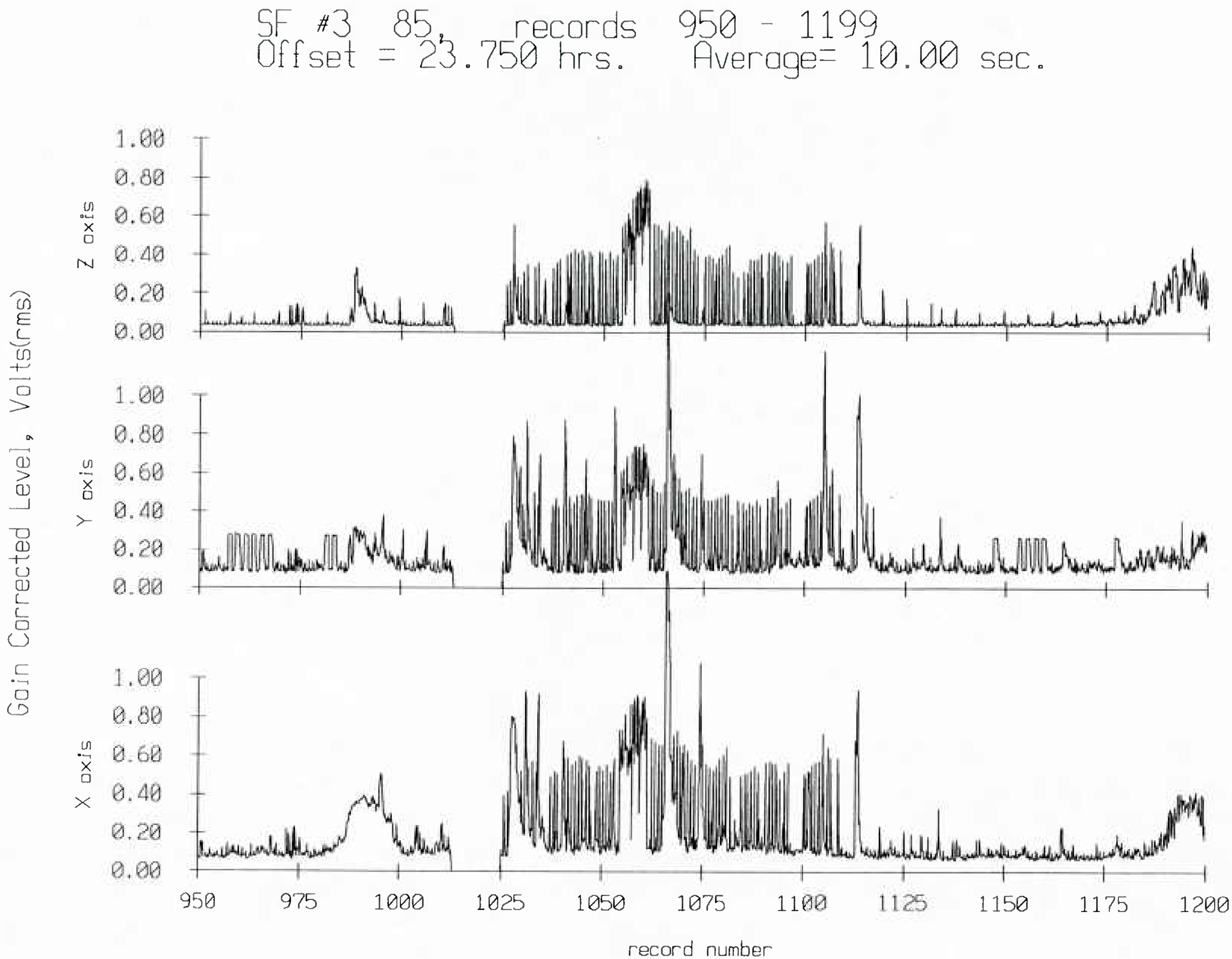

SF #3 85, records 950 - 1199
Offset = 23.750 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
950
975
1000
1025
1050
1075
1100
1125
1150
1175
1200
record number

Figure V.4d

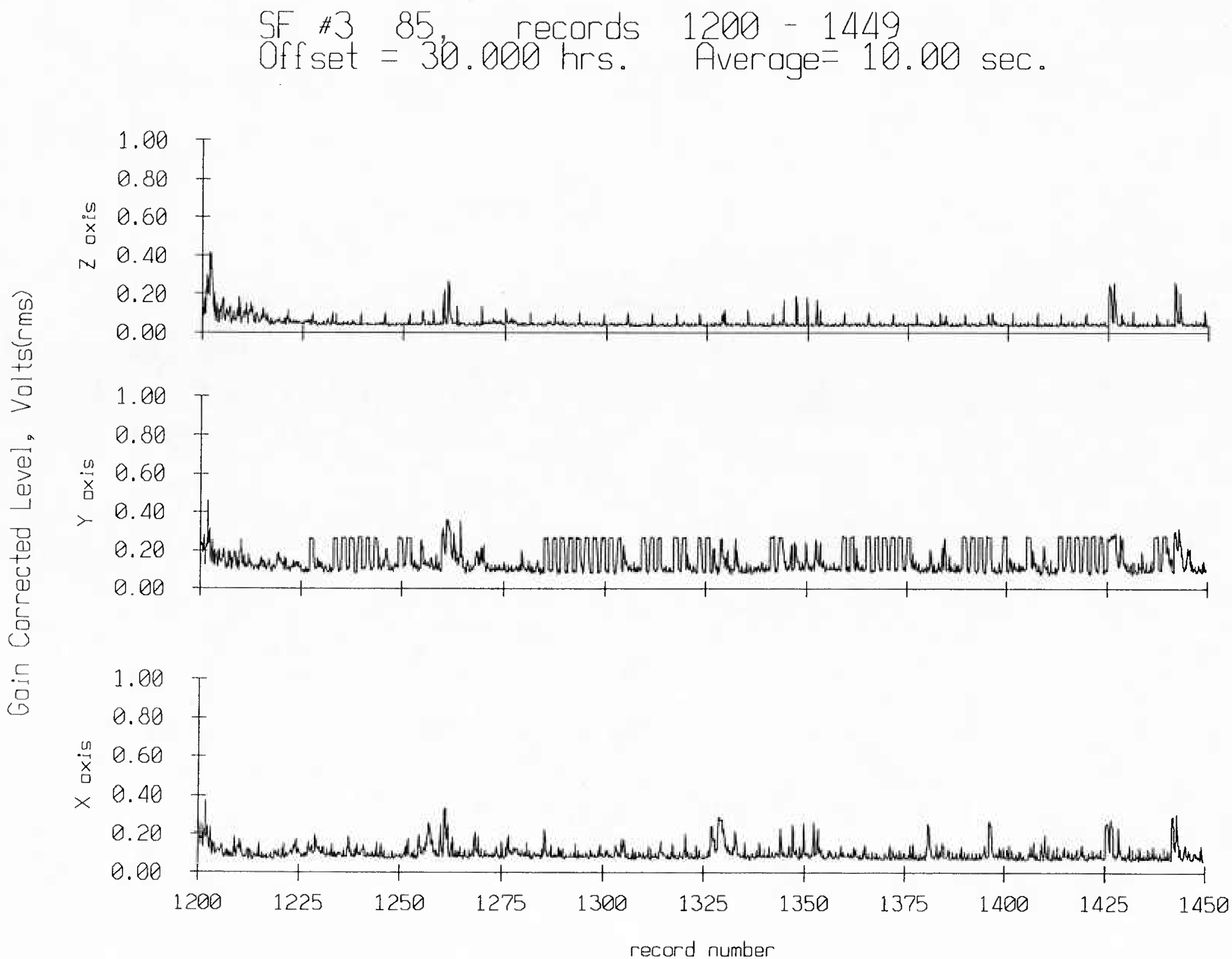

SF #3 85, records 1200 - 1449
Offset = 30.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
1200
1225
1250
1275
1300
1325
1350
1375
1400
1425
1450
record number

Figure V.4e

SF #3 85, records 1450 - 1699
Offset = 36.250 hrs. Average= 10.00 sec.

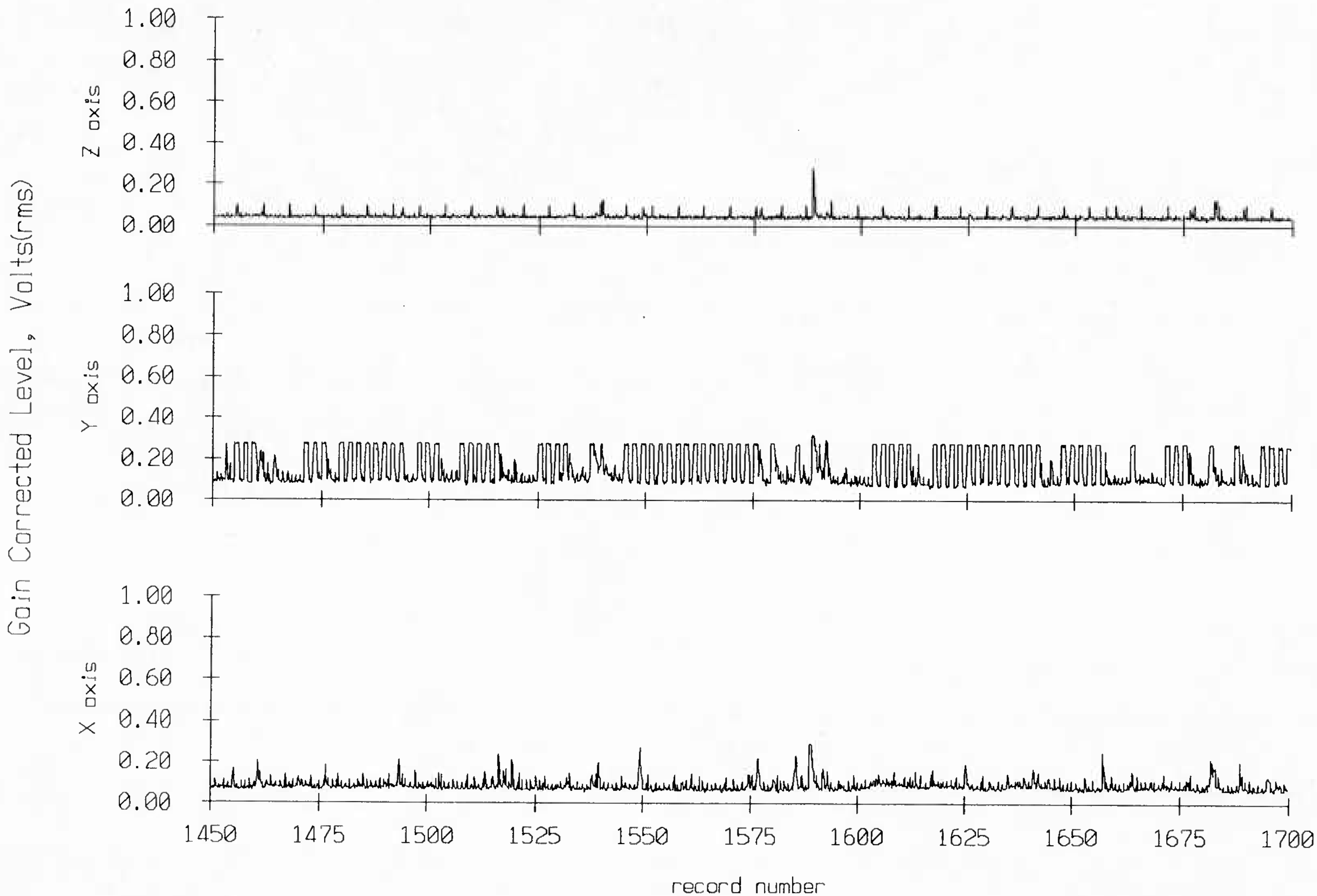
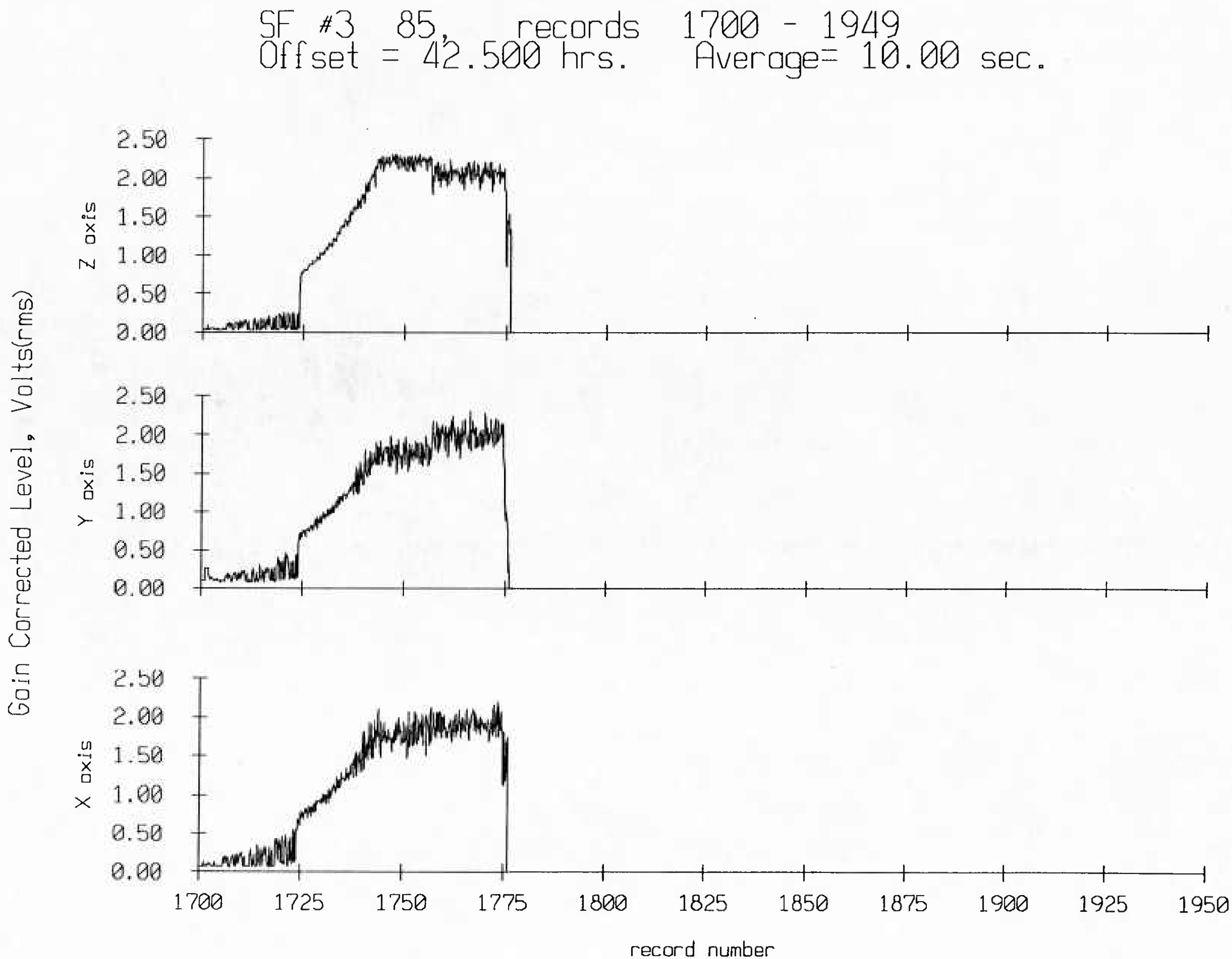


Figure V.4f



SF #3 85, records 1700 - 1949
Offset = 42.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
1700
1725
1750
1775
1800
1825
1850
1875
1900
1925
1950
record number

Figure V.4g

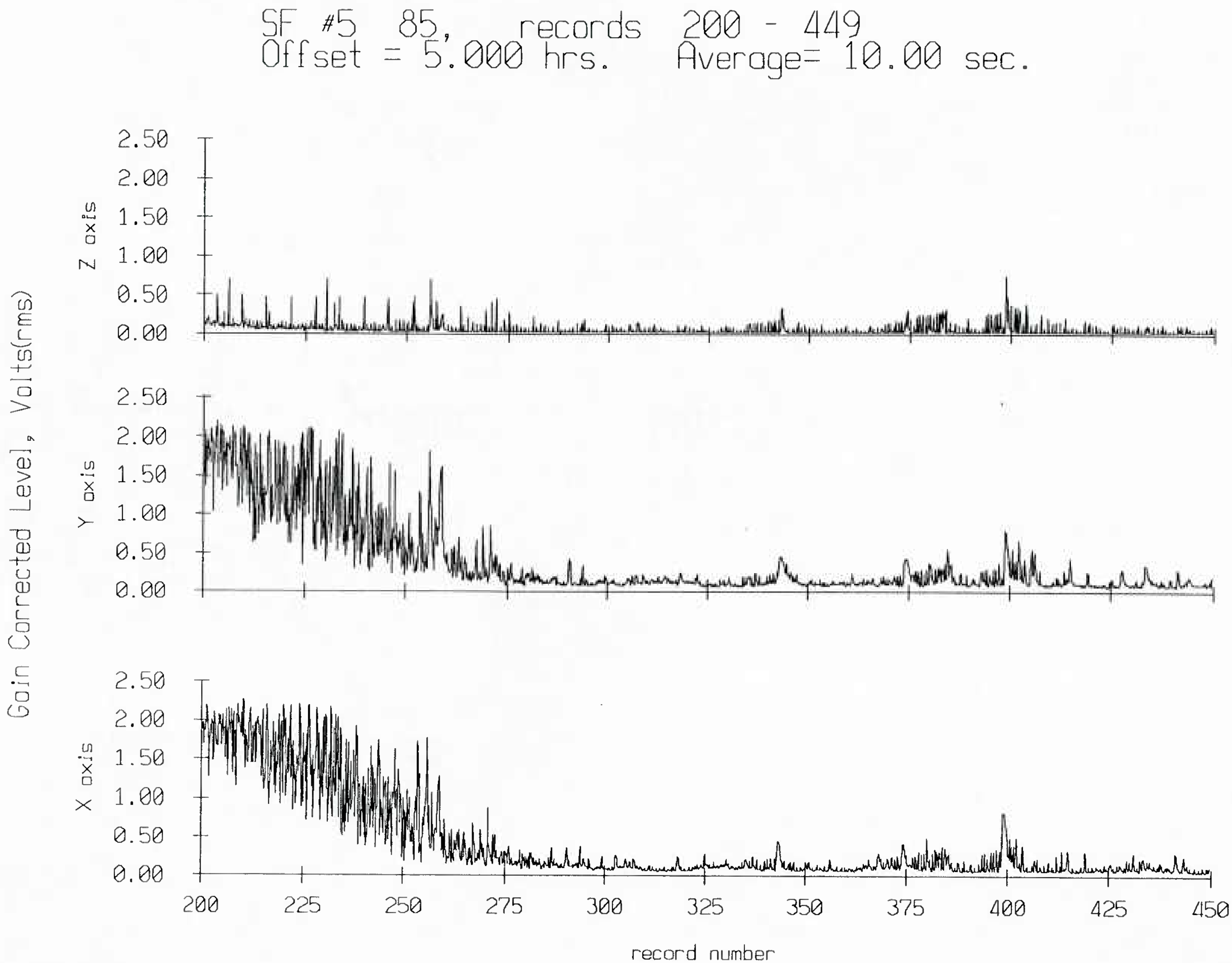
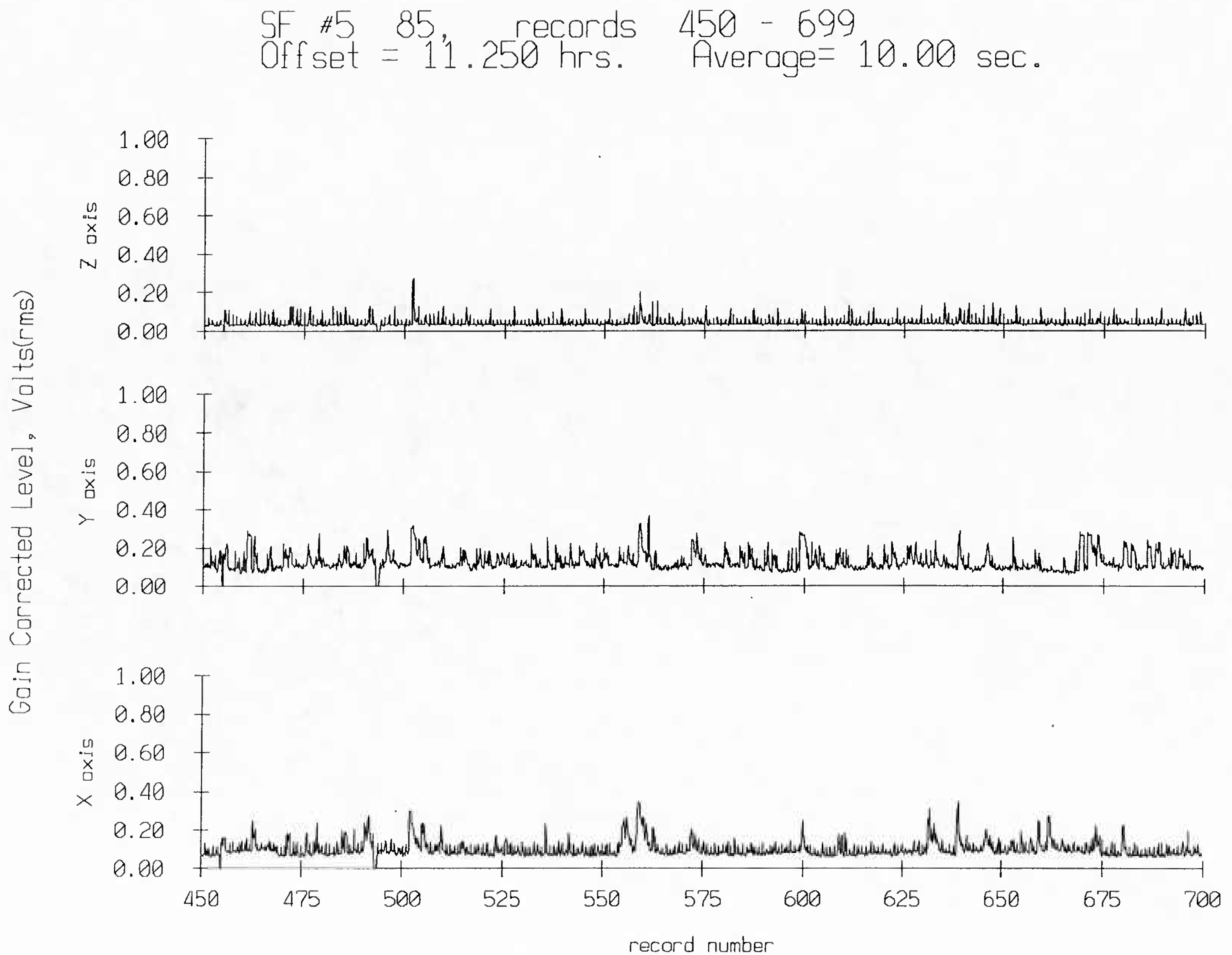

SF #5 85, records 200 - 449
Offset = 5.000 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
2.50
2.00
1.50
1.00
0.50
0.00
200
225
250
275
300
325
350
375
400
425
450
record number

Figure V.5a



SF #5 85, records 450 - 699
Offset = 11.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
450
475
500
525
550
575
600
625
650
675
700
record number

Figure V.5b

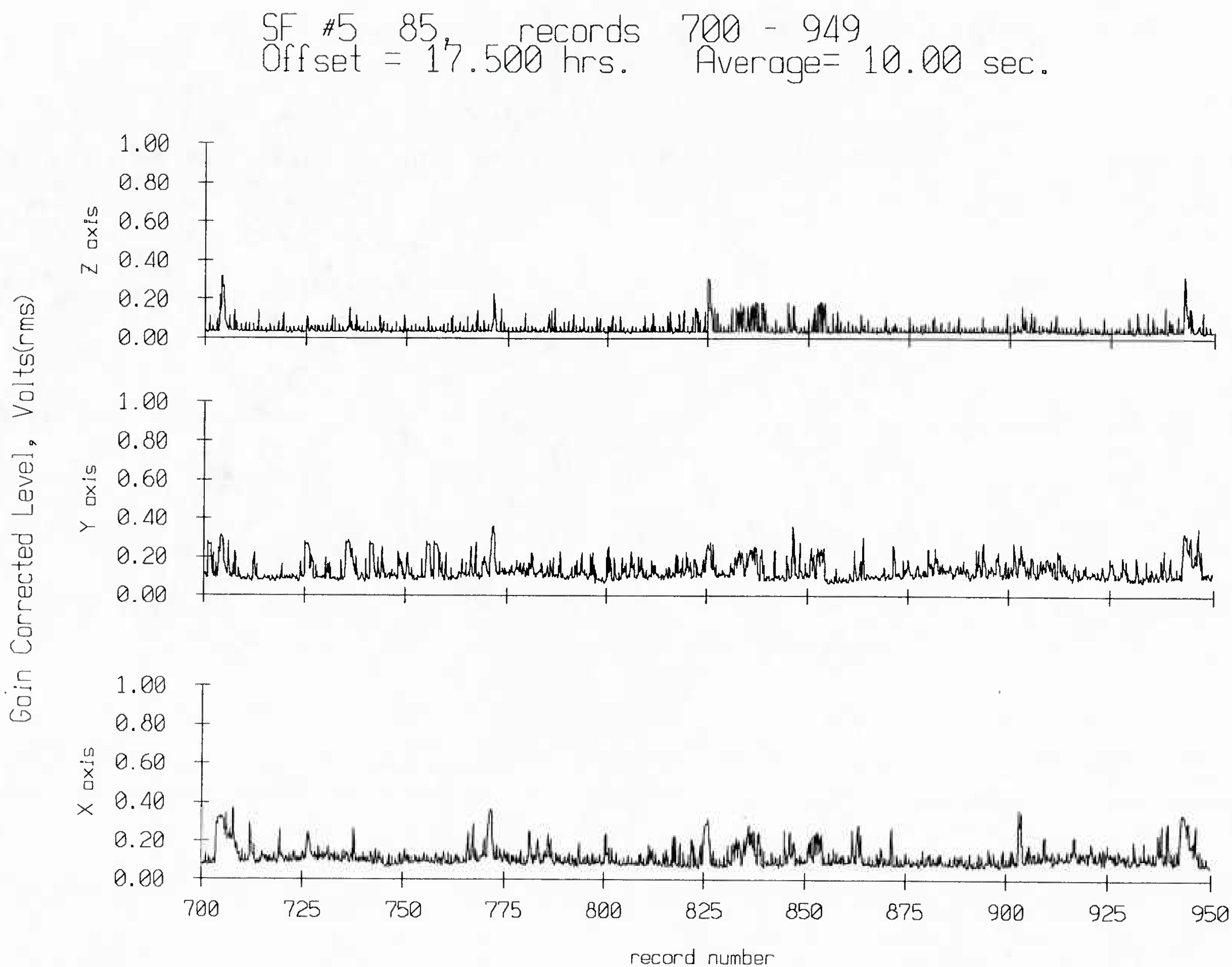

SF #5 85, records 700 - 949
Offset = 17.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
700
725
750
775
800
825
850
875
900
925
950
record number

Figure V.5c

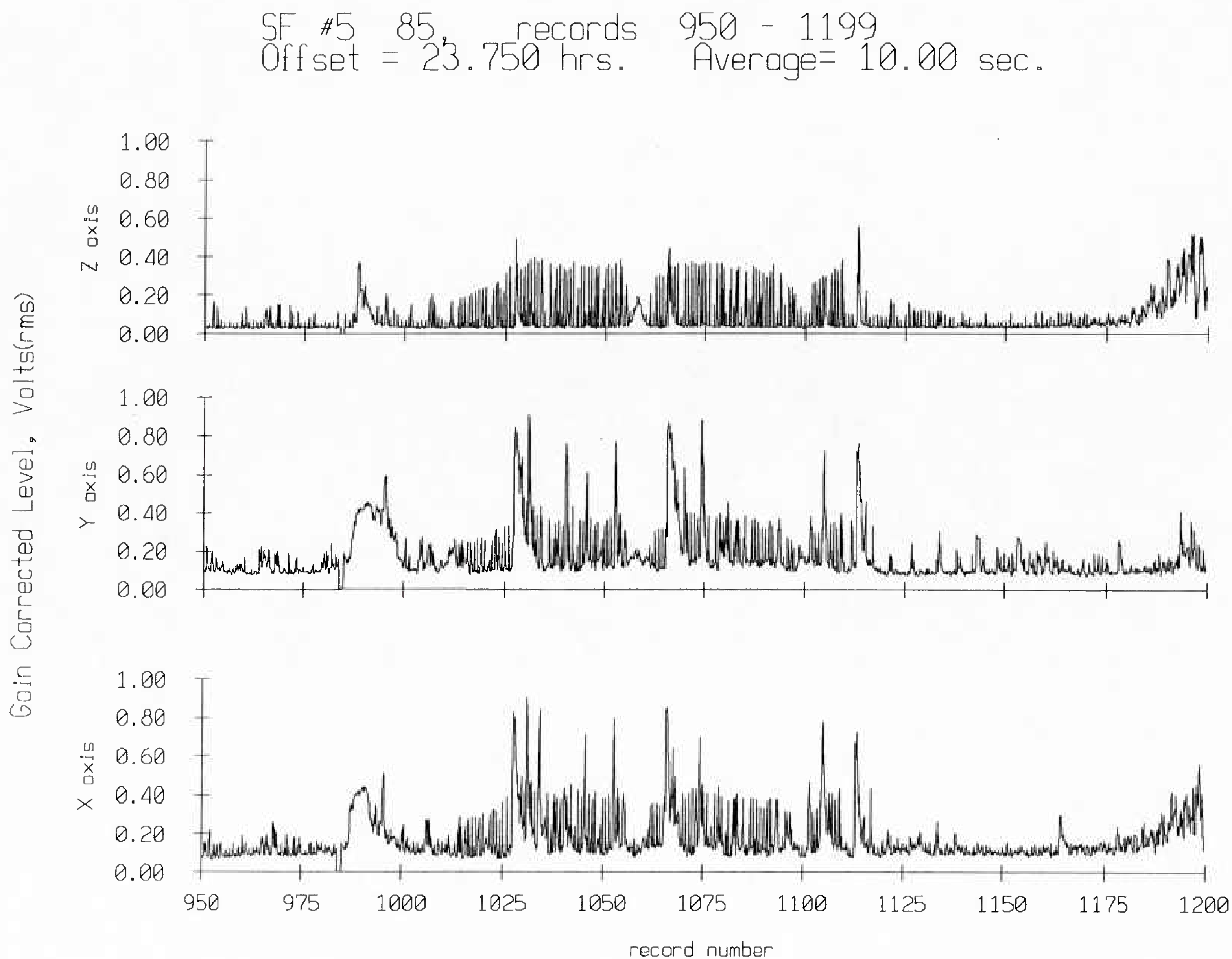

SF #5 85, records 950 - 1199
Offset = 23.750 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
950
975
1000
1025
1050
1075
1100
1125
1150
1175
1200
record number

Figure V.5d

SF #5 85, records 1200 - 1449
Offset = 30.000 hrs. Average= 10.00 sec.

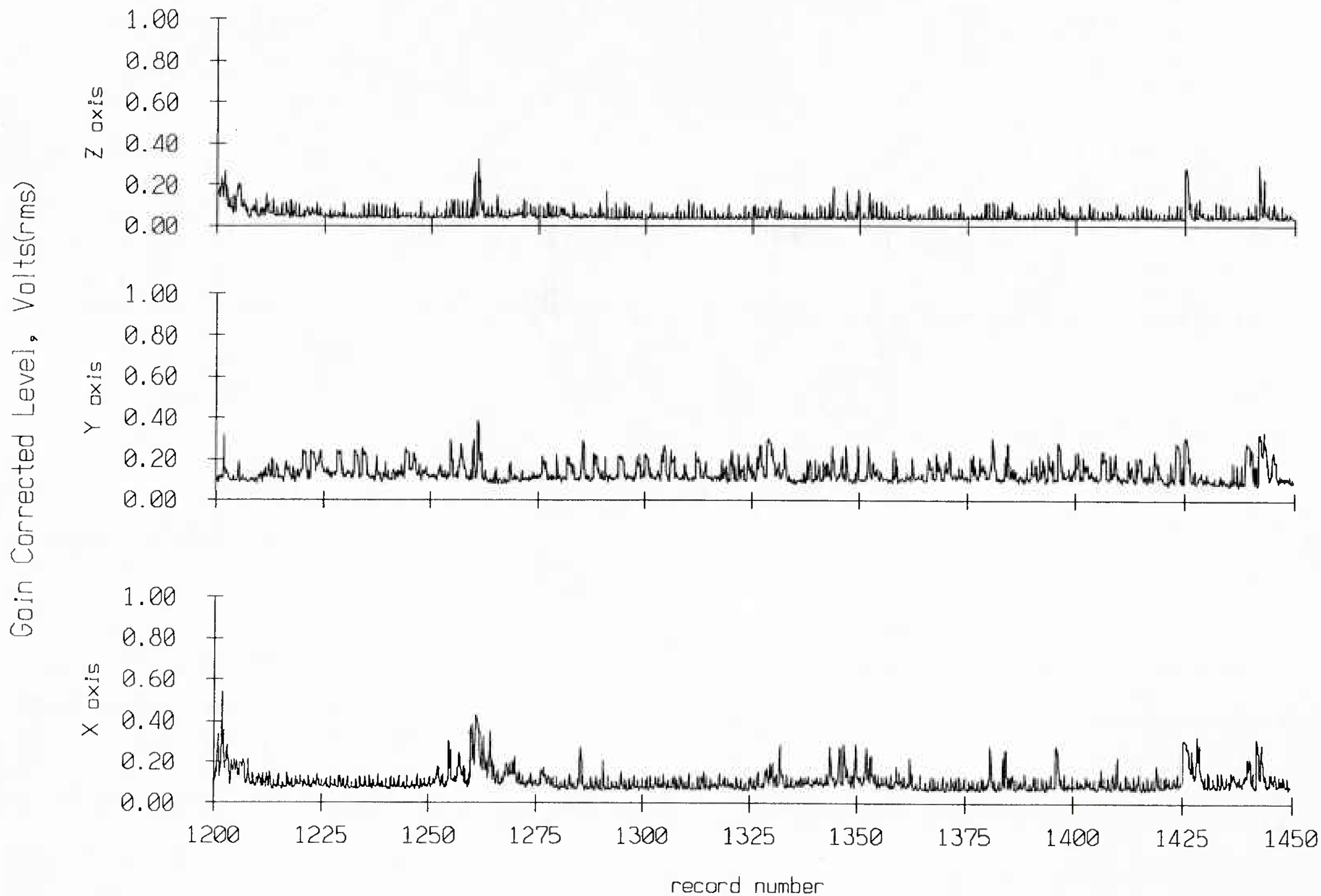


Figure V.5e

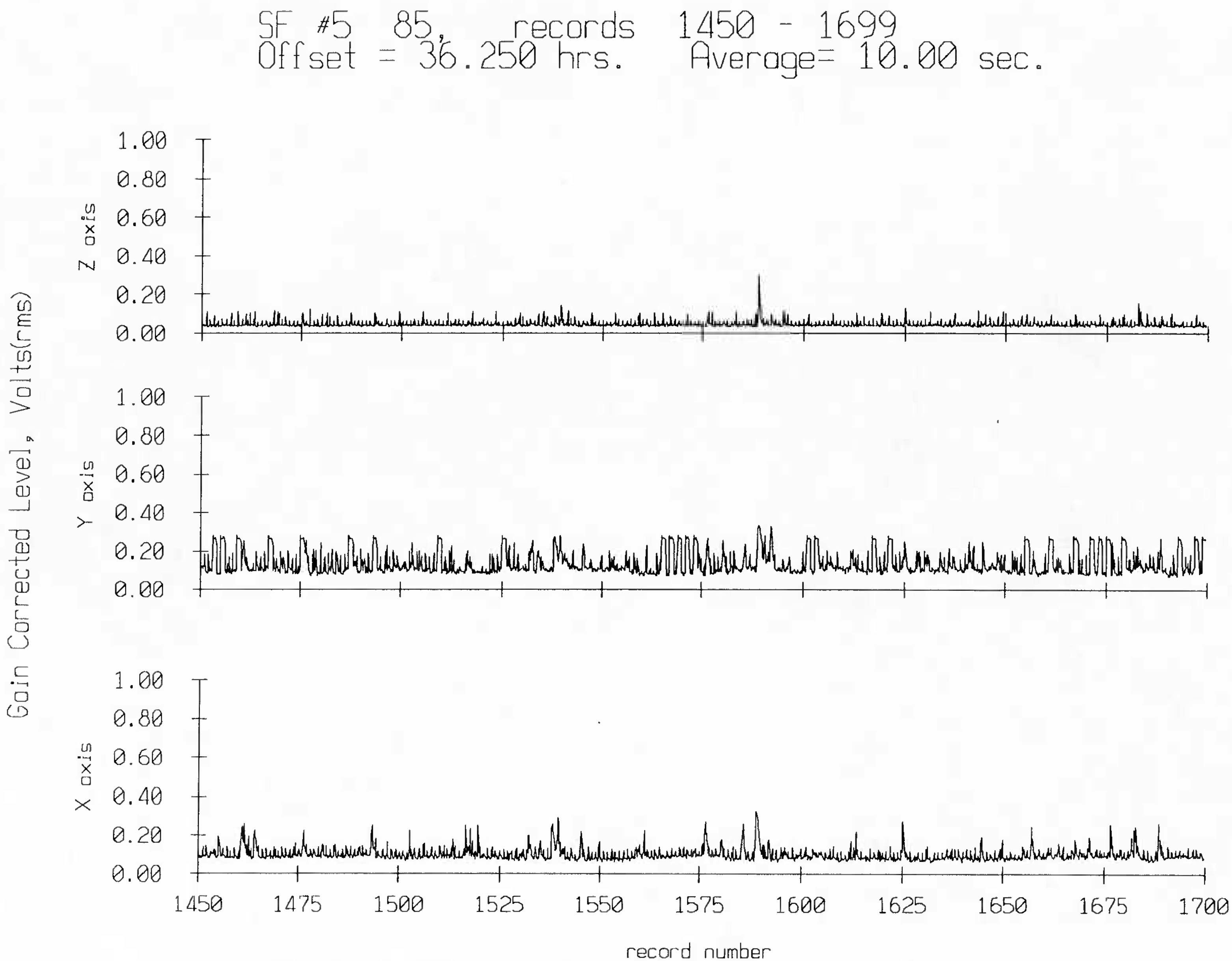

SF #5 85, records 1450 - 1699
Offset = 36.250 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
1.00
0.80
0.60
0.40
0.20
0.00
1450
1475
1500
1525
1550
1575
1600
1625
1650
1675
1700
record number

Figure V.5f

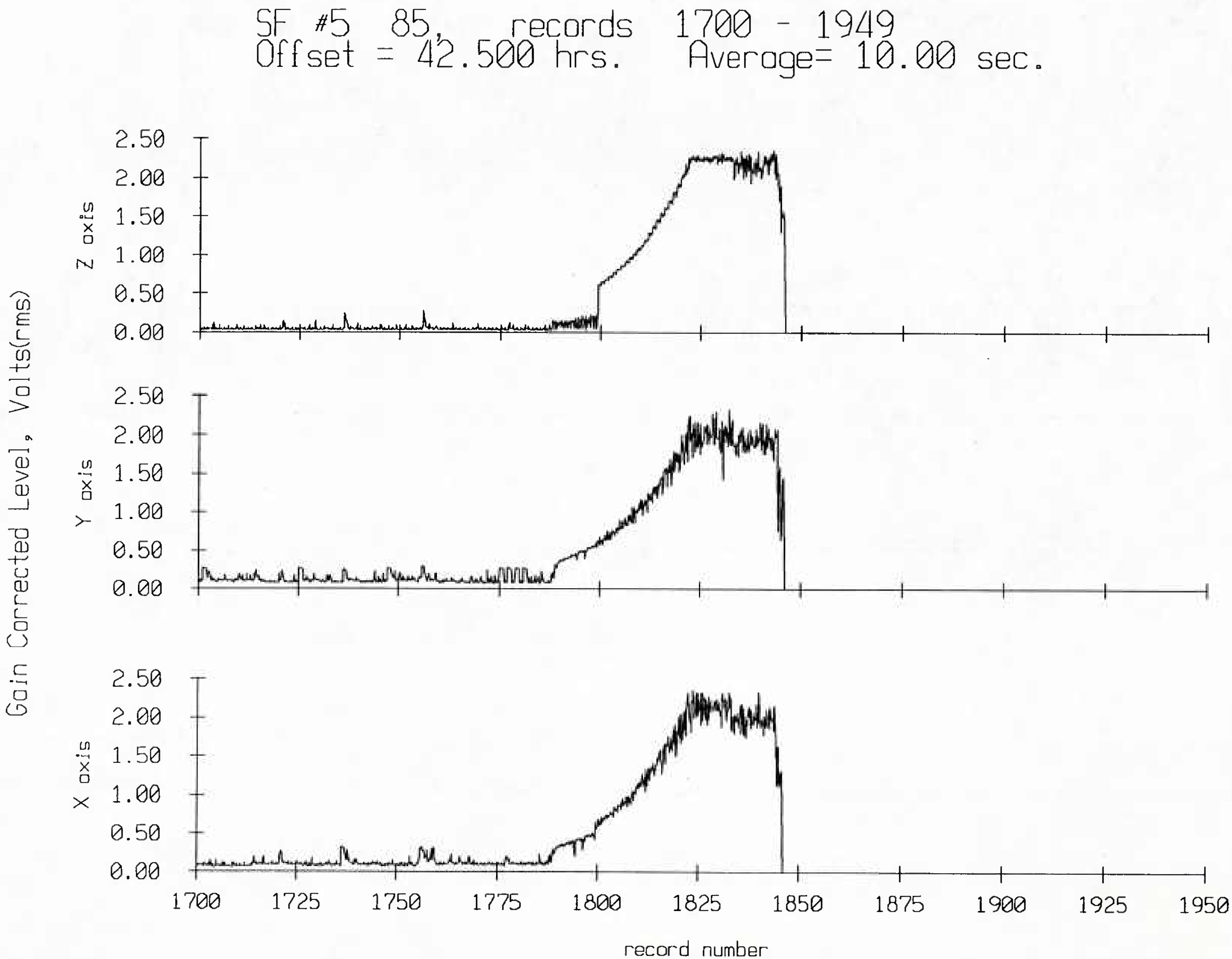

SF #5 85, records 1700 - 1949
Offset = 42.500 hrs. Average= 10.00 sec.
Gain Corrected Level, Volts(rms)
Z axis
Y axis
X axis
0.00
0.50
1.00
1.50
2.00
2.50
1700
1725
1750
1775
1800
1825
1850
1875
1900
1925
1950
record number

Figure V.5g

VI. Velocity Time Series

This Section contains plots of selected particle velocity data from the five floats. Particular records were selected for inclusion in this Section in order to show that particle velocity data from the floats contain features corresponding to events which are known to have occurred during the deployment. Table VI.1 shows the records selected and the events they contain. Interpretive information is provided in subsequent paragraphs.

Figures	Record Number for: Float 0	Float 2	Floats 3-5	Events Contained
VI.1 - VI.5	761	233	1025	acoustic interrogation pulses, positioning system pulse
VI.6 - VI.13	814-815	286-287	1078-1079	acoustic interrogation pulses, seal bomb explosions, positioning system pulses
VI.14 - VI.16		588-590	1380-1382	y axis clipping (float 2), x and y axis clipping (all floats), positioning system pulse
VI.17 - VI.21	1211	683	1475	y axis clipping (floats 3 and 5), positioning system pulse

Table VI.1: Key to Figures, showing records and events contained.

Interpretation of Figures VI.1 - VI.5

Evidence of the floats receiving and responding to acoustic interrogation pulses from the ship may be seen in these Figures. The disturbance shown in the record is caused by the float's reply pulse rather than the interrogation pulse itself. The floats are interrogated sequentially at 16 second intervals, and Table VI.2 shows when the floats received interrogation pulses and their approximate range from the ship at that time. Pulse receipt times were read from the Figures and ranges from the ship are taken from experiment logbook entries. The floats did not receive interrogation pulses at exactly 16 second intervals because of their different ranges from the ship and different internal clock rates.[3] Note that float 5's record contains a positioning system pulse 20 seconds into the record (Figure VI.5).

Float	Time (seconds)	Approx. range from the ship (m)
5	13	3641
0	31	4000
2	45	1466
3	64	5300
4	79	3980

Table VI.2: Interrogation pulse receipt times for Figures VI.1 - VI.5.

Interpretation of Figures VI.6 - VI.13

These Figures show the float's receipt of interrogation pulses and of disturbances from seal bomb explosions which occurred during the deployment (Section I). Table VI.3 summarizes when the floats received interrogation pulses and the approximate range from the ship at that time. Evidence of seal bomb explosions may be seen at 67 seconds into record 814 of float 0 and record 1078 of float 3, 4 and 5, and at 3 seconds into record 815 of float 0 and record 1079 of float 3, 4 and 5. Three of these events are shown in expanded form in Figures VI.11 through VI.13. Neither explosion is evident in float 2's record. Note also that acoustic positioning system pulses were emitted by float 4 in record 1078 and float 5 in record 1079 at 20 seconds into the record.

Float	Record/time (sec)	Approx. range from the ship (m)
0	814/2	5711
2	286/17	4593
3	1078/33	3164
4	1078/50	5237
5	1078/63	3928
0	814/82	5683
2	287/7	4657
3	1079/23	3310
4	1079/40	5245
5	1079/53	4070
0	815/72	5671
2	287/87	4700

Table VI.3: Interrogation pulse receipt times for Figures VI.6 - VI.10.

Interpretaion of Figures VI.14 - VI.16

Figures VI.14-VI.16 contain particle velocity data from only the 3 floats deployed to 1200 meters. and were chosen from a period when no external events took place. Float 2's y axis data are hard clipped in record 588 (Figure VI.14). The period of the clipped signal (about 2.8 seconds) is thought to be related to the decay constant of the resonant, overdriving amplifier circuit responsible for the clipping. Float 2's y axis data are of very low level in records 589 and 590. All three floats display x axis clipping near the end of the first record and start of the second record. This same feature is evident in y axis data from floats 3 and 5 and appears to be the result of variations in signal level exceeding the dynamic range of the analog to digital converter. The transient in z axis data at the start of each record is thought to be associated with starting and stopping the tape recorder between record.[3]

In general, x and y direction velocity amplitudes are greater than those in the z direction. This is reasonable in light of published ocean ambient noise directionality measurements which indicate that low frequency sound pressure levels are higher in the horizontal direction than at higher or lower incident angles.[5,6]

Interpretation of Figures VI.17 - VI.21

No external events occurred during the records shown in these Figures, but they do reflect peculiarities in the floats' functioning. Data from float 0 are very low in all channels. Note that the float's AGC level was correspondingly high during this record (Figure IV.1).

Float 2's x and z axis data are reasonable while y data are heavily attenuated. Y axis data in both floats 3 and 5 contain hard clipped waveforms with periods of about 3.5 and 5.4 seconds, respectively, which is attributed to the aforementioned amplifier oscillation problem. X and z data appear reasonable. Float 4's data appear reasonable for a bottomed float. An acoustic range pulse was emitted by float 5 at 20 seconds into record 1475.

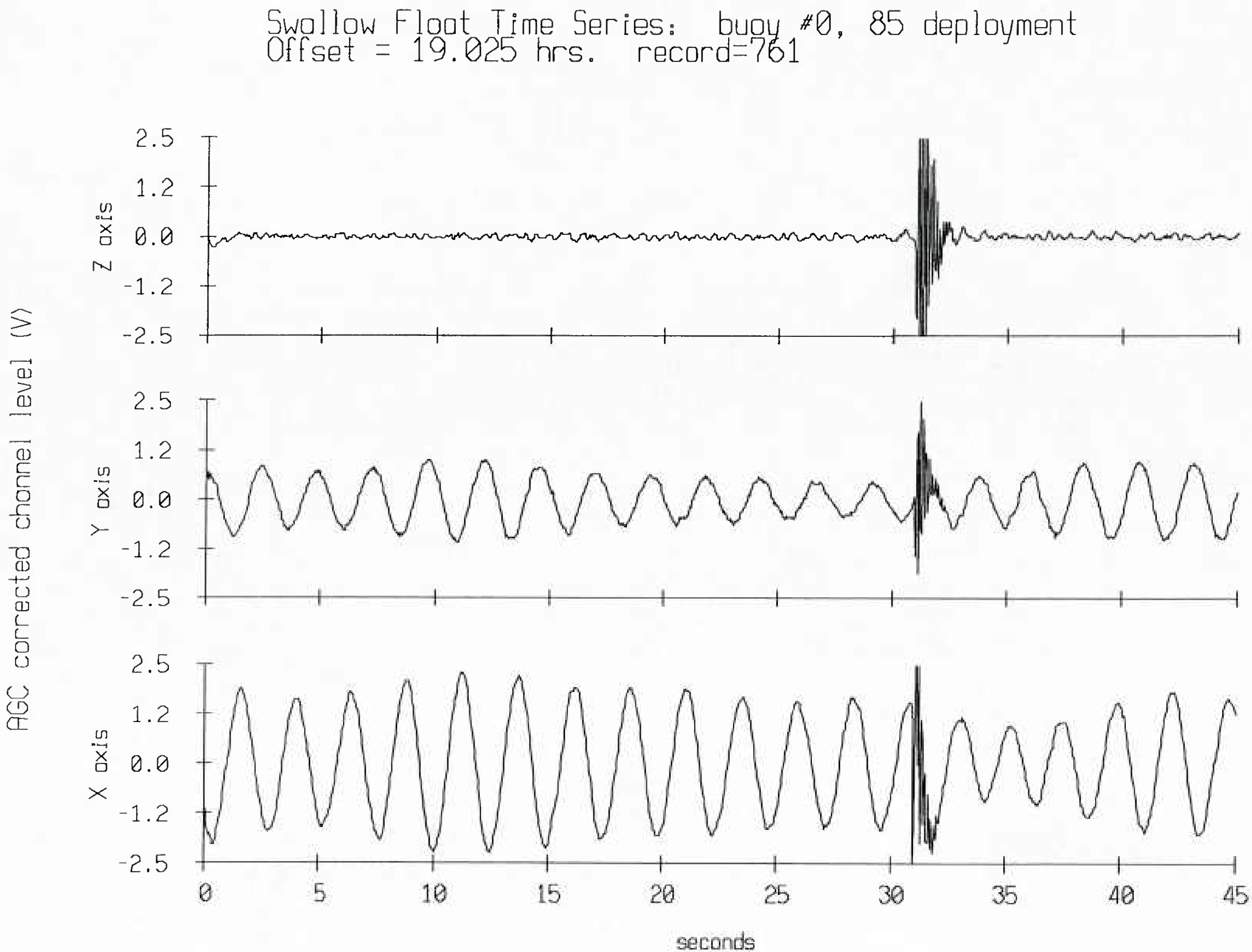
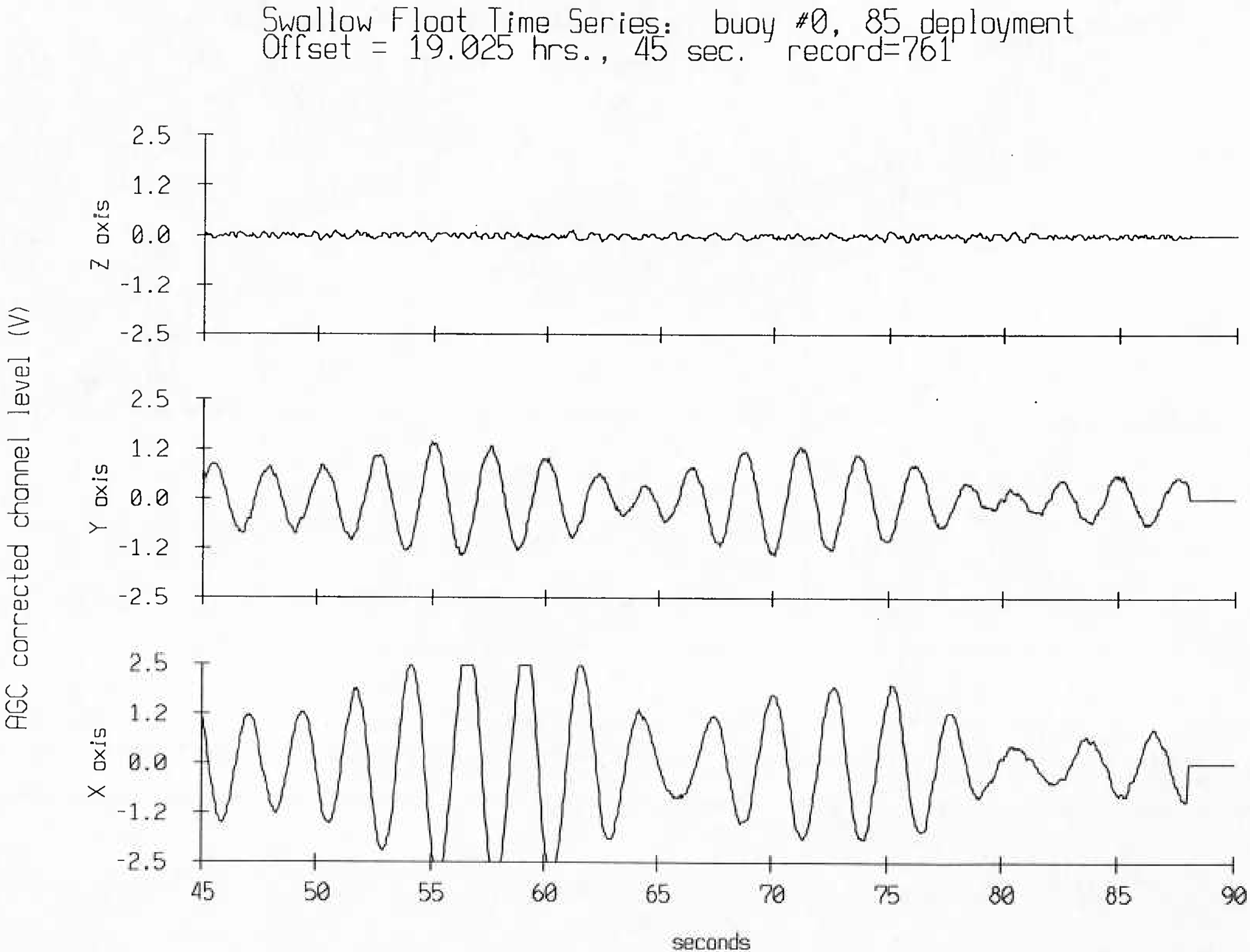
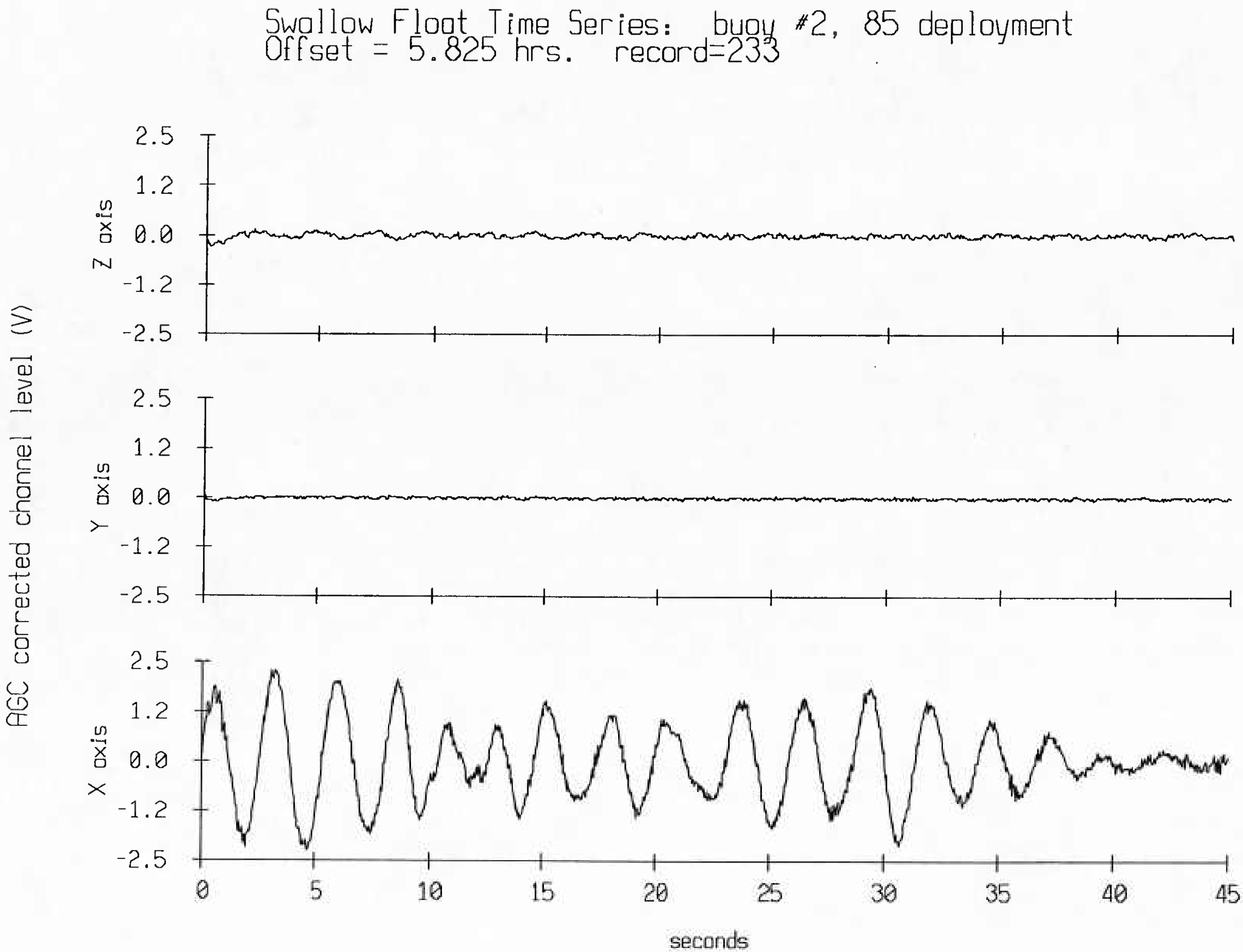

Swallow Float Time Series: buoy #0, 85 deployment
Offset = 19.025 hrs. record=761
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.1a



Swallow Float Time Series: buoy #0, 85 deployment
Offset = 19.025 hrs., 45 sec. record=761
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.1b



Swallow Float Time Series: buoy #2, 85 deployment
Offset = 5.825 hrs. record=233
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.2a

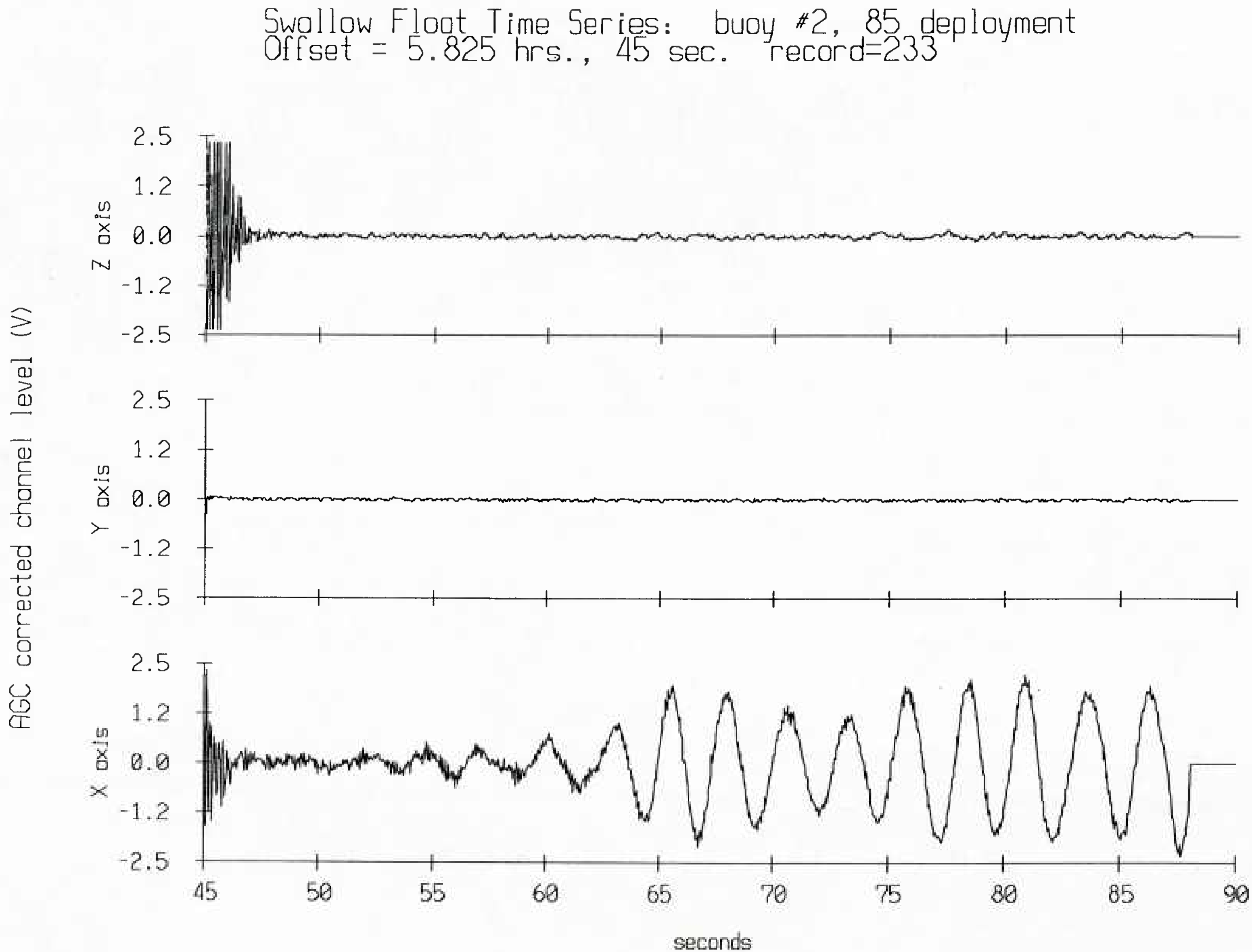

Swollow Float Time Series: buoy #2, 85 deployment
Offset = 5.825 hrs., 45 sec. record=233
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.2b

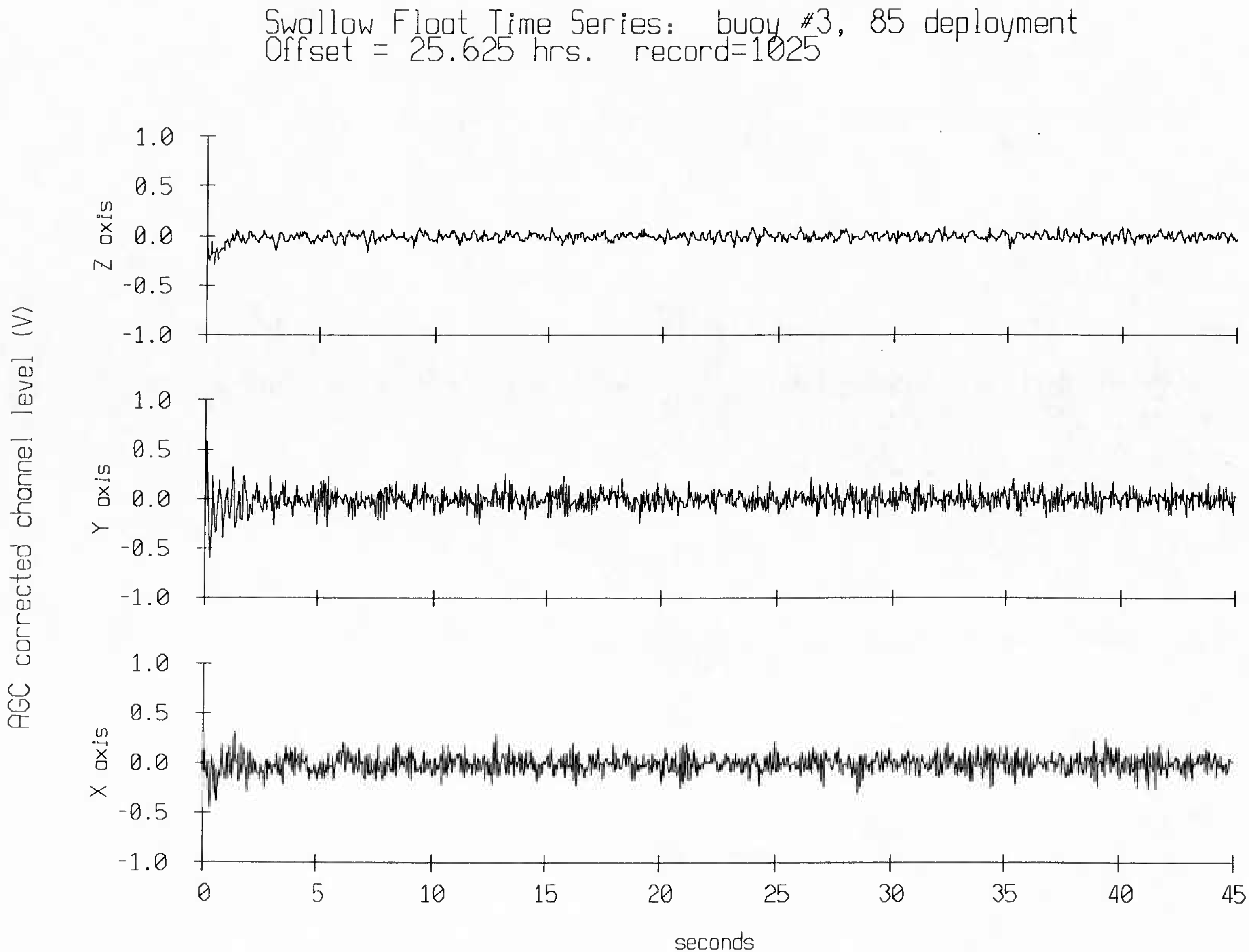
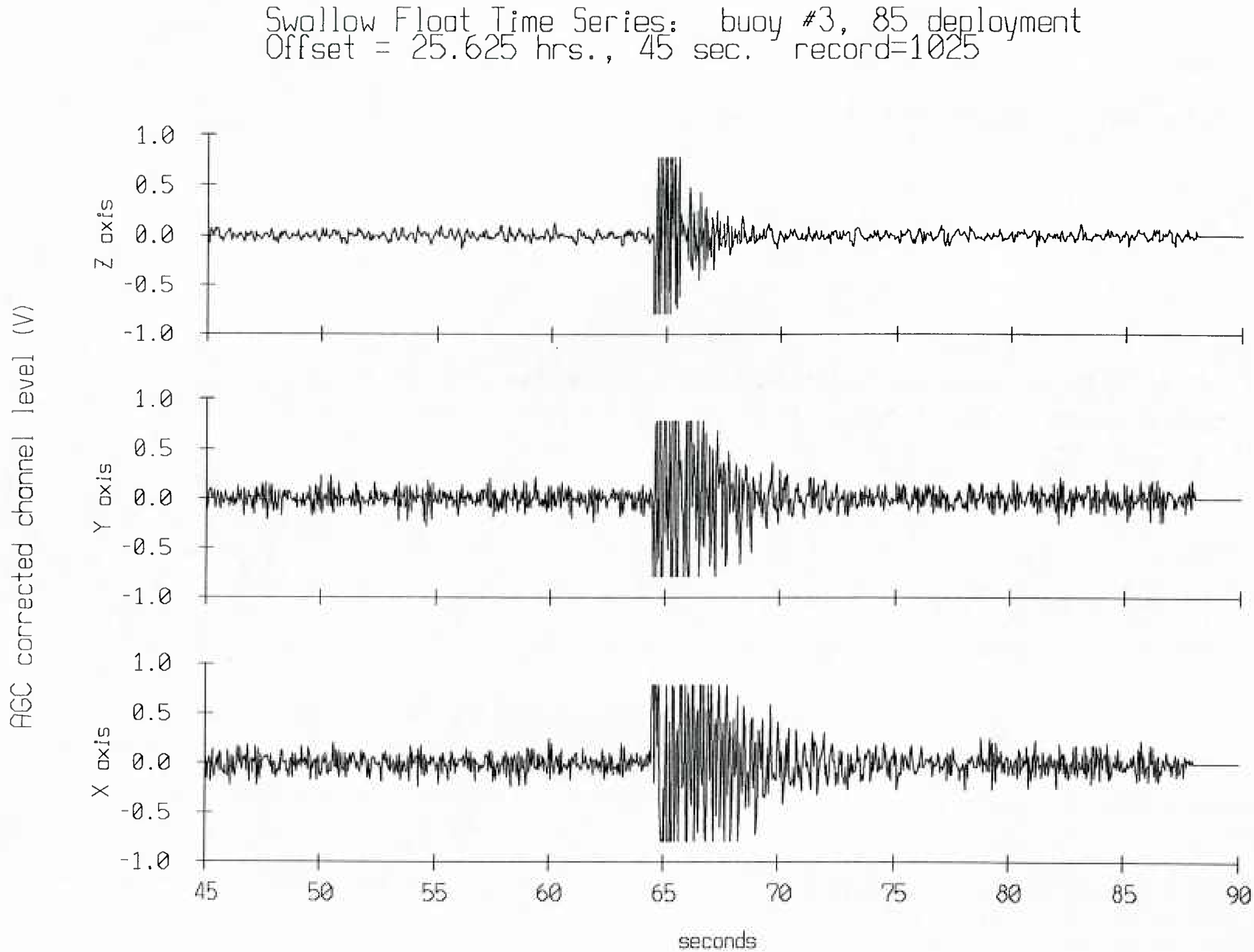
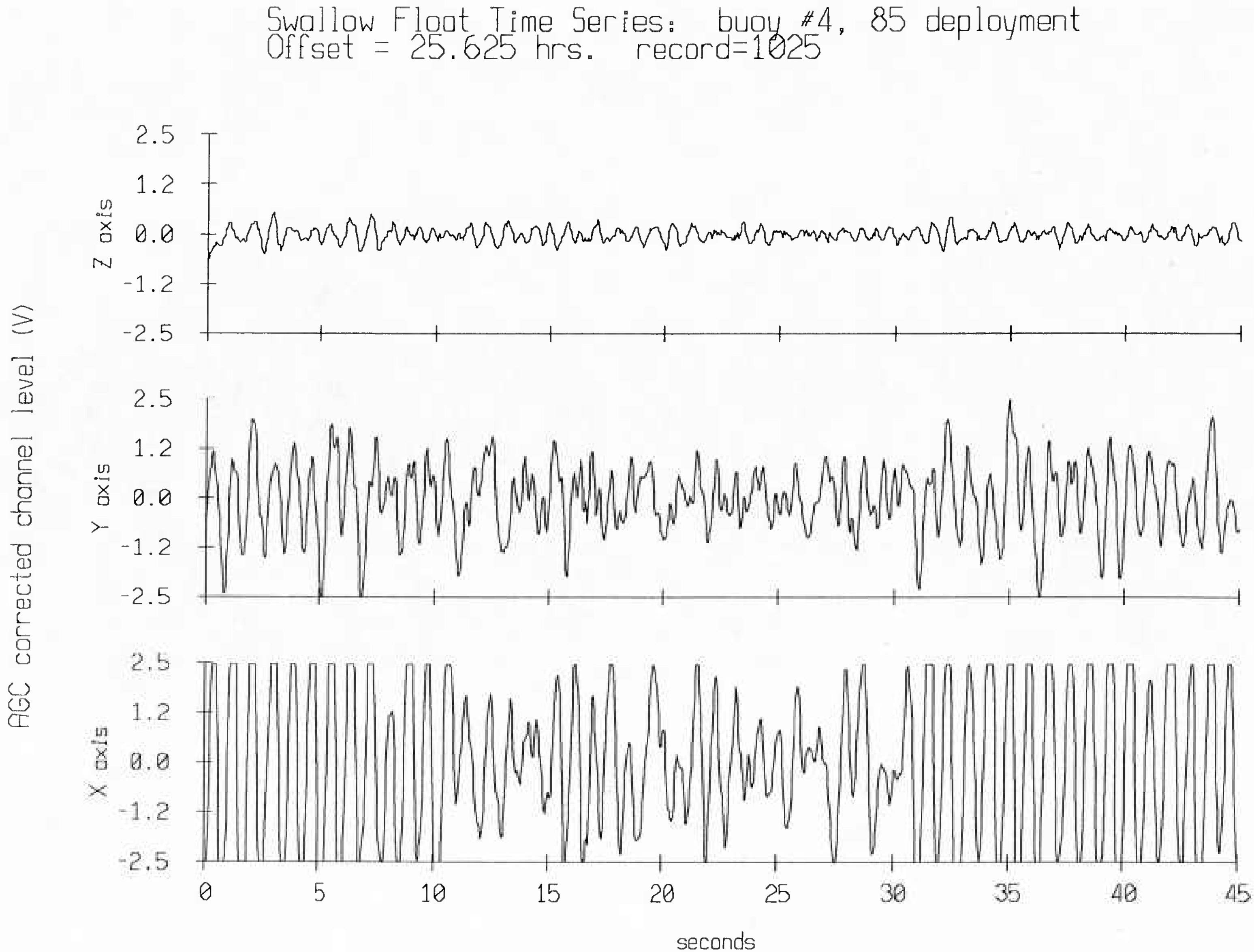

Swallow Float Time Series: buoy #3, 85 deployment
Offset = 25.625 hrs. record=1025
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.3a



Swallow Float Time Series: buoy #3, 85 deployment
Offset = 25.625 hrs., 45 sec. record=1025
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.3b



Swallow Float Time Series: buoy #4, 85 deployment
Offset = 25.625 hrs. record=1025
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.4a

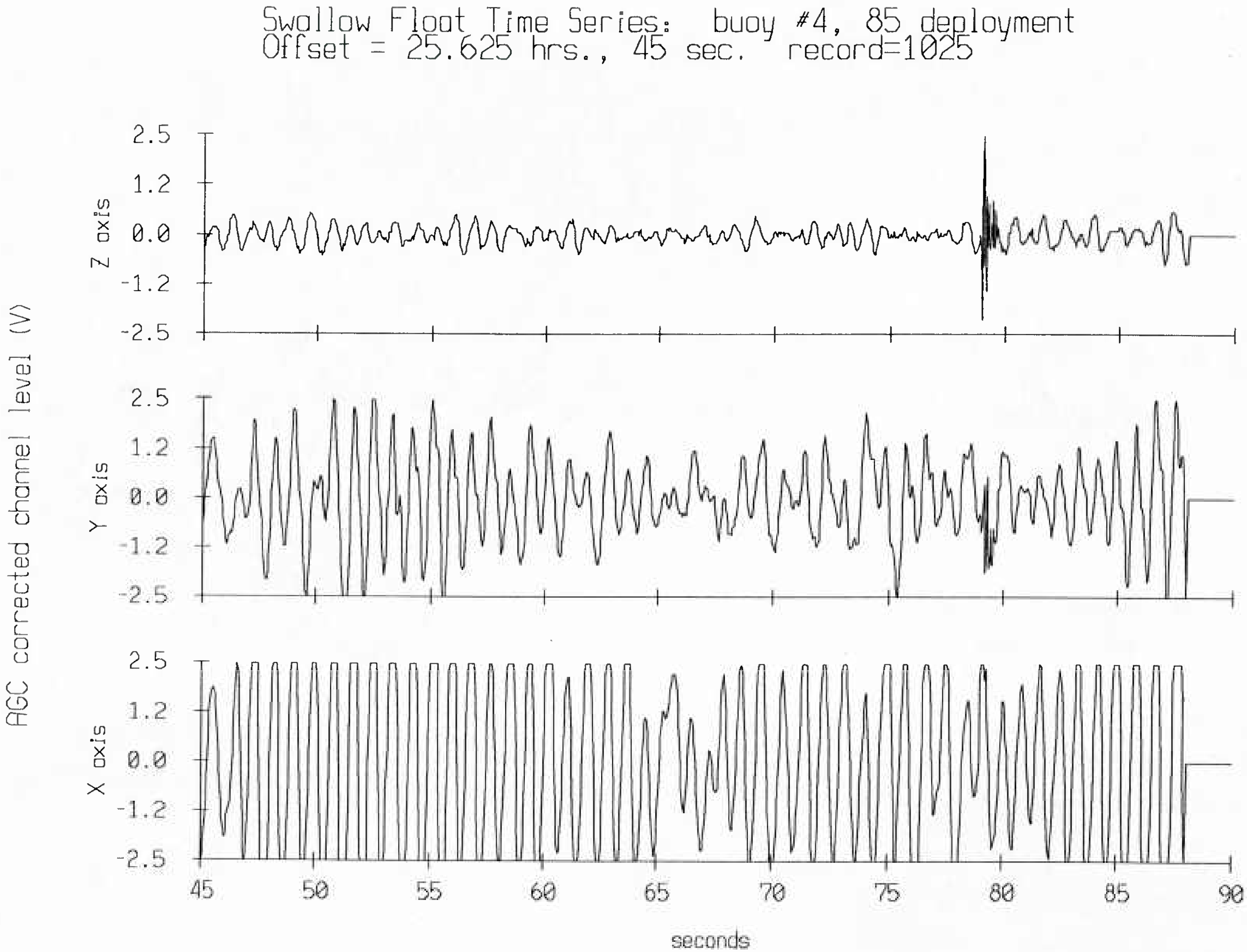

Swallow Float Time Series: buoy #4, 85 deployment
Offset = 25.625 hrs., 45 sec. record=1025
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.4b

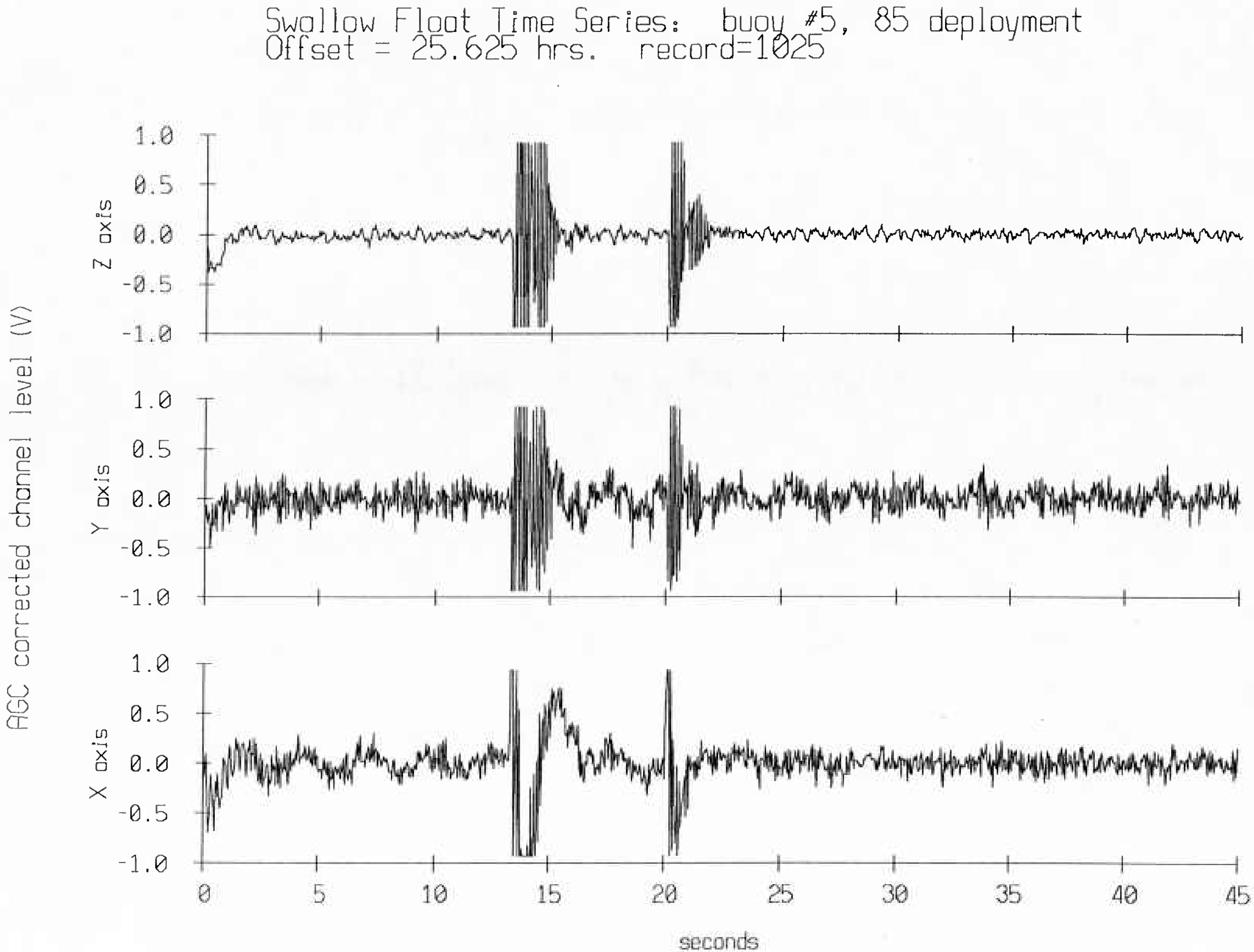

Swallow Float Time Series: buoy #5, 85 deployment
Offset = 25.625 hrs. record=1025
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.5a

Swallow Float Time Series: buoy #5, 85 deployment
Offset = 25.625 hrs., 45 sec. record=1025

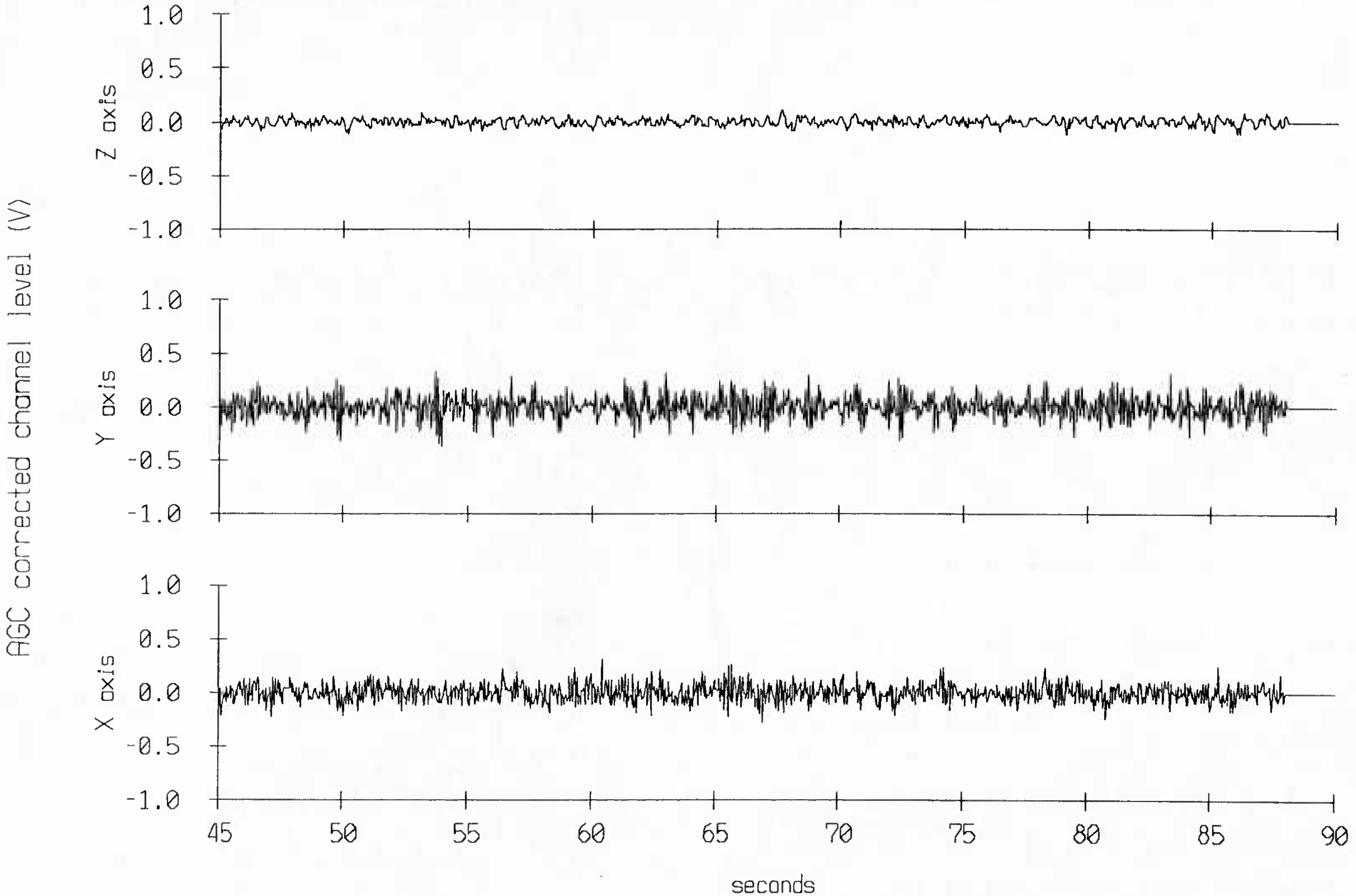


Figure VI.5b

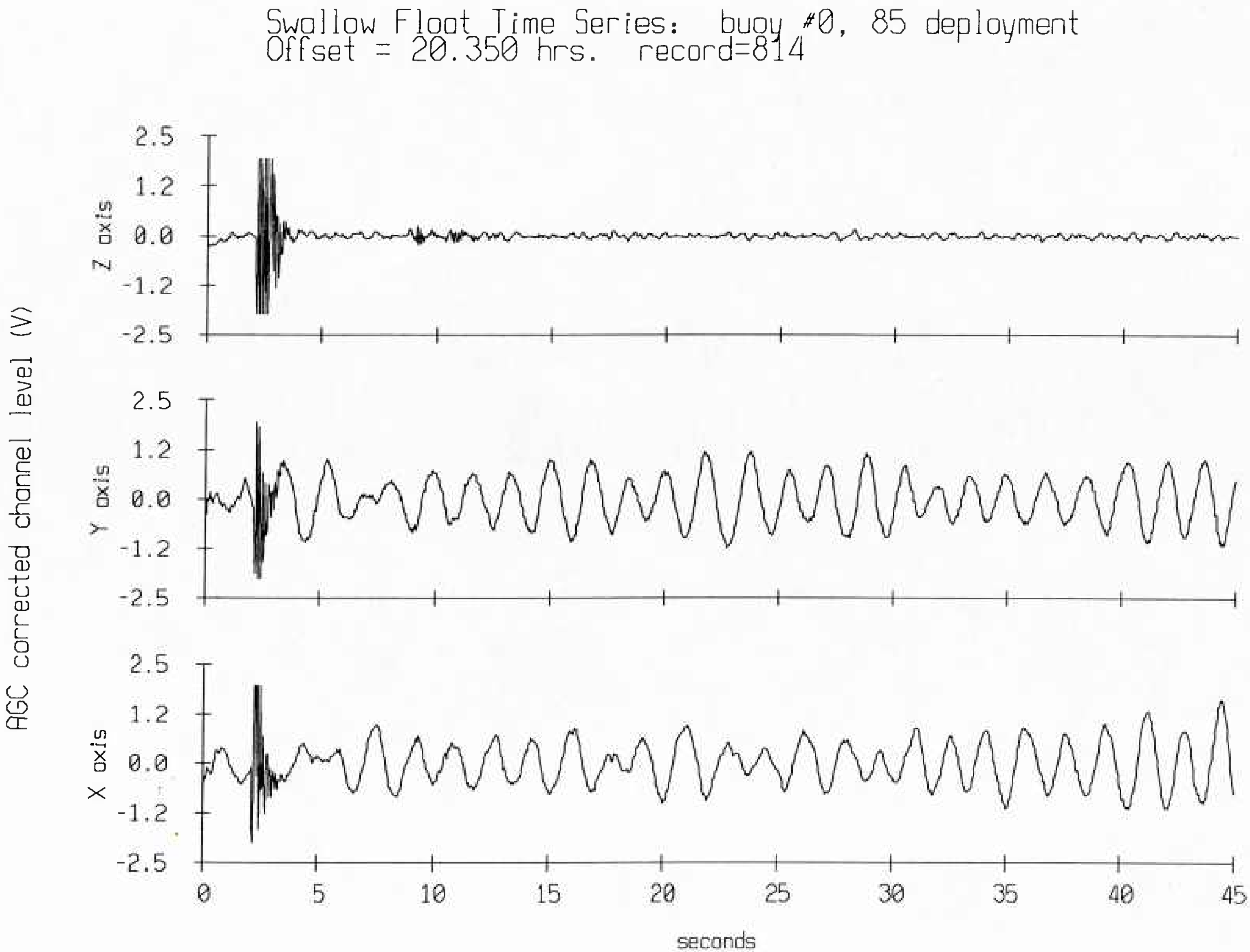
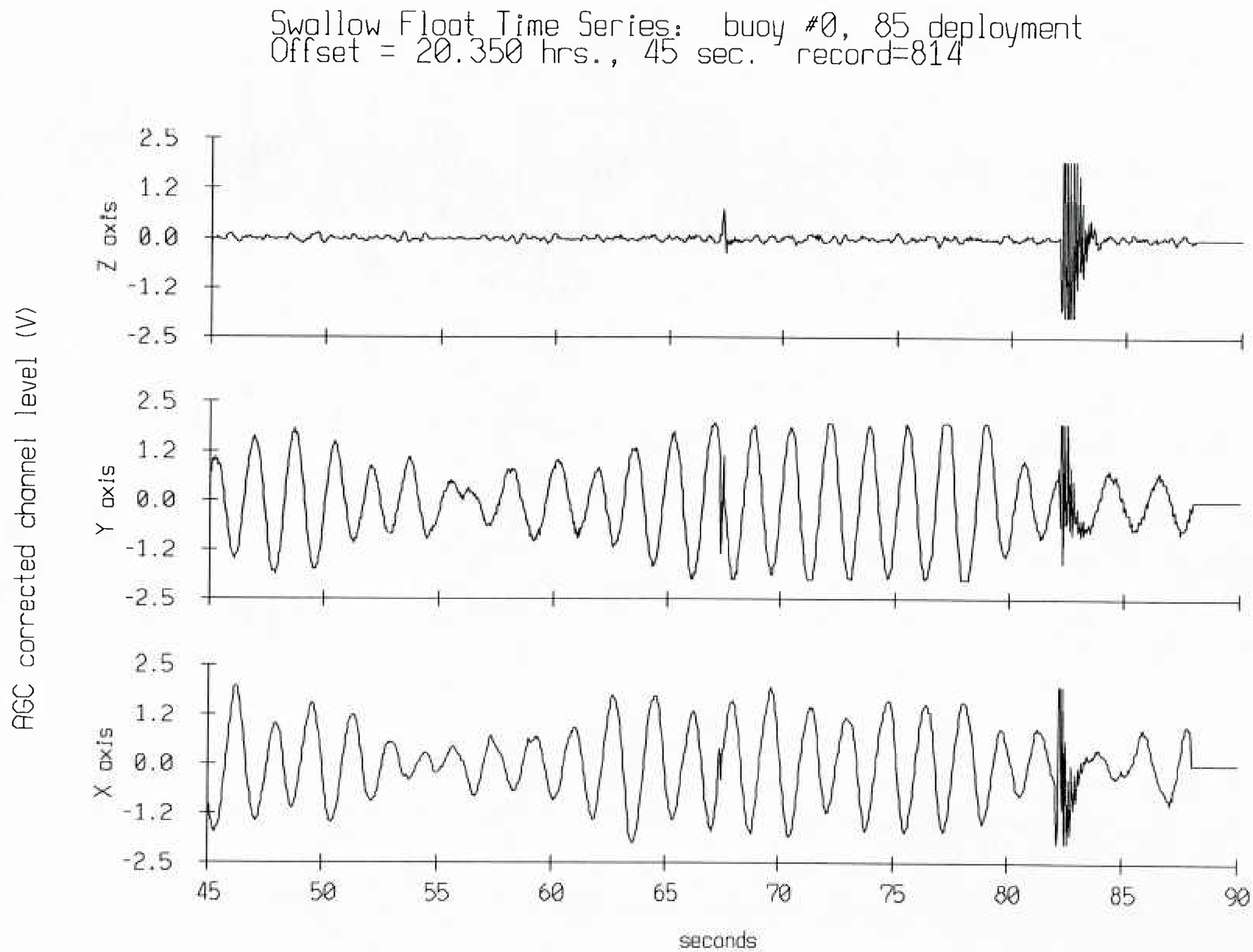
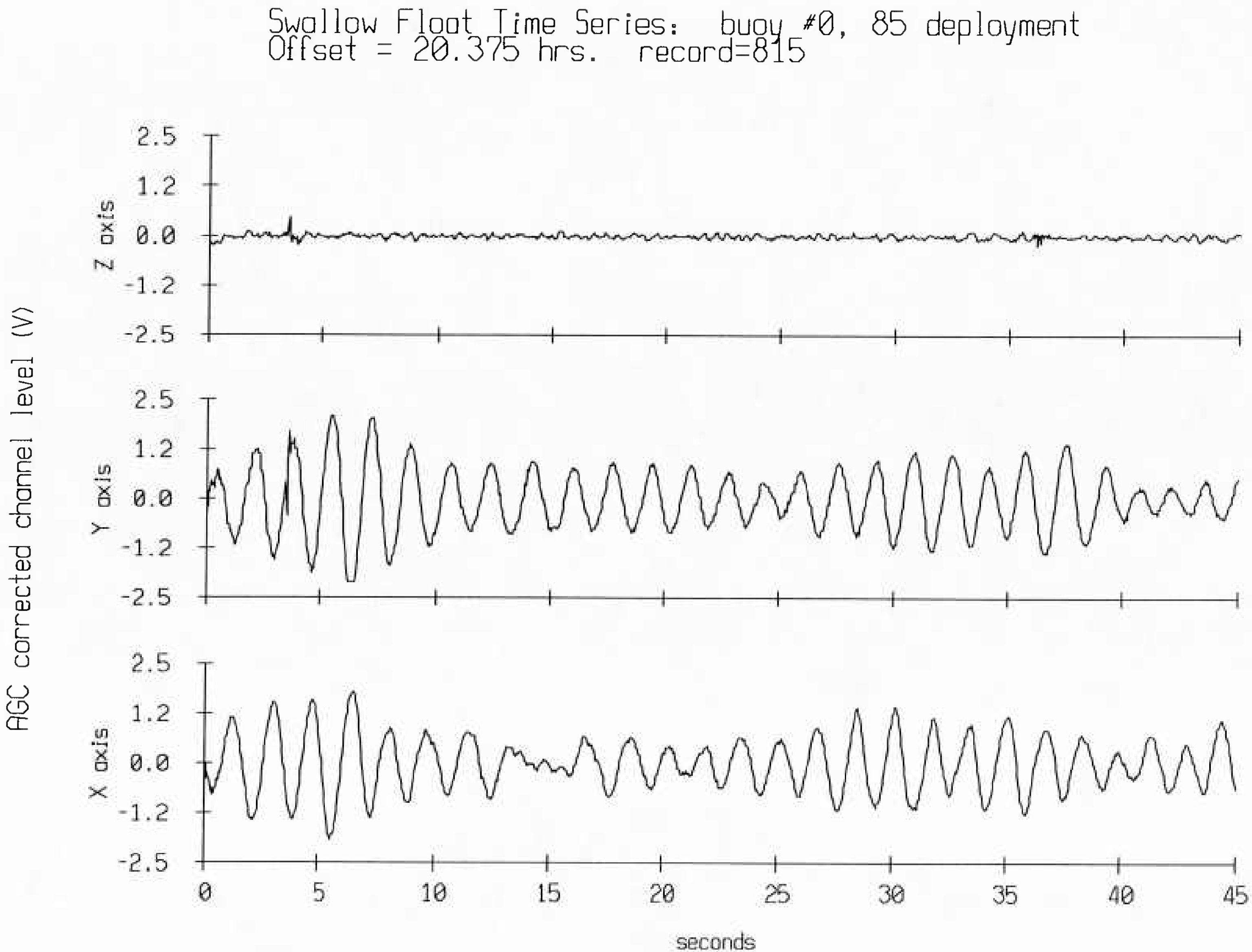

Swallow Float Time Series: buoy #0, 85 deployment
Offset = 20.350 hrs. record=814
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.6a



Swallow Float Time Series: buoy #0, 85 deployment
Offset = 20.350 hrs., 45 sec. record=814
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.6b



Swallow Float Time Series: buoy #0, 85 deployment
Offset = 20.375 hrs. record=815
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.6c

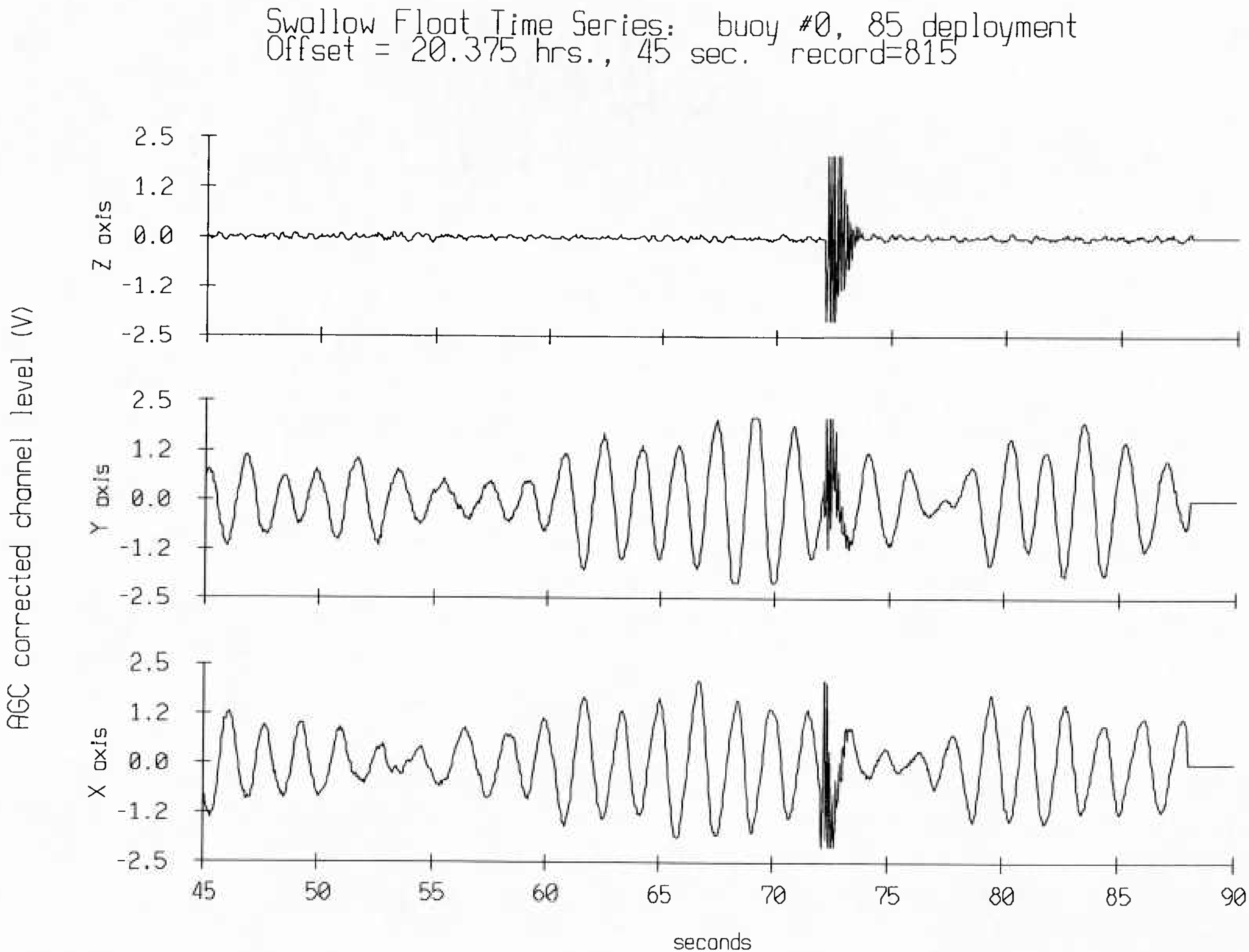
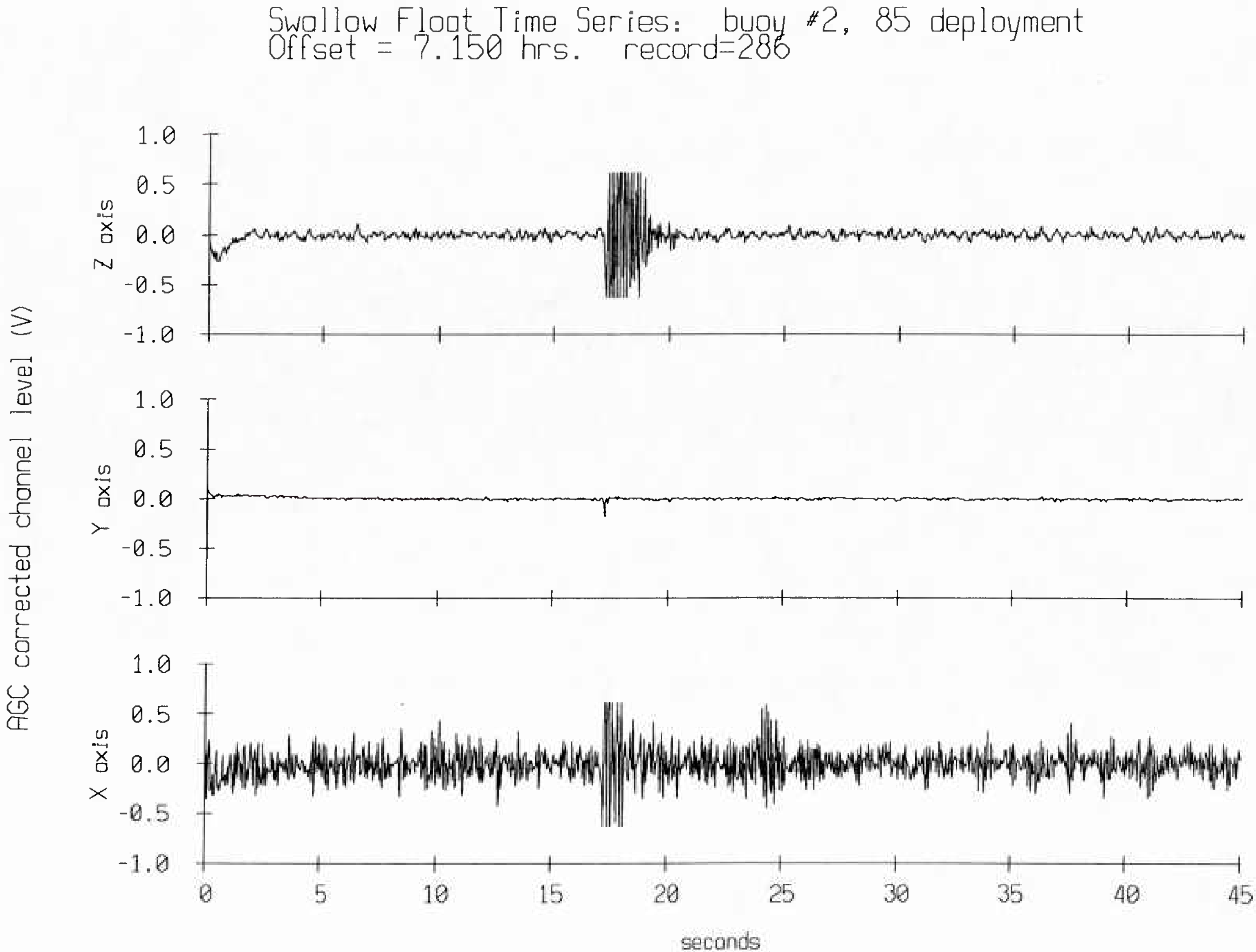

Swallow Float Time Series: buoy #0, 85 deployment
Offset = 20.375 hrs., 45 sec. record=815
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.6d



Swallow Float Time Series: buoy #2, 85 deployment
Offset = 7.150 hrs. record=286
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.7a

Swallow Float Time Series: buoy #2, 85 deployment
Offset = 7.150 hrs., 45 sec. record=286

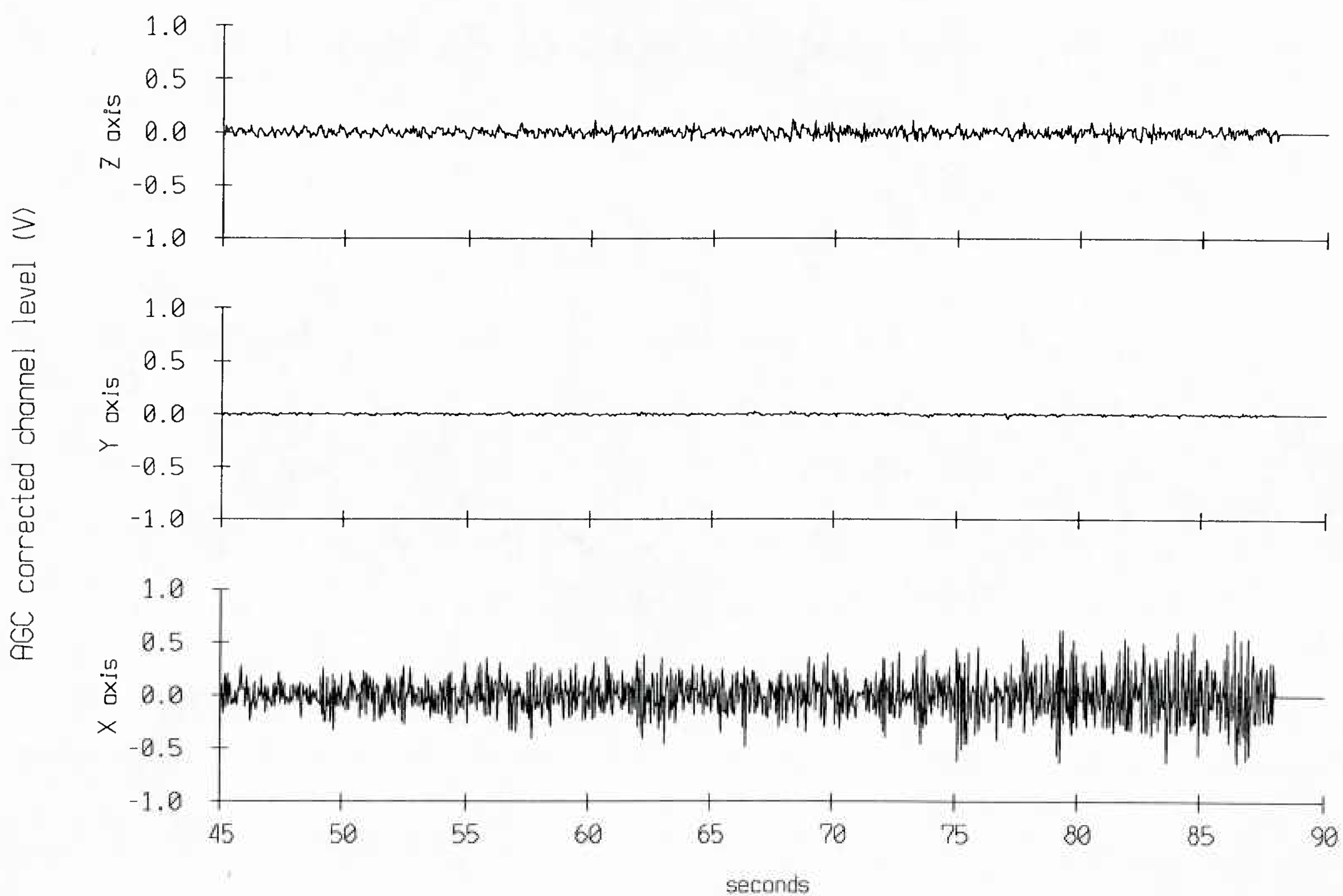


Figure VI.7b

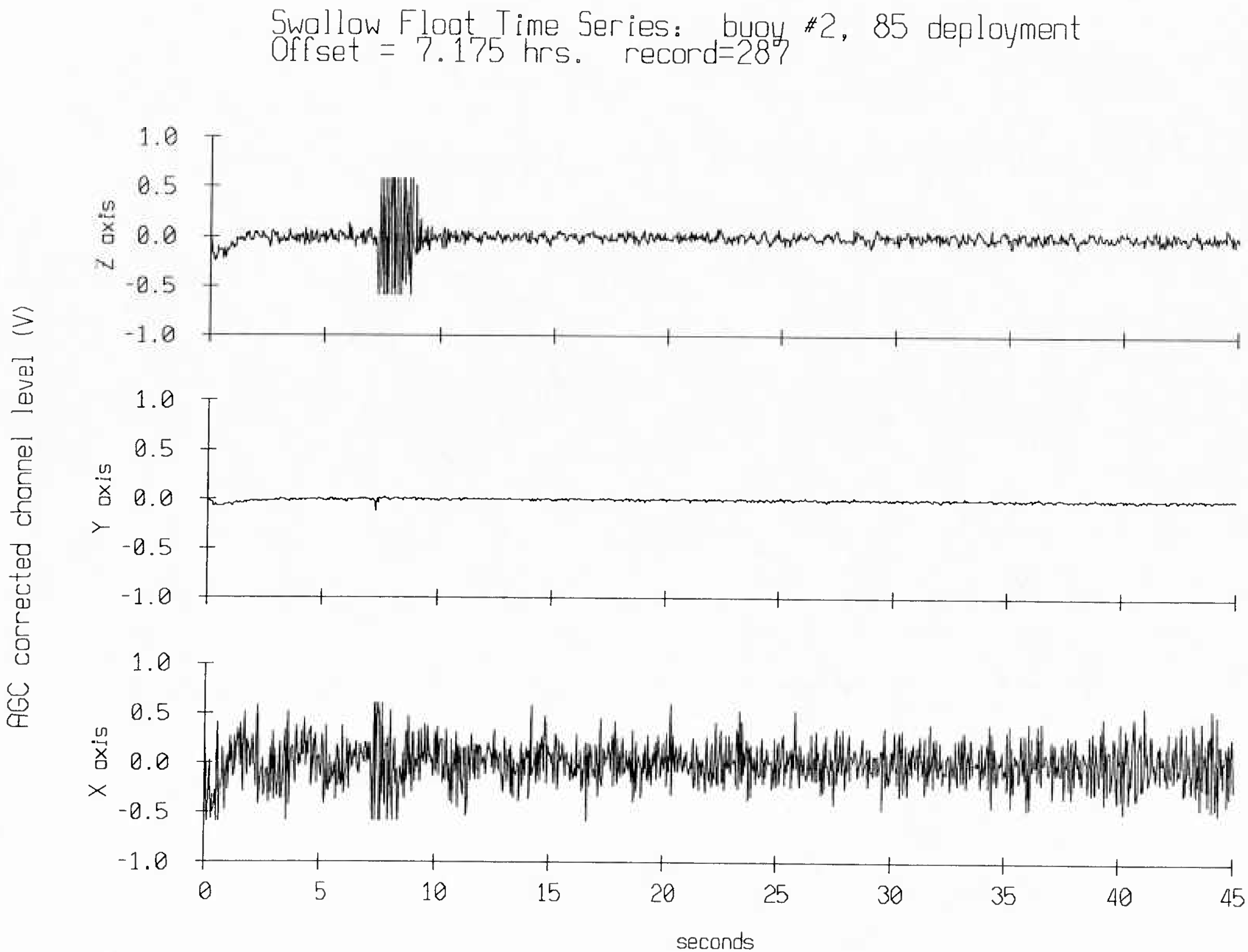
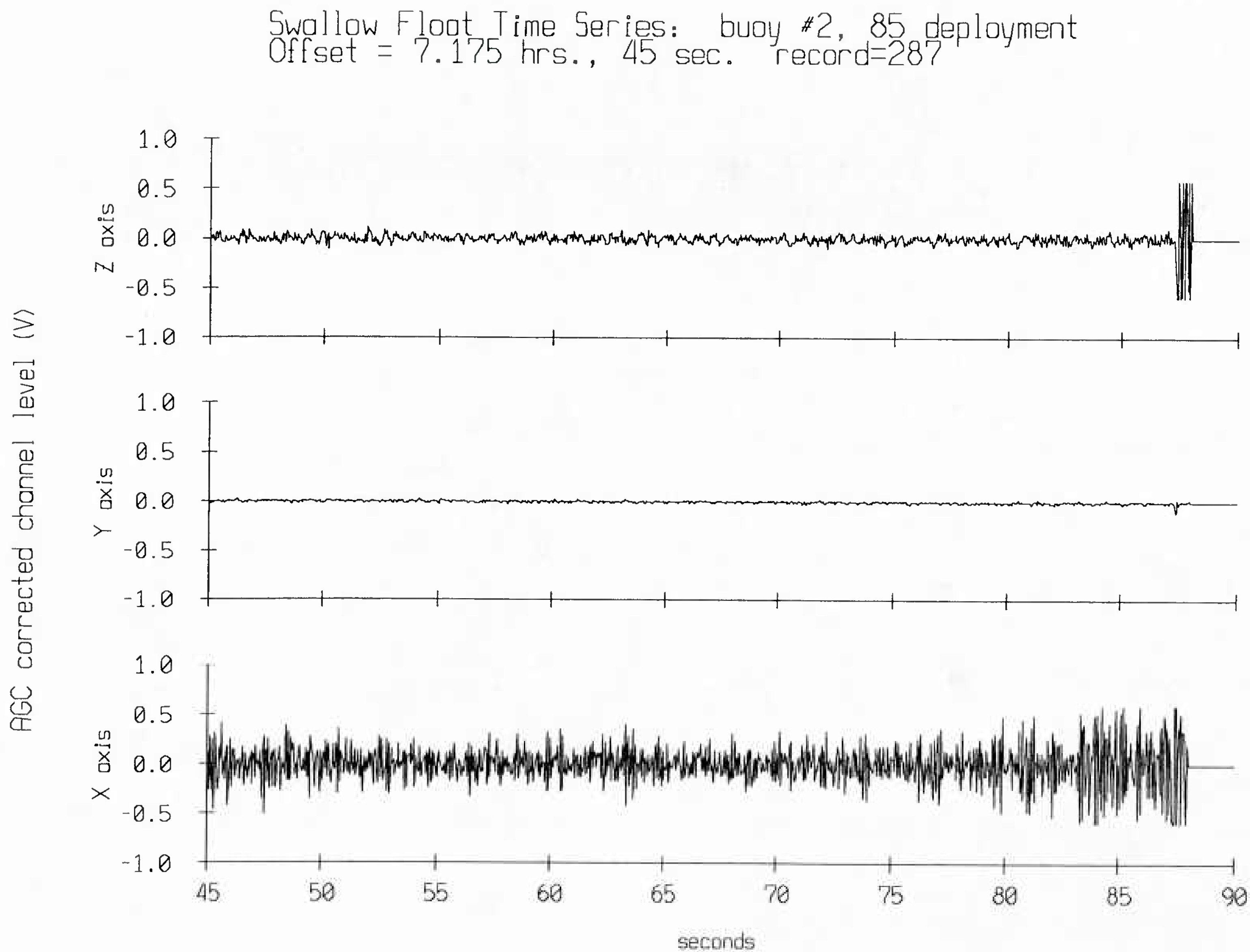

Swallow Float Time Series: buoy #2, 85 deployment
Offset = 7.175 hrs. record=287
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.7c



Swallow Float Time Series: buoy #2, 85 deployment
Offset = 7.175 hrs., 45 sec. record=287
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.7d

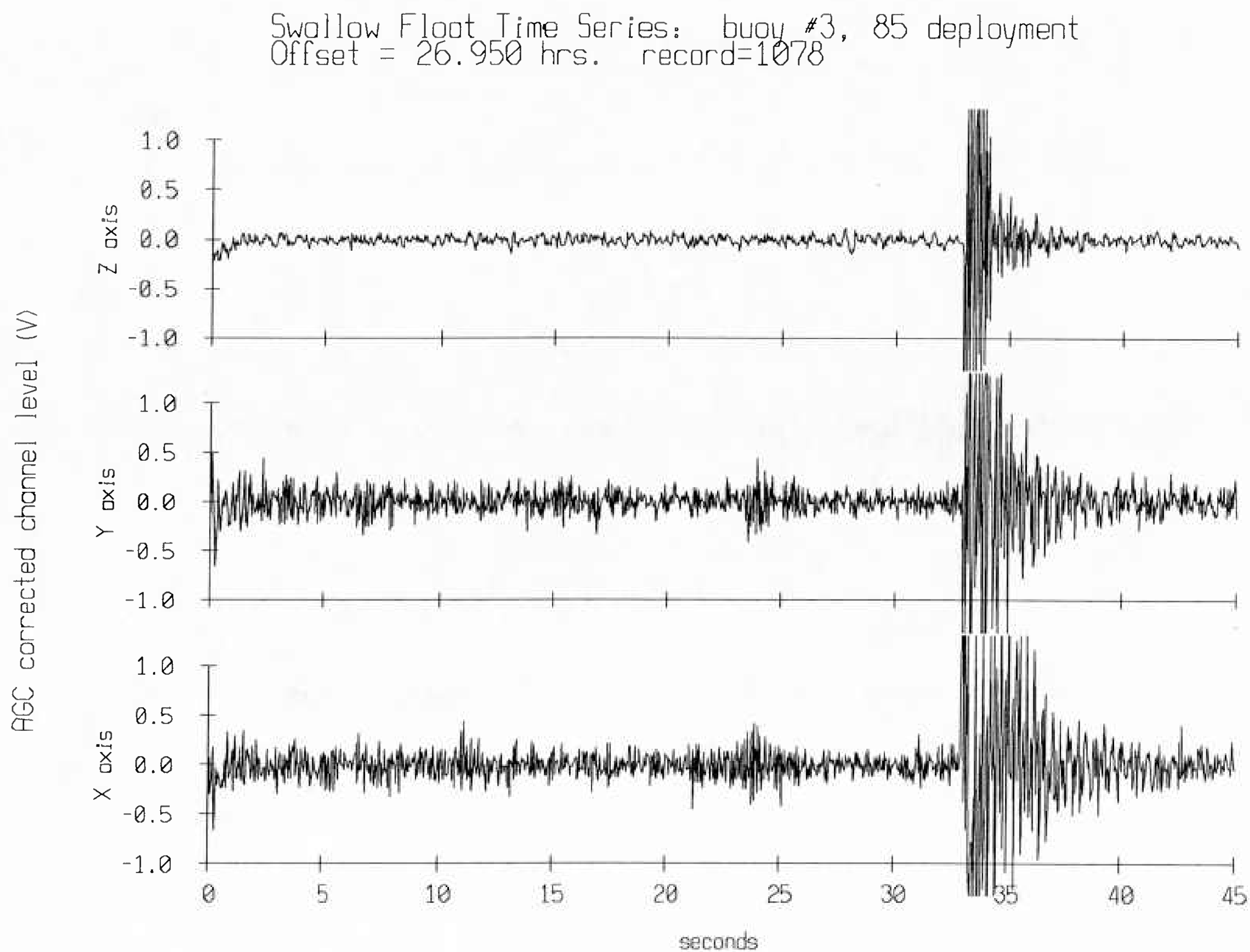

Swallow Float Time Series: buoy #3, 85 deployment
Offset = 26.950 hrs. record=1078
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.8a

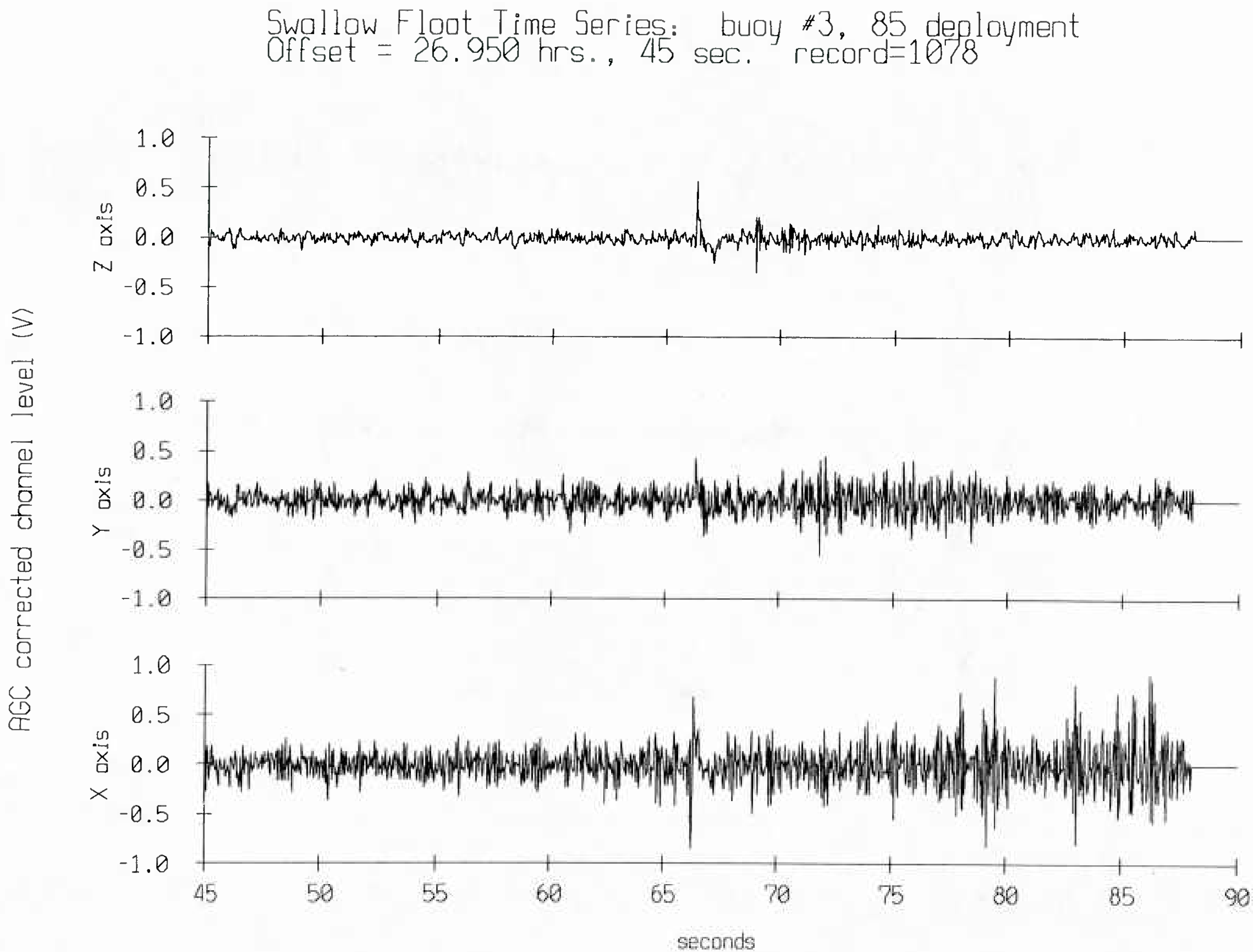

Swallow Float Time Series: buoy #3, 85 deployment
Offset = 26.950 hrs., 45 sec. record=1078
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.8b

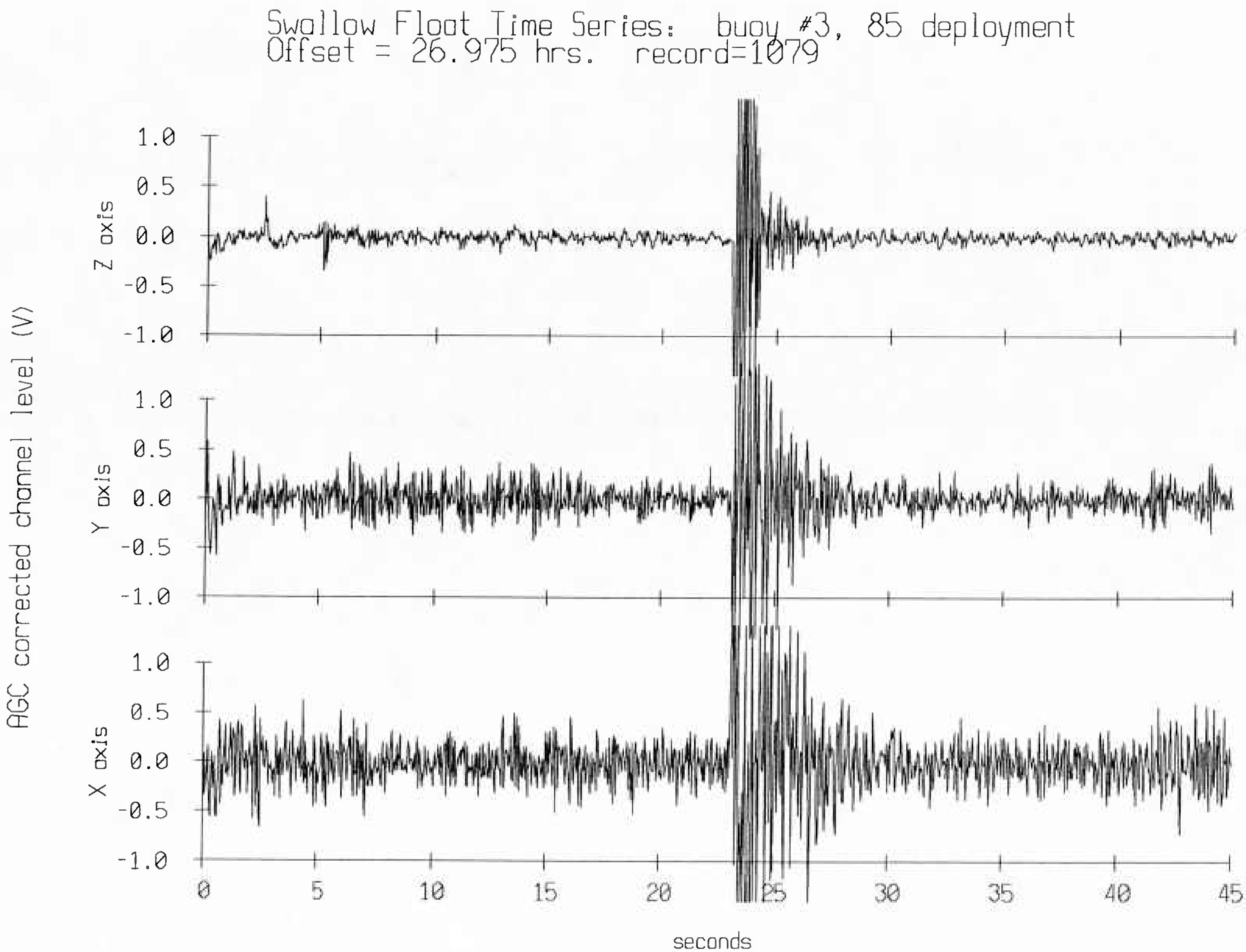
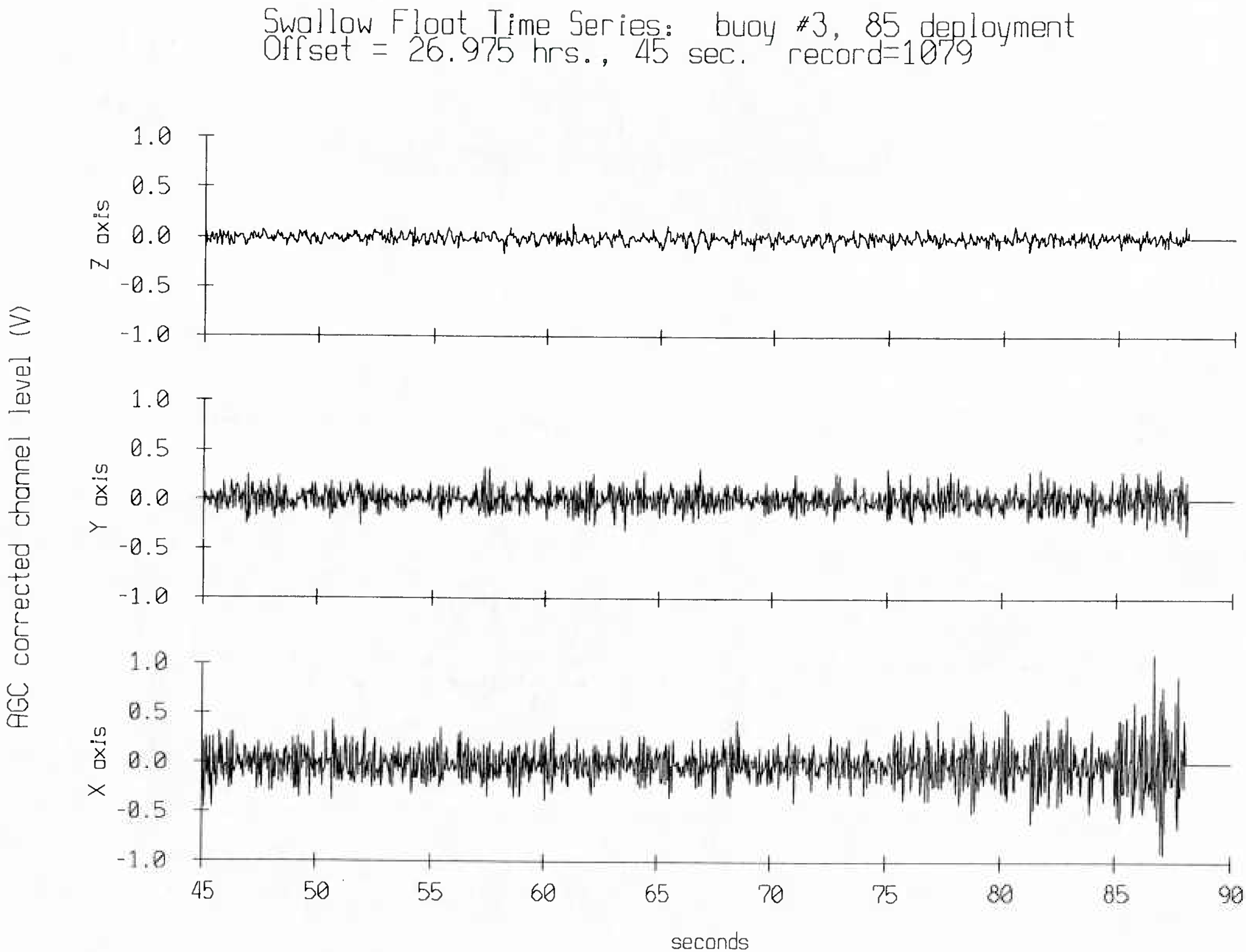

Swallow Float Time Series: buoy #3, 85 deployment
Offset = 26.975 hrs. record=1079
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.8c



Swallow Float Time Series: buoy #3, 85 deployment
Offset = 26.975 hrs., 45 sec. record=1079
AGC corrected channel level (V)
Z axis
Y axis
X axis
1.0
0.5
0.0
-0.5
-1.0
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.8d

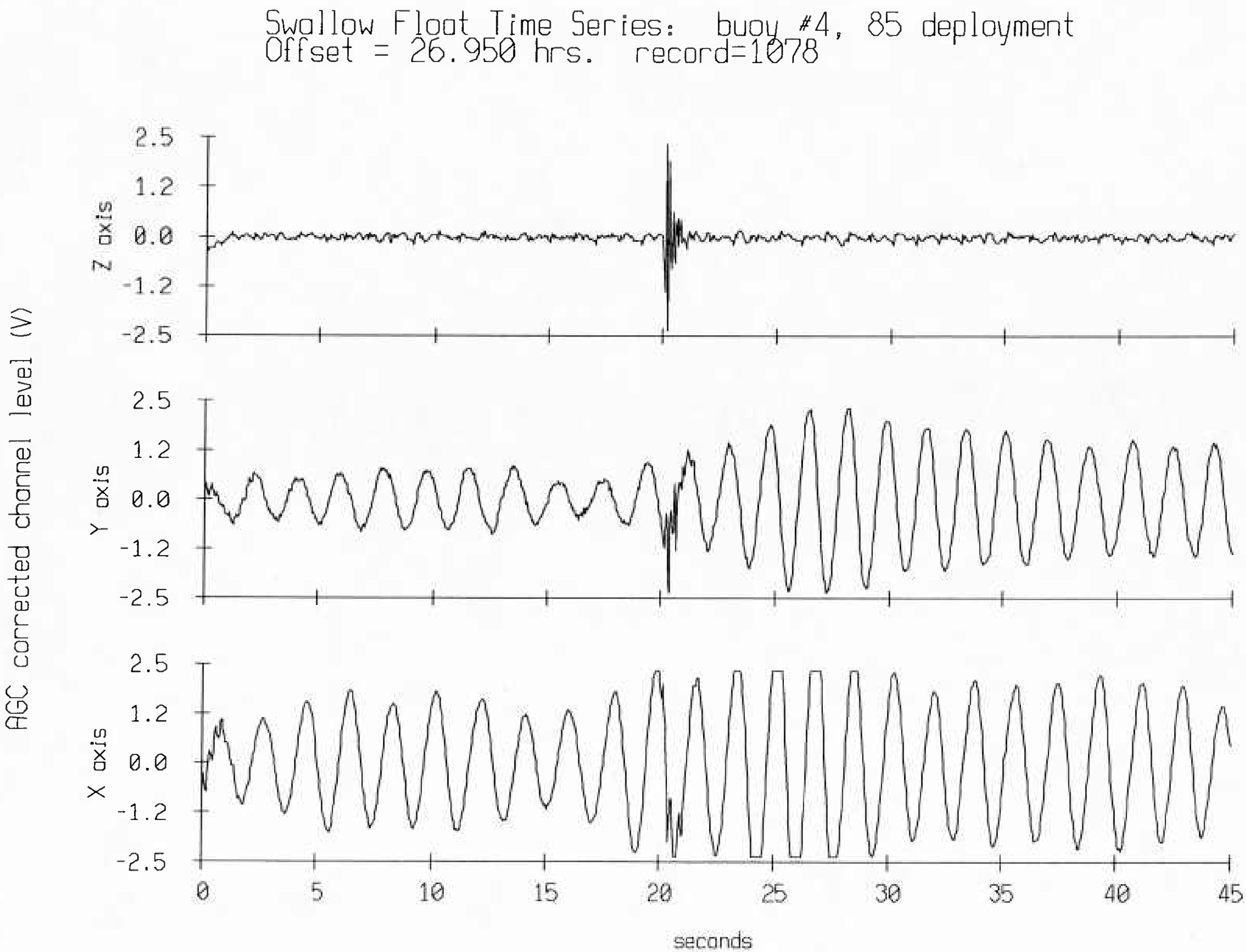

Swallow Float Time Series: buoy #4, 85 deployment
Offset = 26.950 hrs. record=1078
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.9a

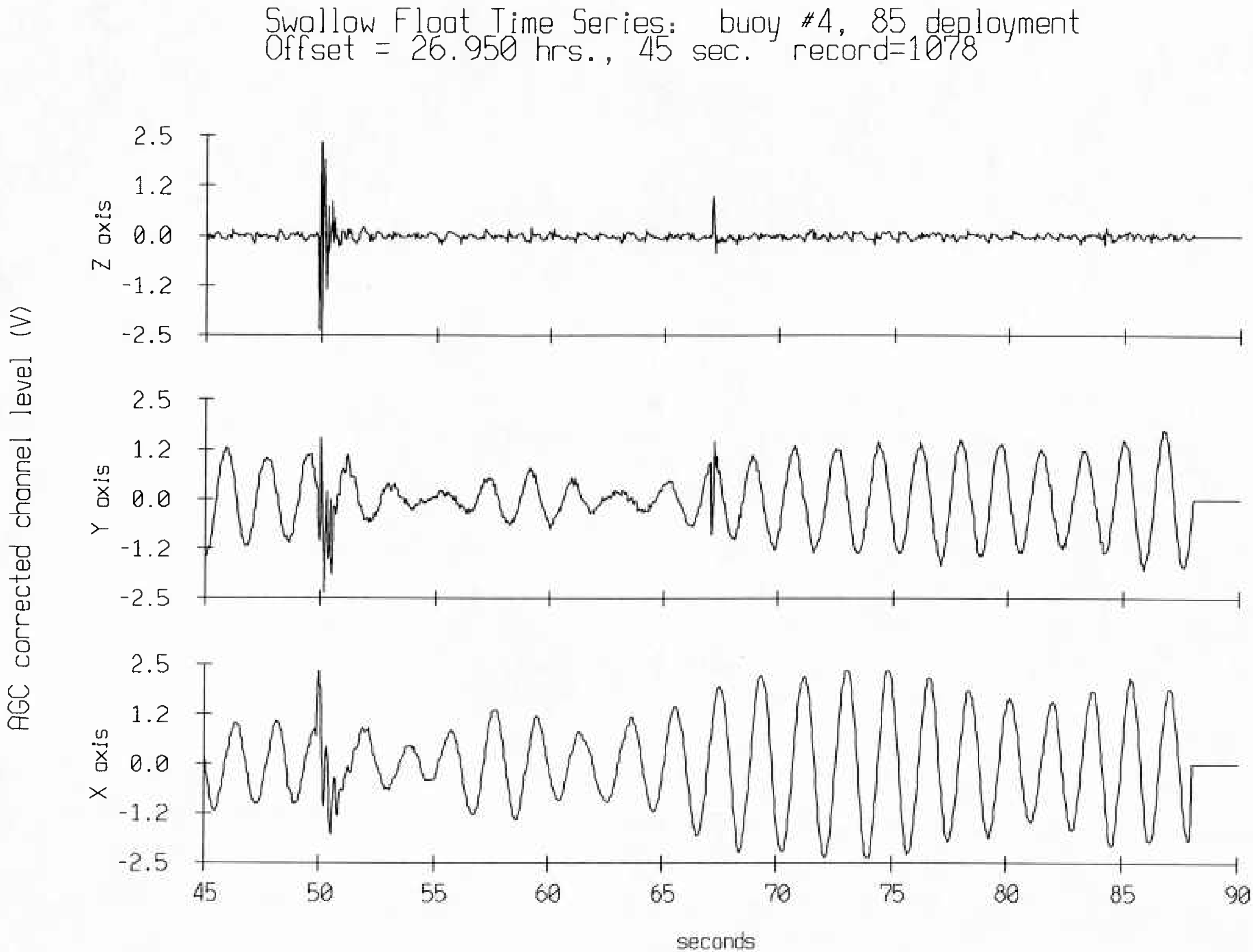

Swallow Float Time Series: buoy #4, 85 deployment
Offset = 26.950 hrs., 45 sec. record=1078
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.9b

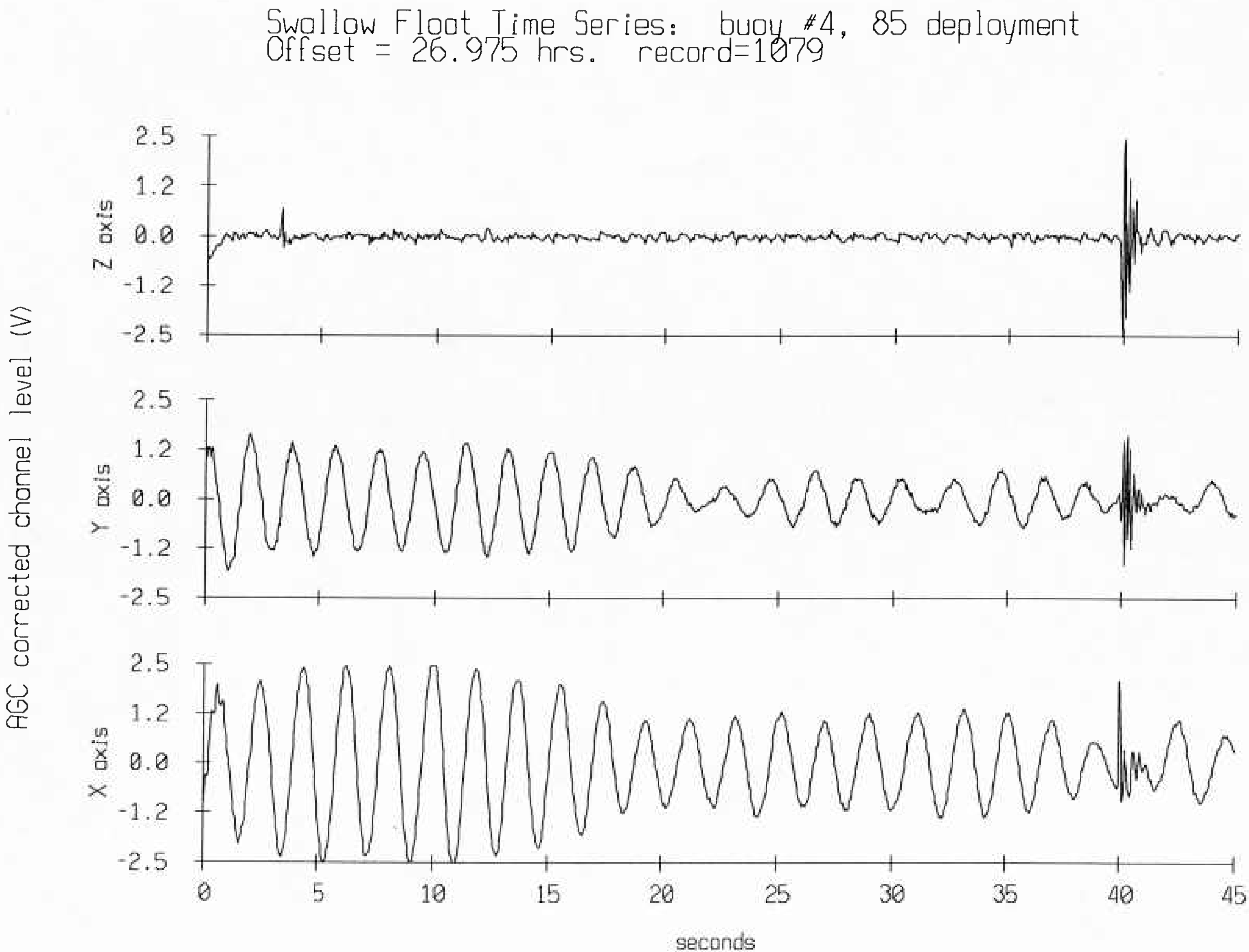

Swallow Float Time Series: buoy #4, 85 deployment
Offset = 26.975 hrs. record=1079
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
0
5
10
15
20
25
30
35
40
45
seconds

Figure VI.9c

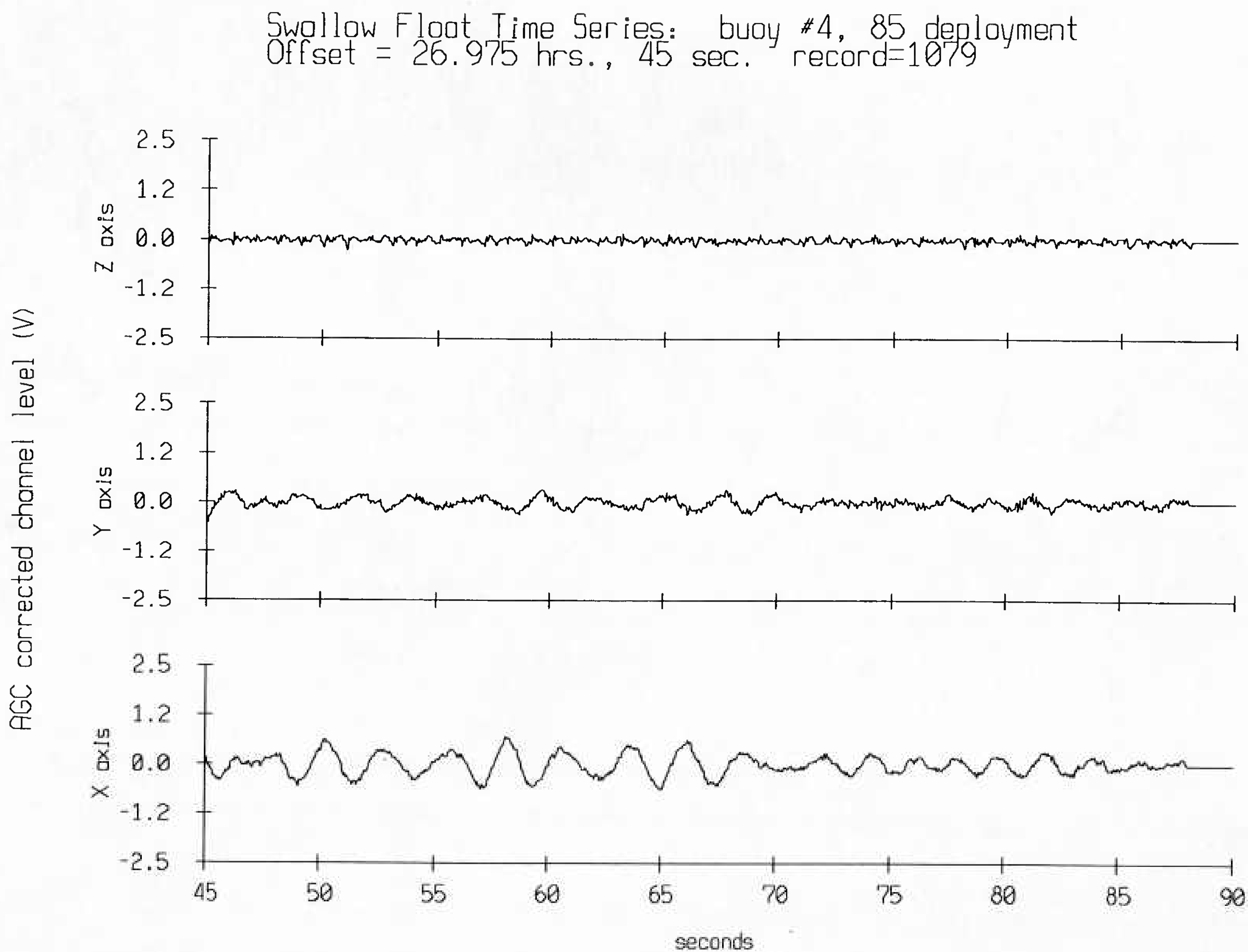

Swallow Float Time Series: buoy #4, 85 deployment
Offset = 26.975 hrs., 45 sec. record=1079
AGC corrected channel level (V)
Z axis
Y axis
X axis
2.5
1.2
0.0
-1.2
-2.5
45
50
55
60
65
70
75
80
85
90
seconds

Figure VI.9d

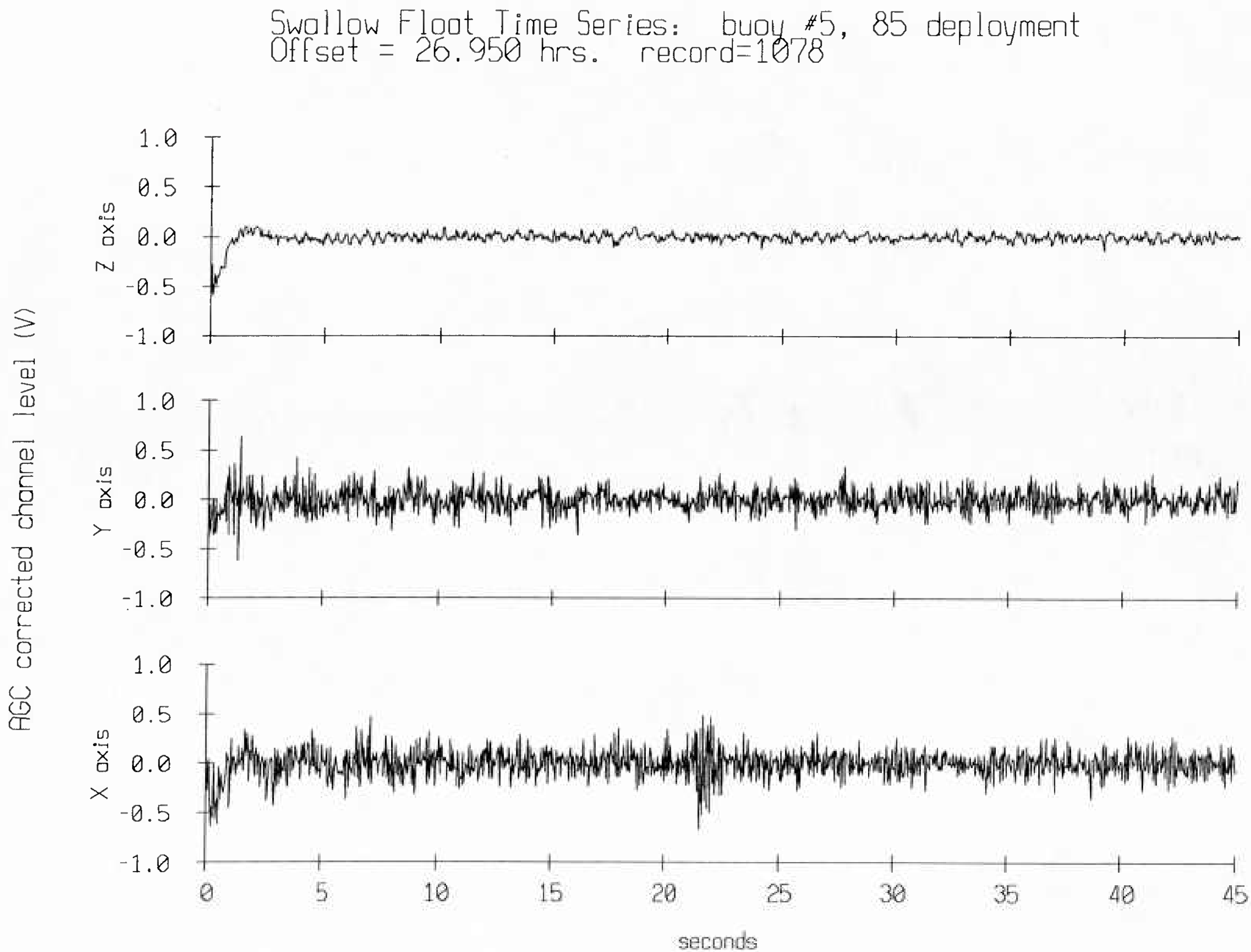


Figure VI.10a

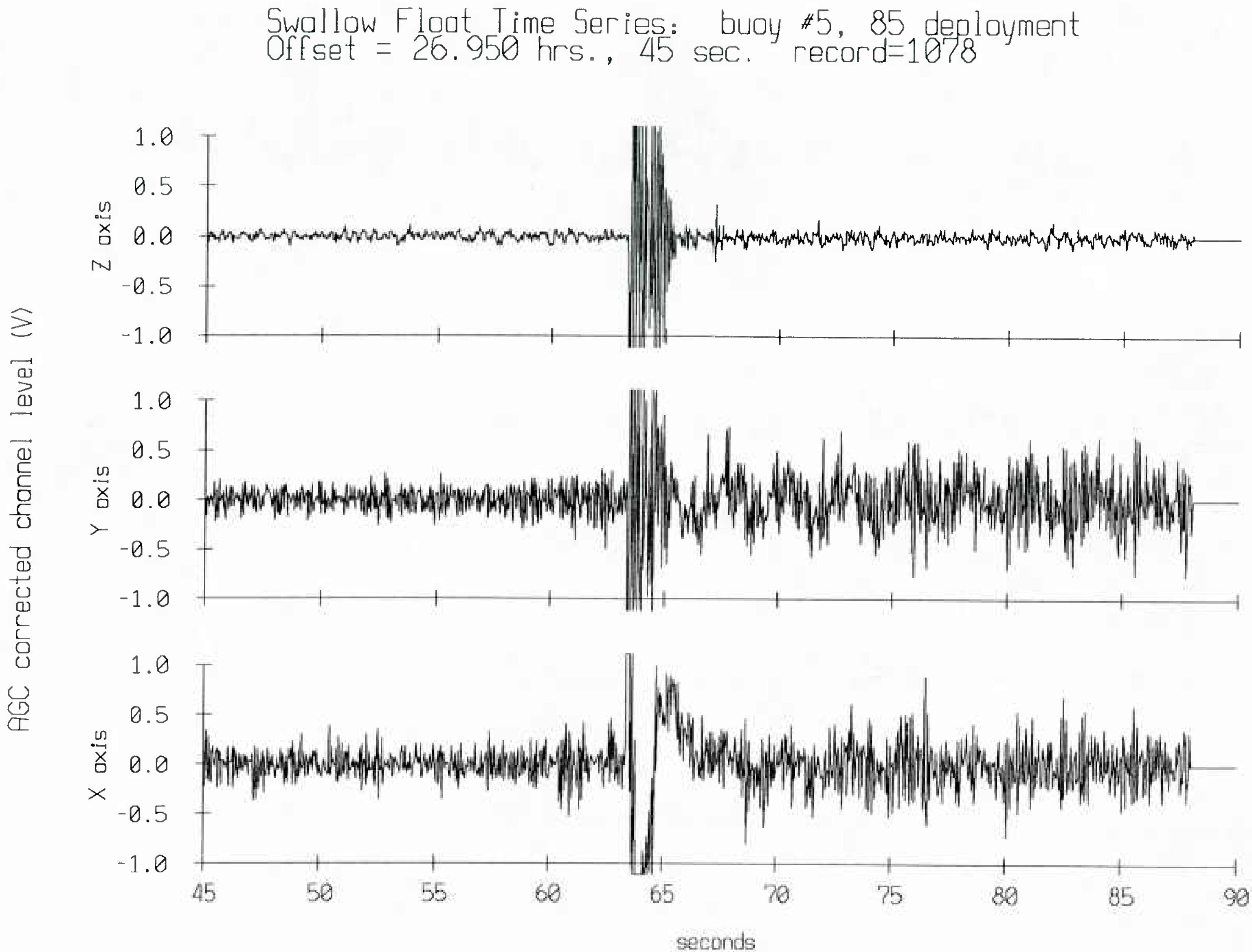


Figure VI.10b

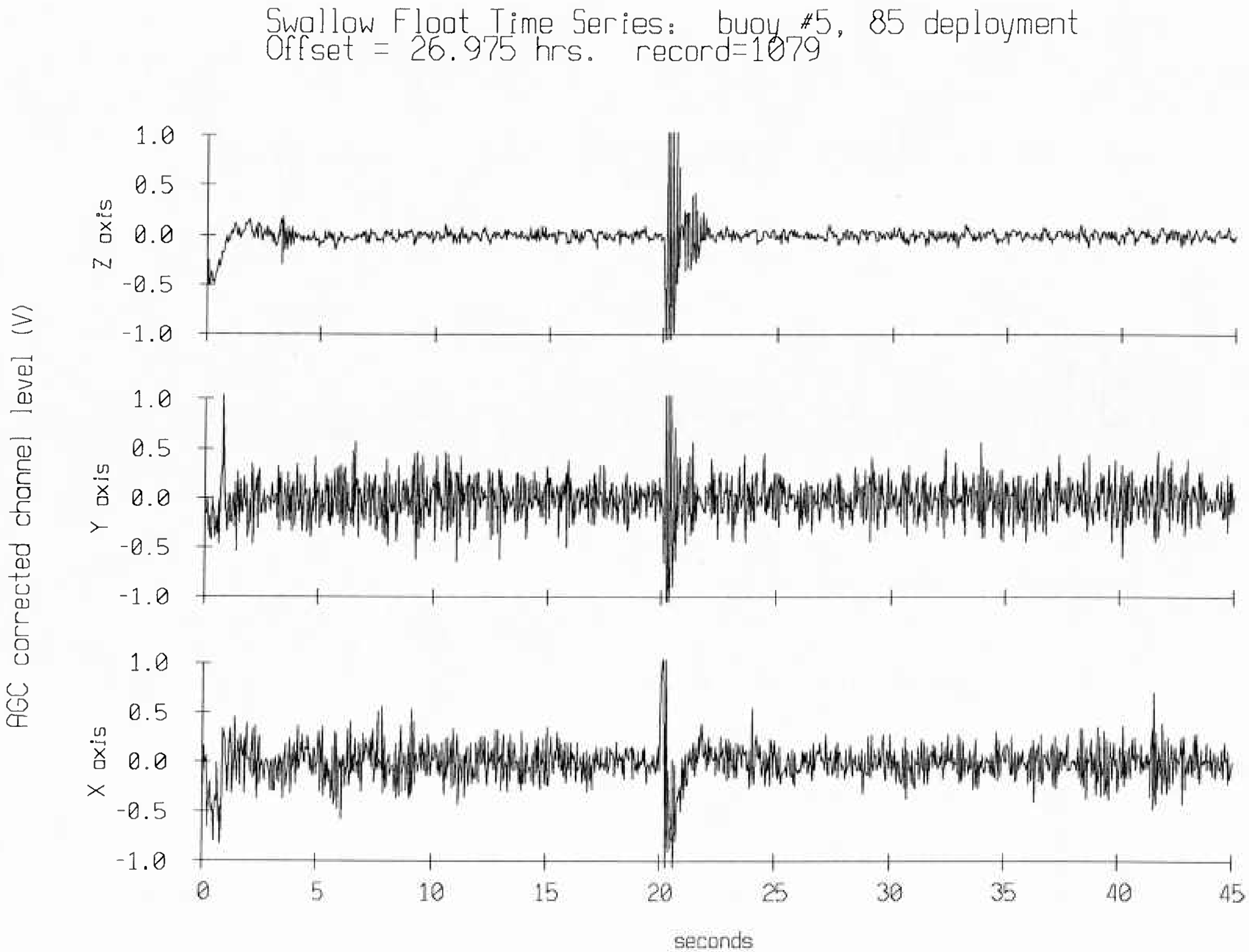


Figure VI.10c

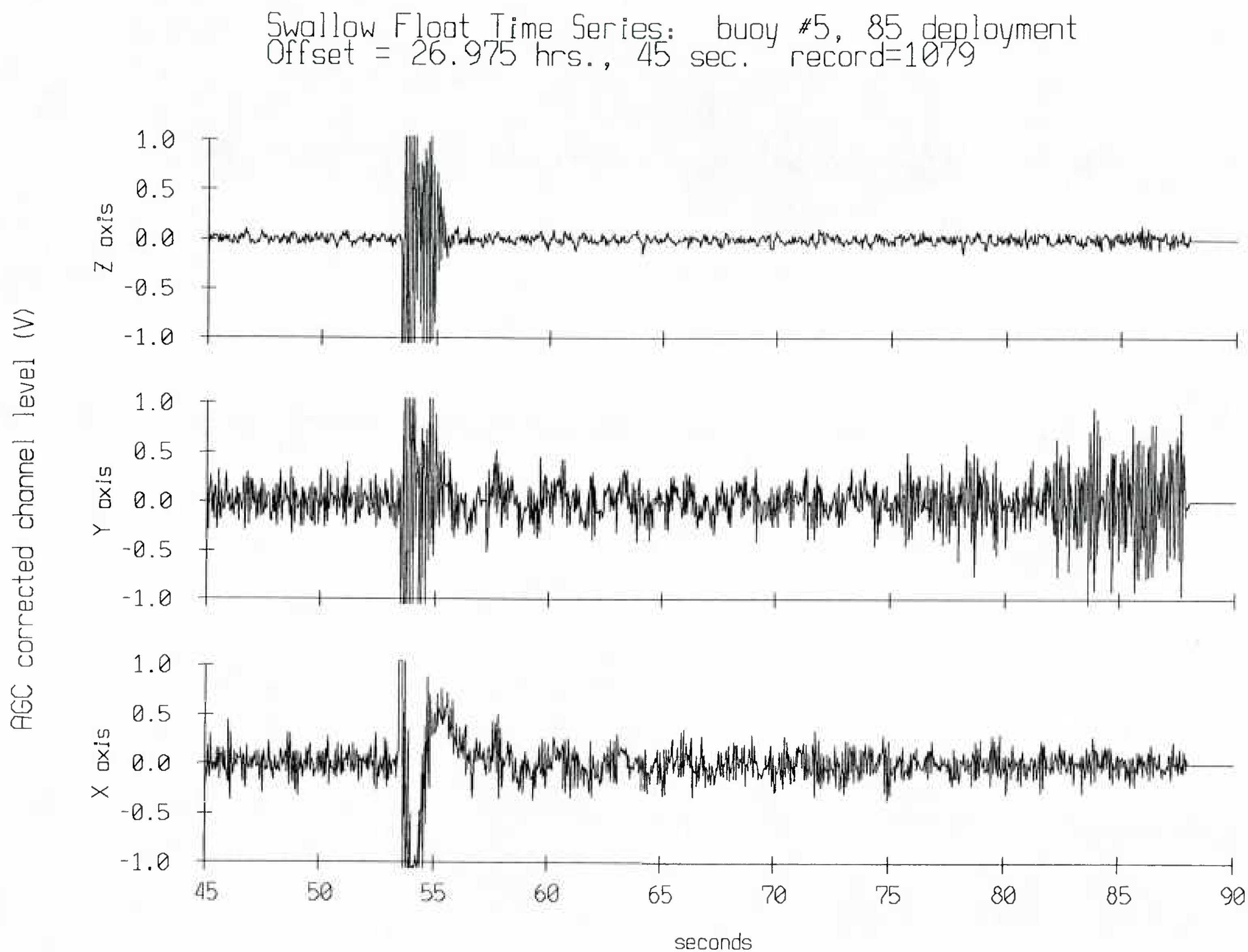


Figure VI.10d

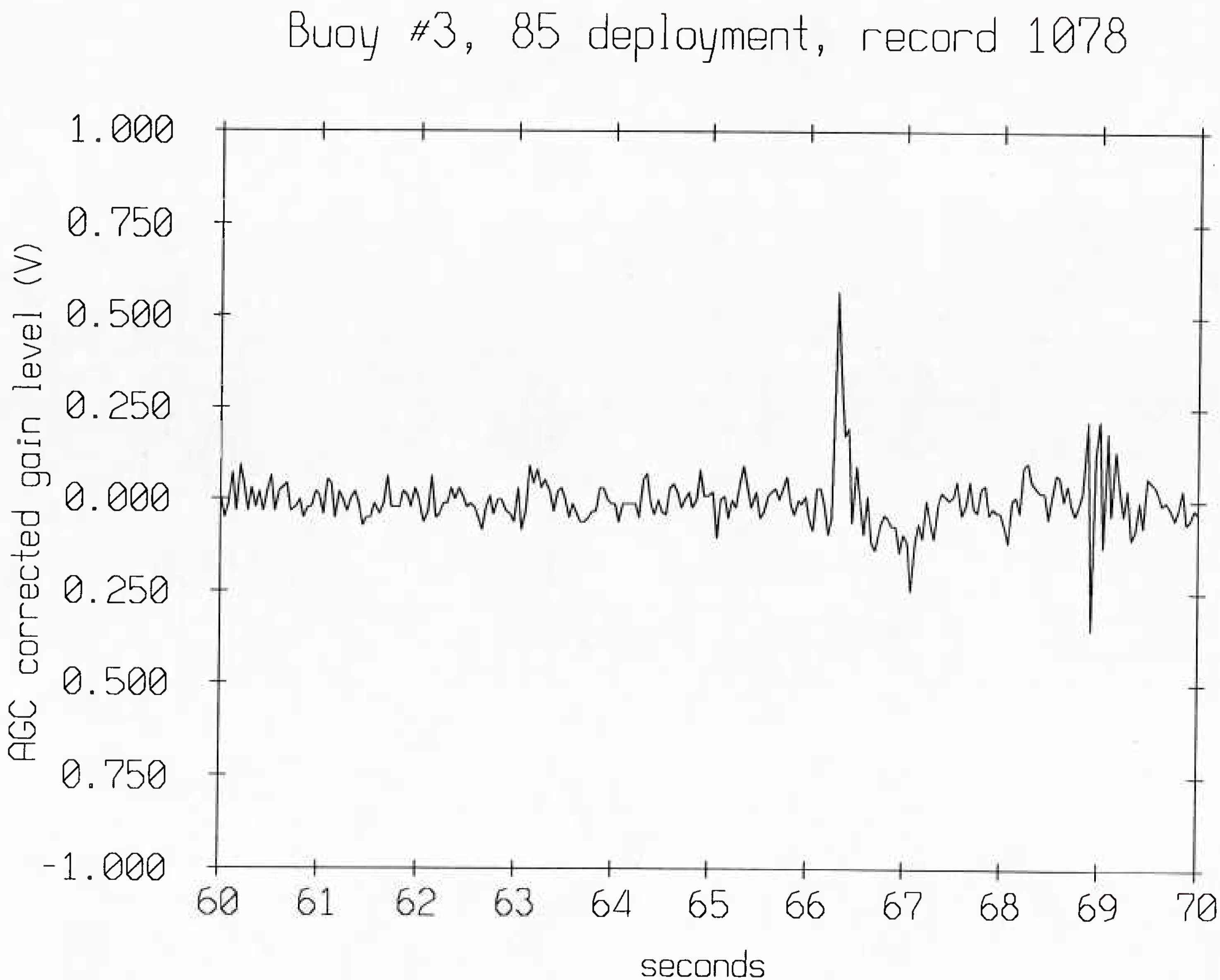

Buoy #3, 85 deployment, record 1078
1.000
0.750
0.500
0.250
0.000
0.250
0.500
0.750
-1.000
AGC corrected gain level (V)
60
61
62
63
64
65
66
67
68
69
70
seconds

Figure VI.11

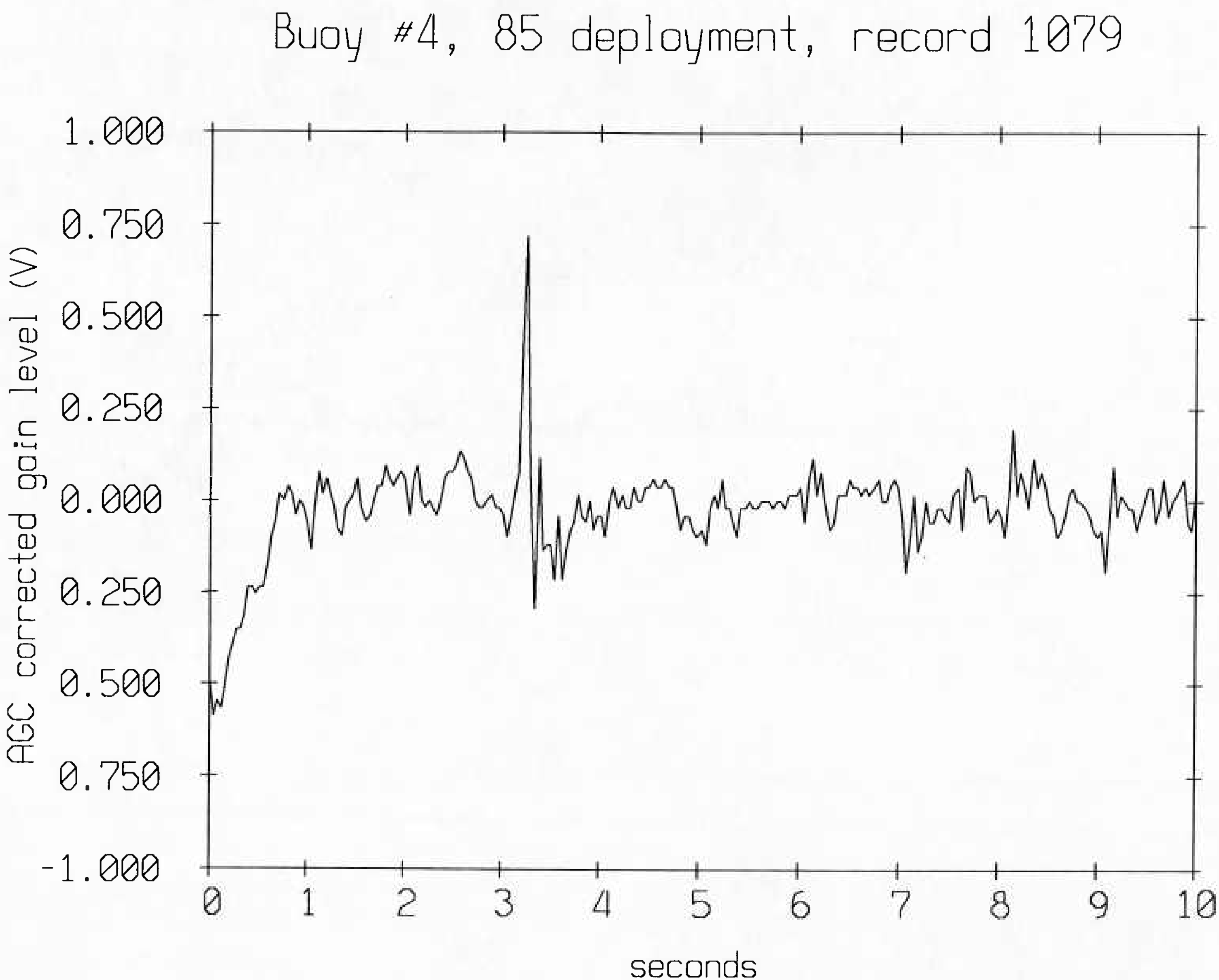

Buoy #4, 85 deployment, record 1079
1.000
0.750
0.500
0.250
0.000
0.250
0.500
0.750
-1.000
AGC corrected gain level (V)
0
1
2
3
4
5
6
7
8
9
10
seconds

Figure VI.12

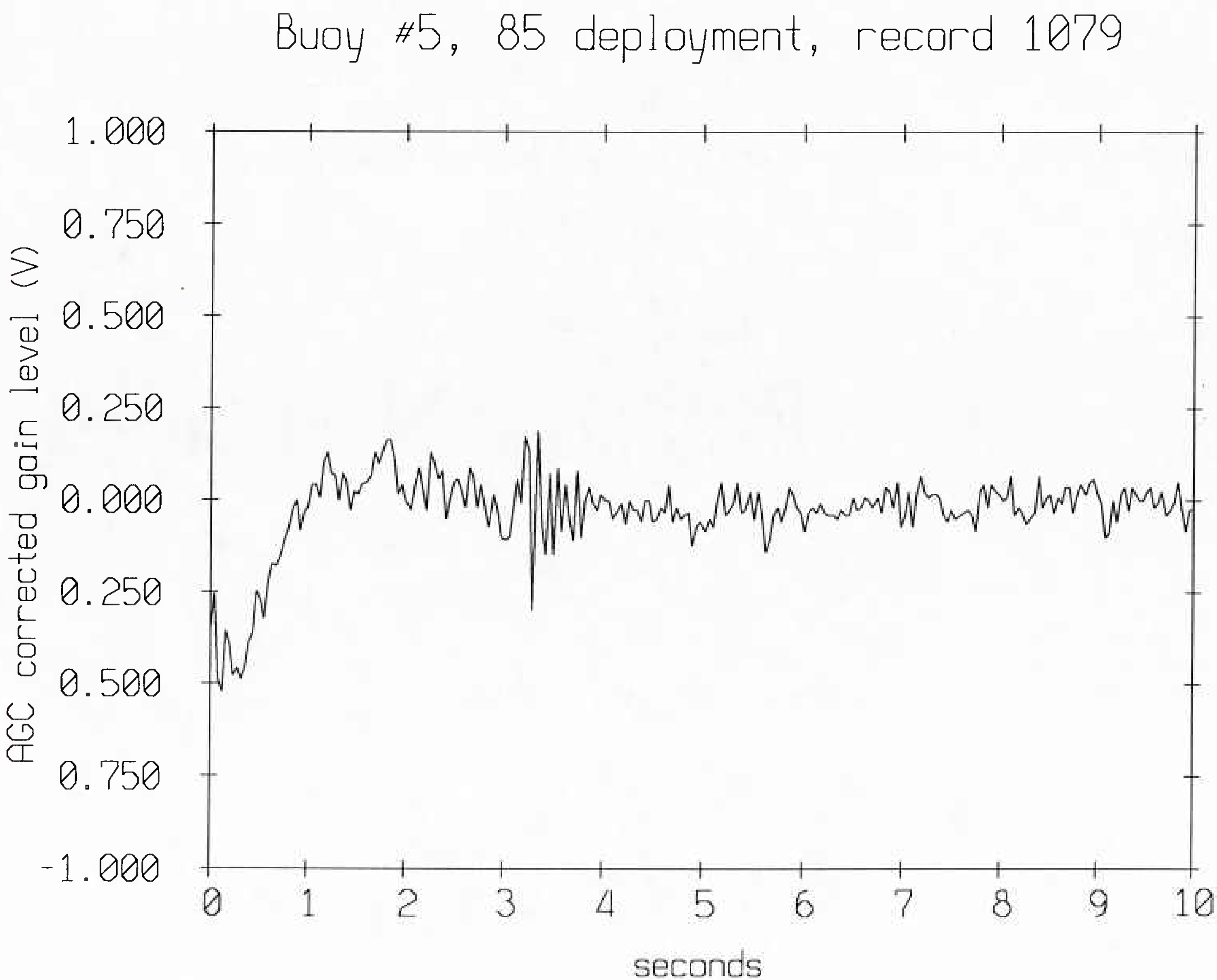

Buoy #5, 85 deployment, record 1079
1.000
0.750
0.500
0.250
0.000
0.250
0.500
0.750
-1.000
AGC corrected gain level (V)
0
1
2
3
4
5
6
7
8
9
10
seconds

Figure VI.13

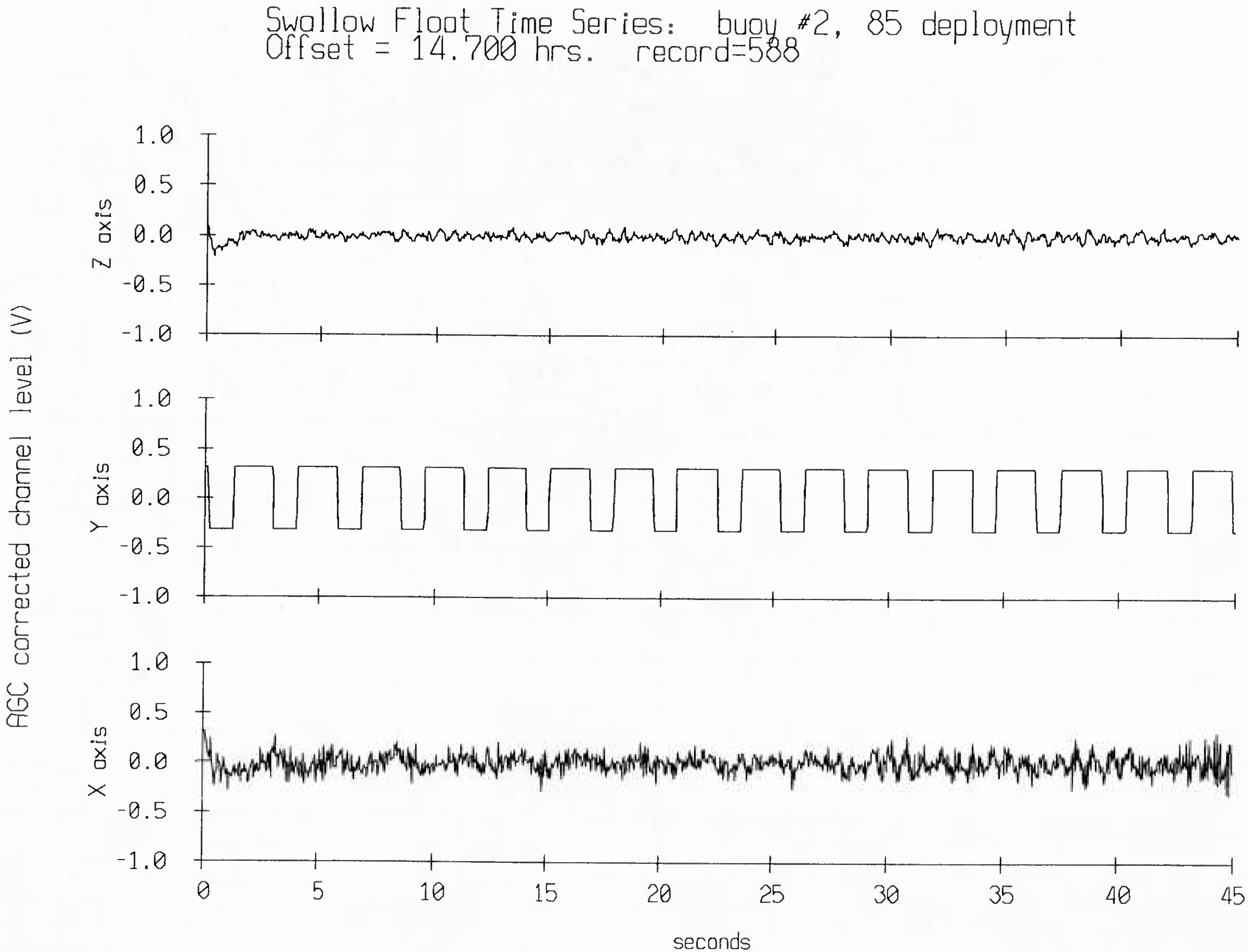


Figure VI.14a

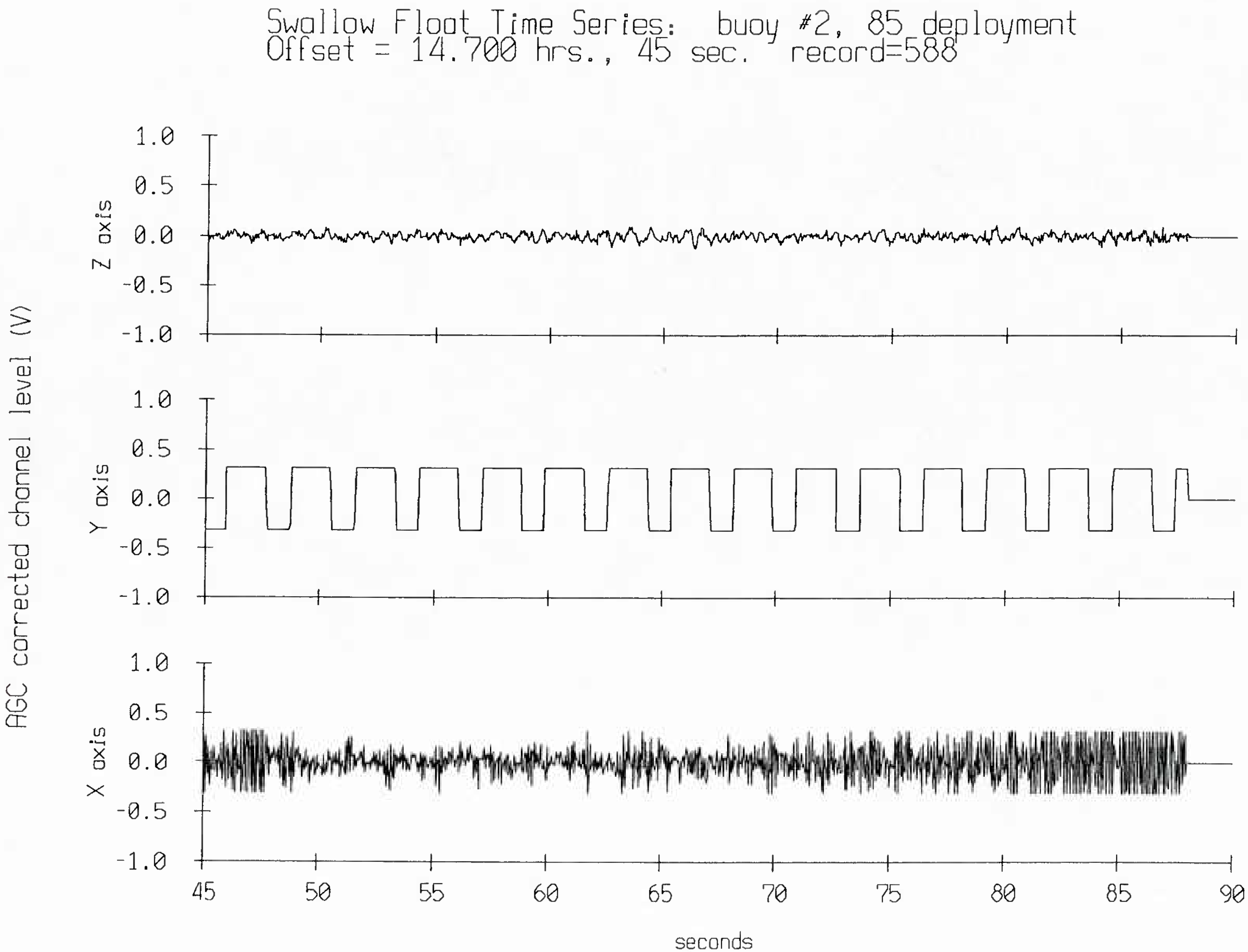


Figure VI.14b

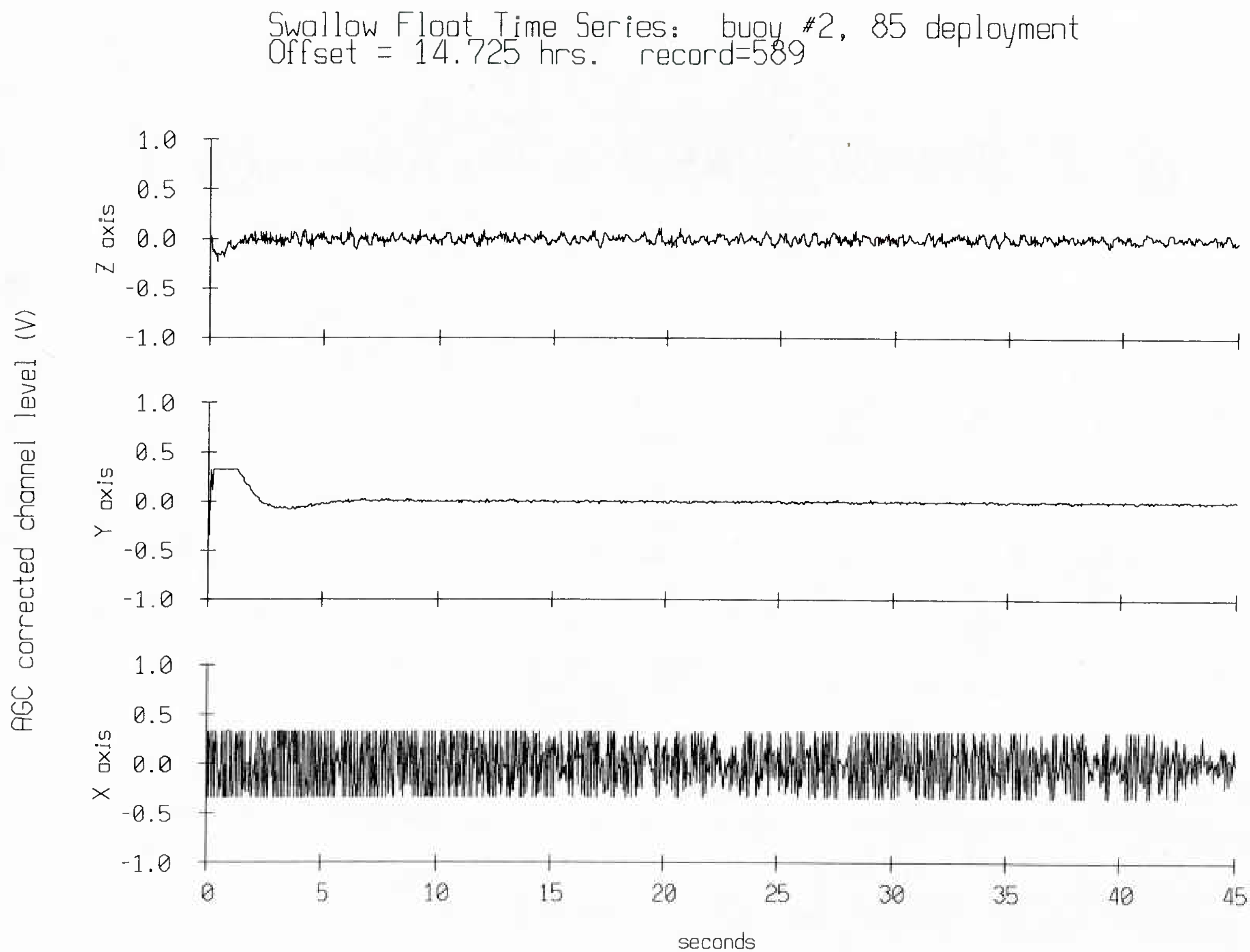


Figure VI.14c

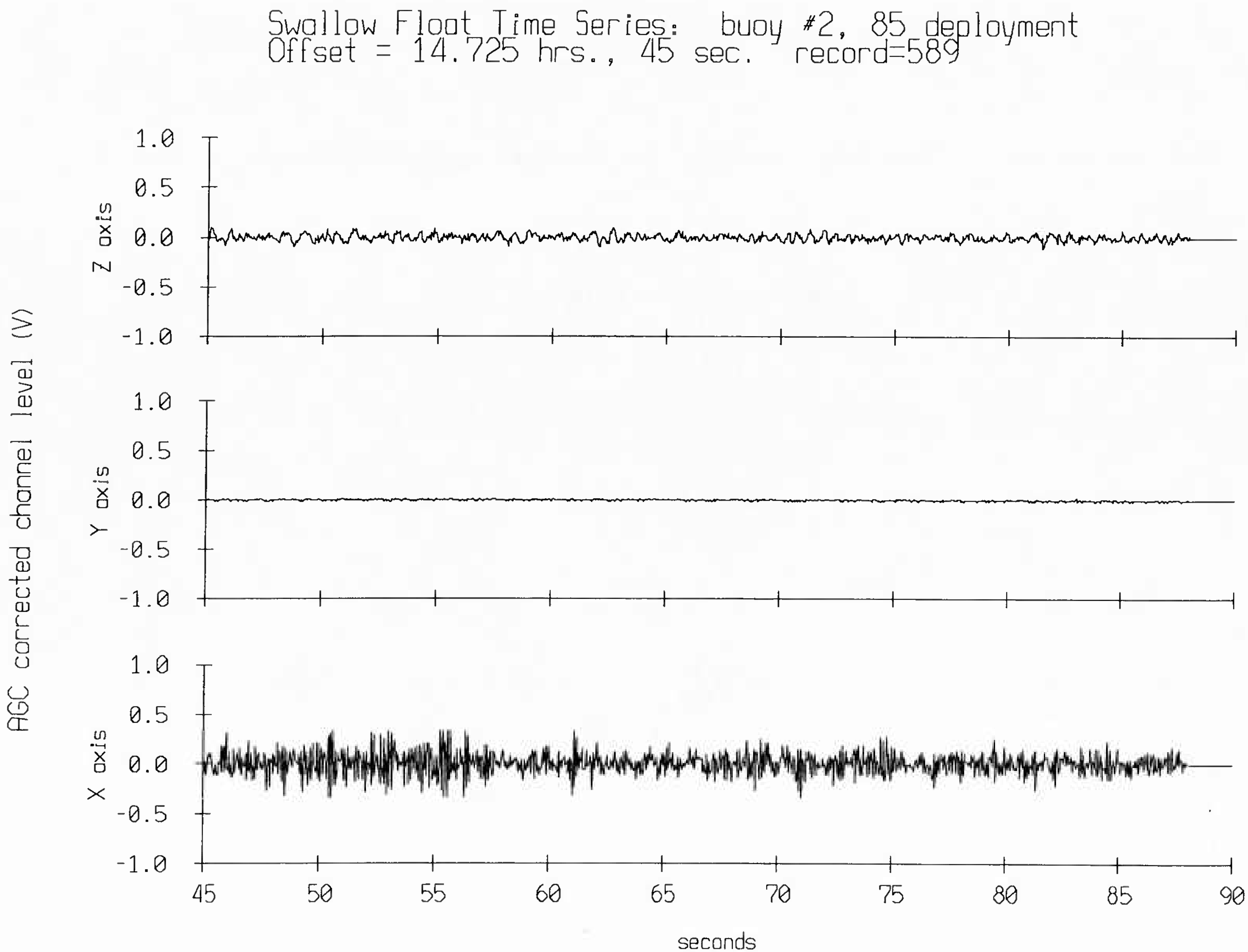


Figure VI.14d

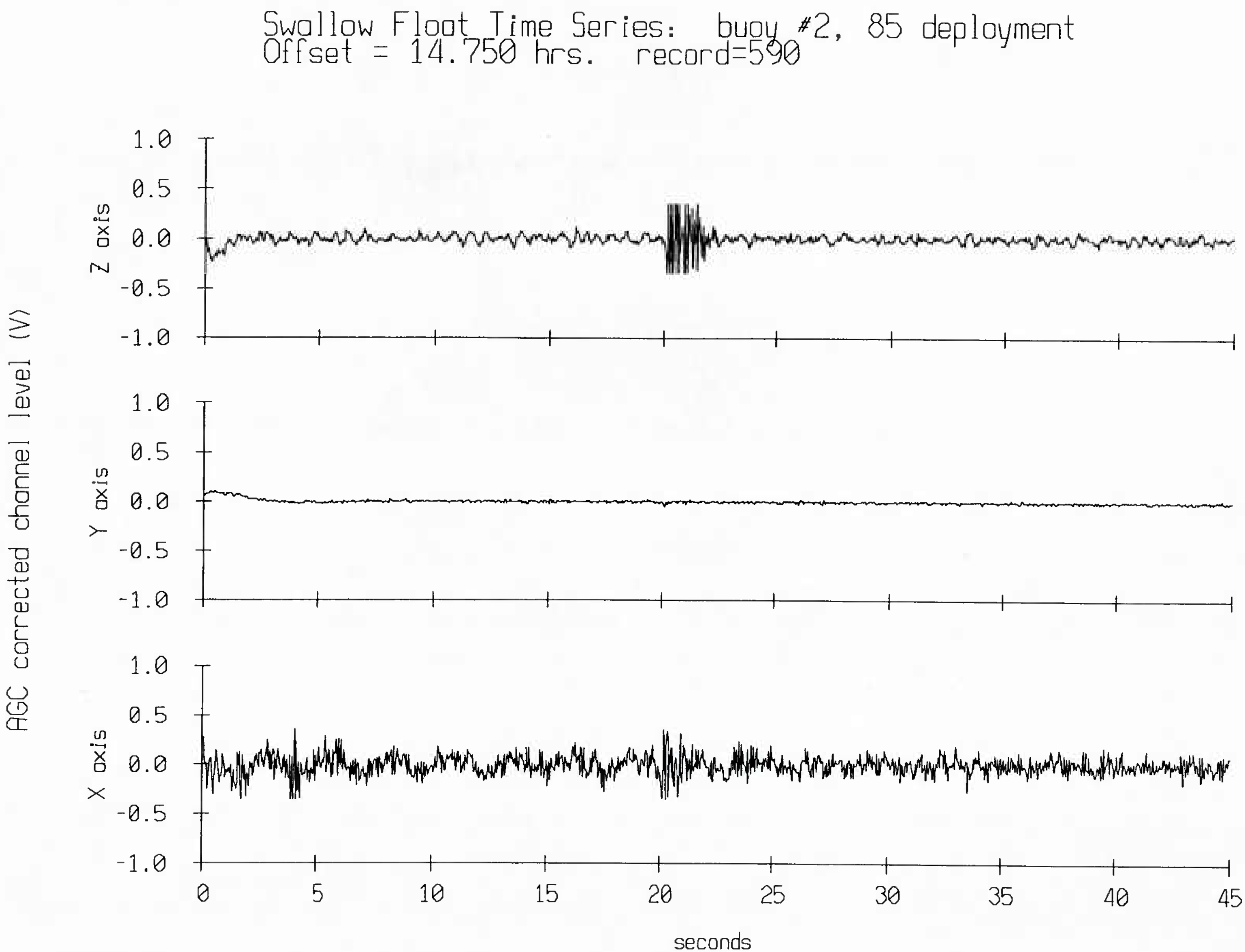


Figure VI.14e

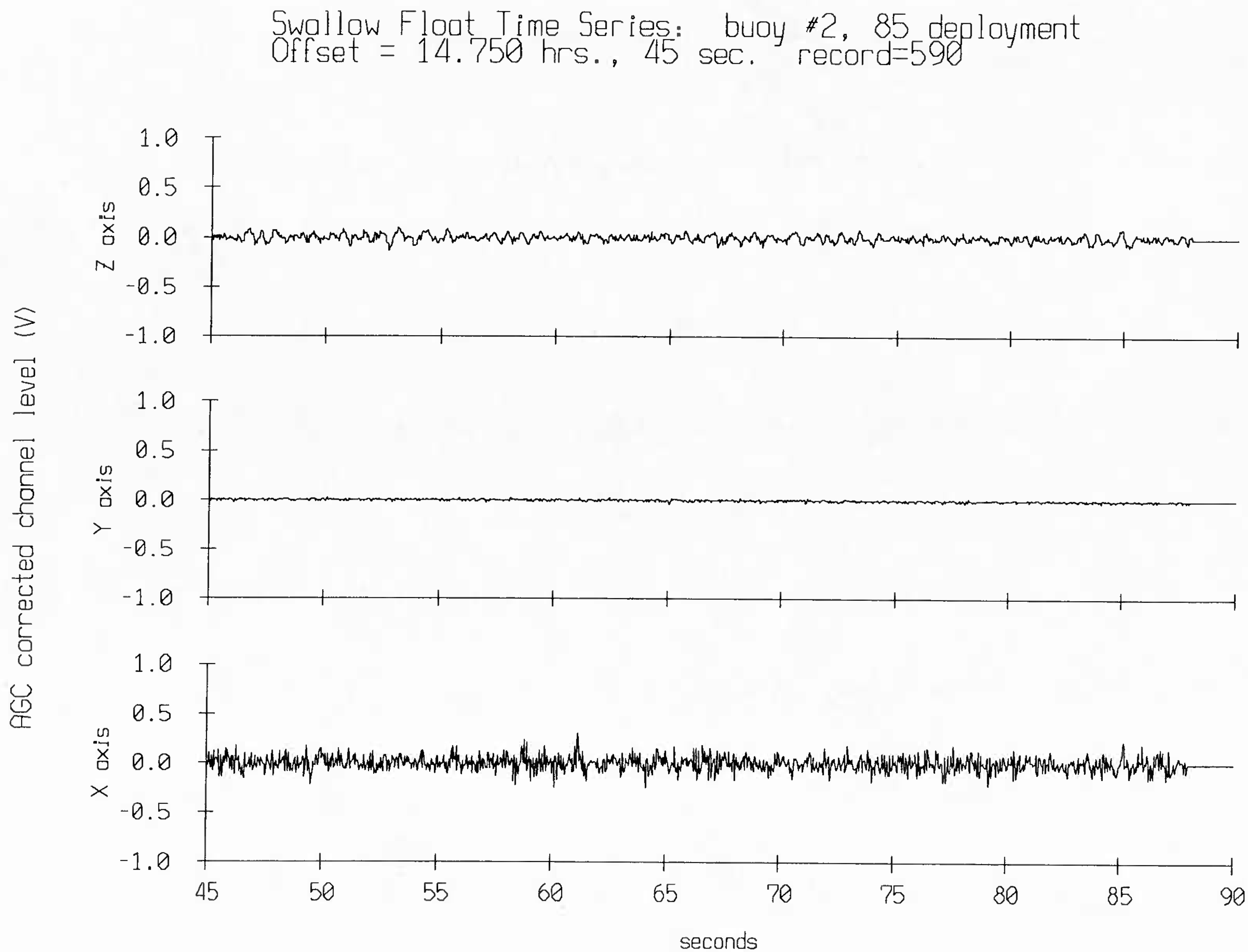


Figure VI.14f

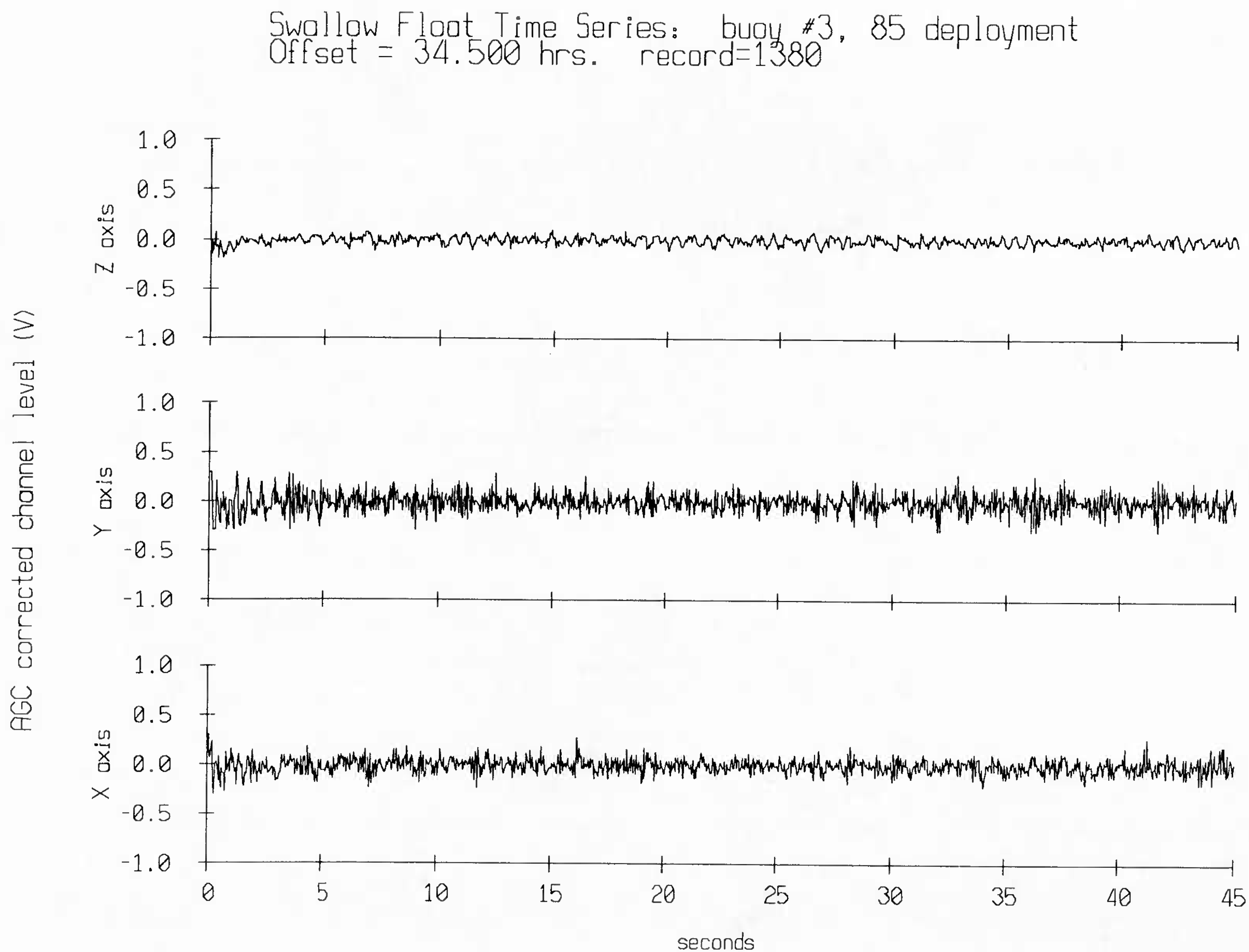


Figure VI.15a

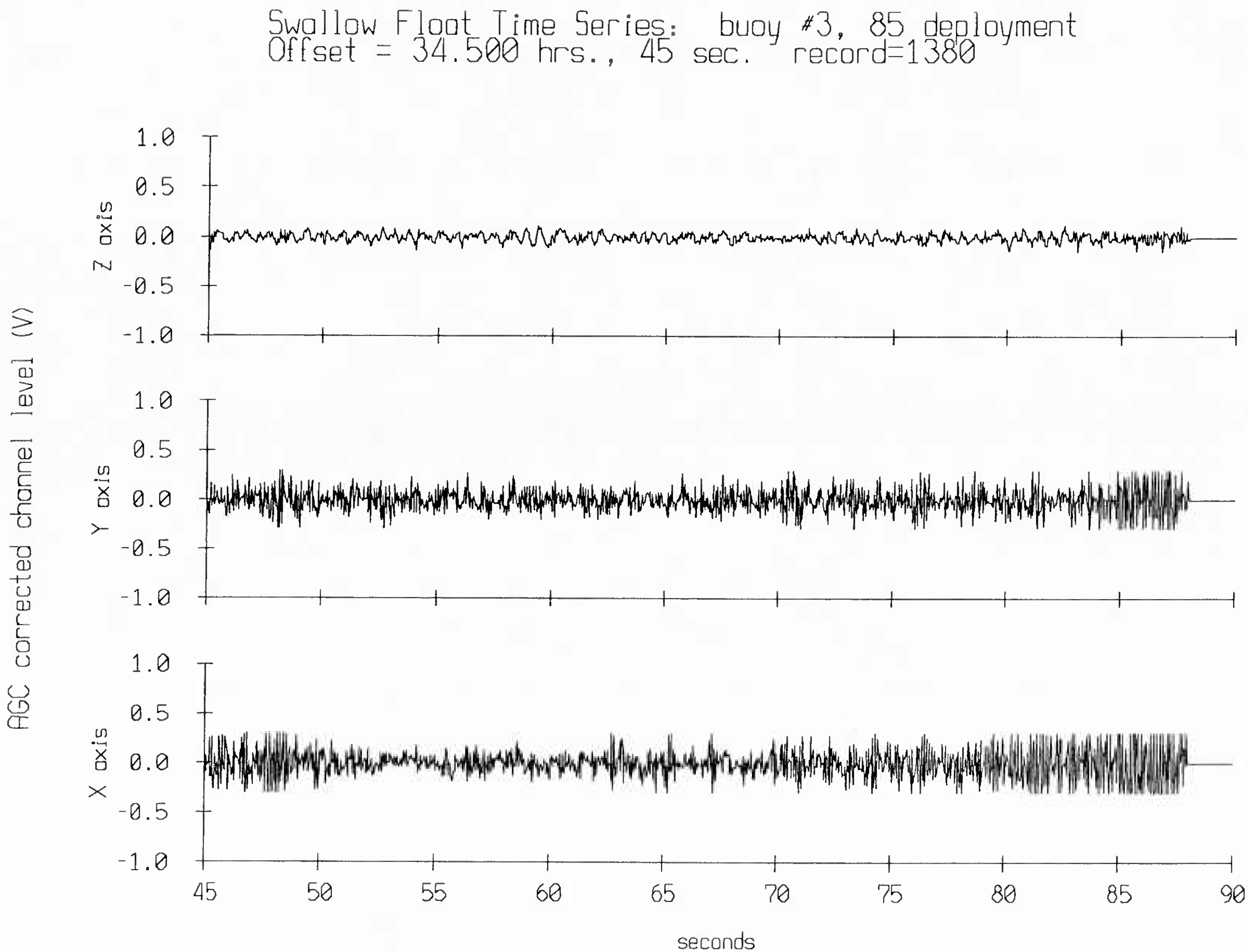


Figure VI.15b

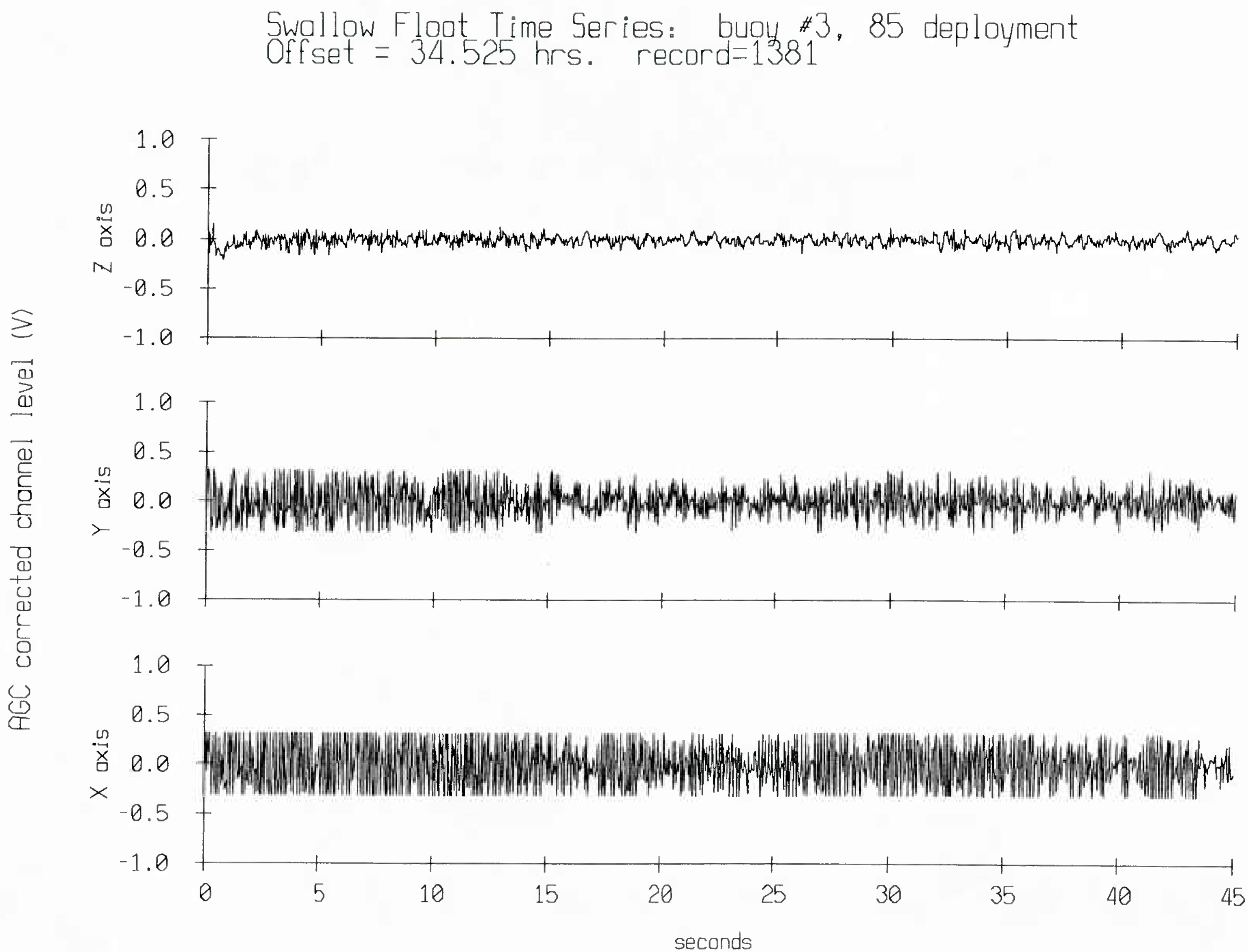


Figure VI.15c

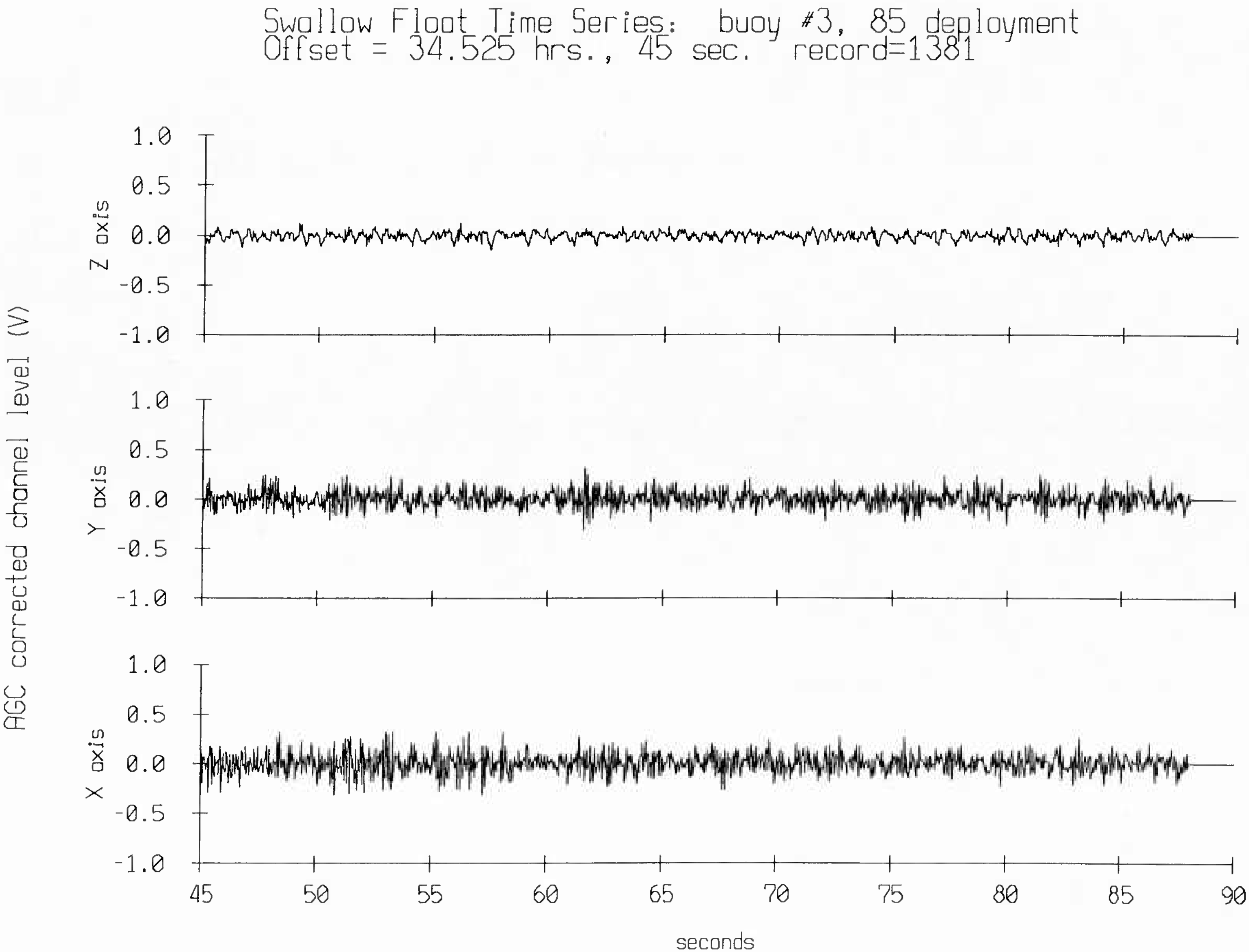


Figure VI.15d

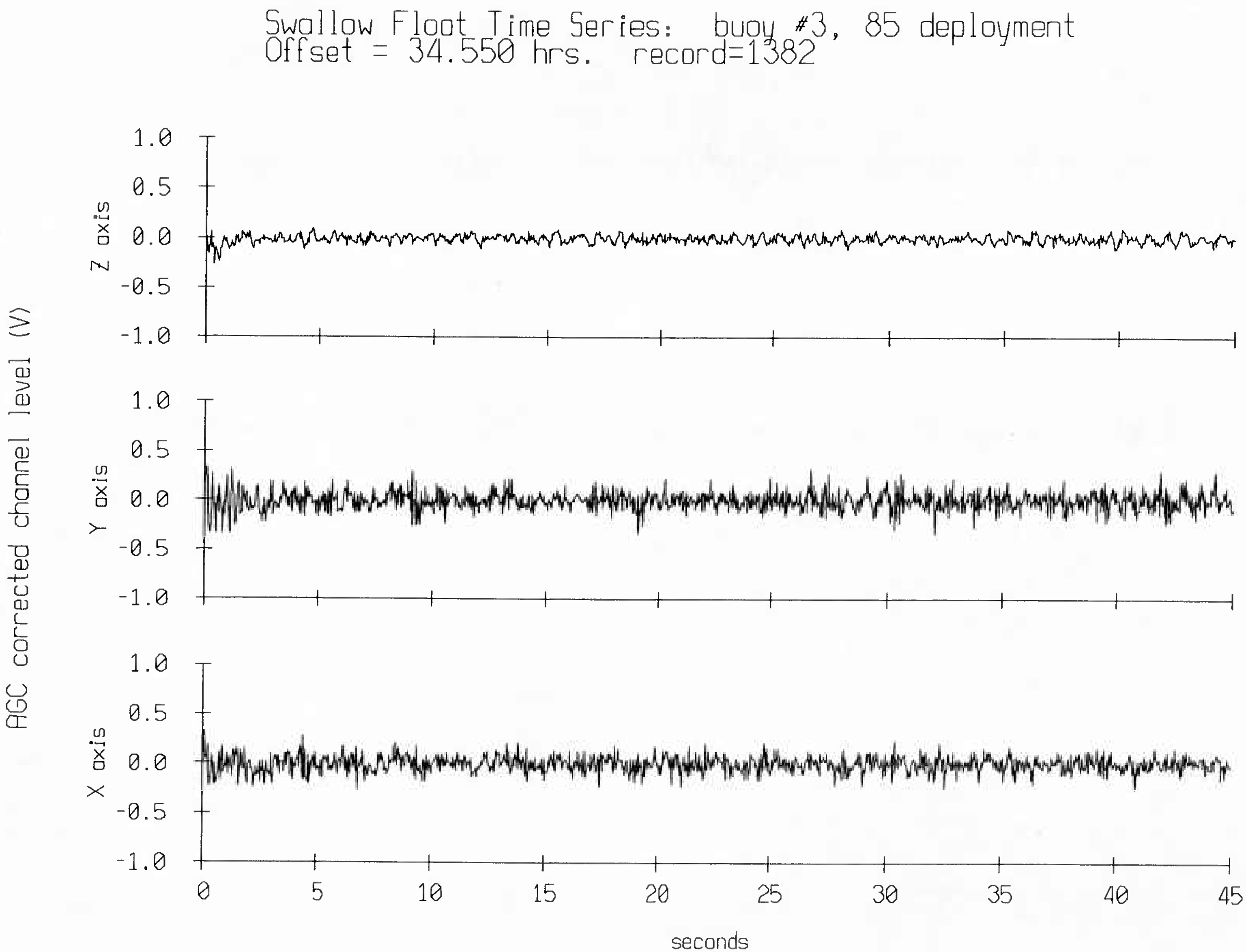


Figure VI.15e

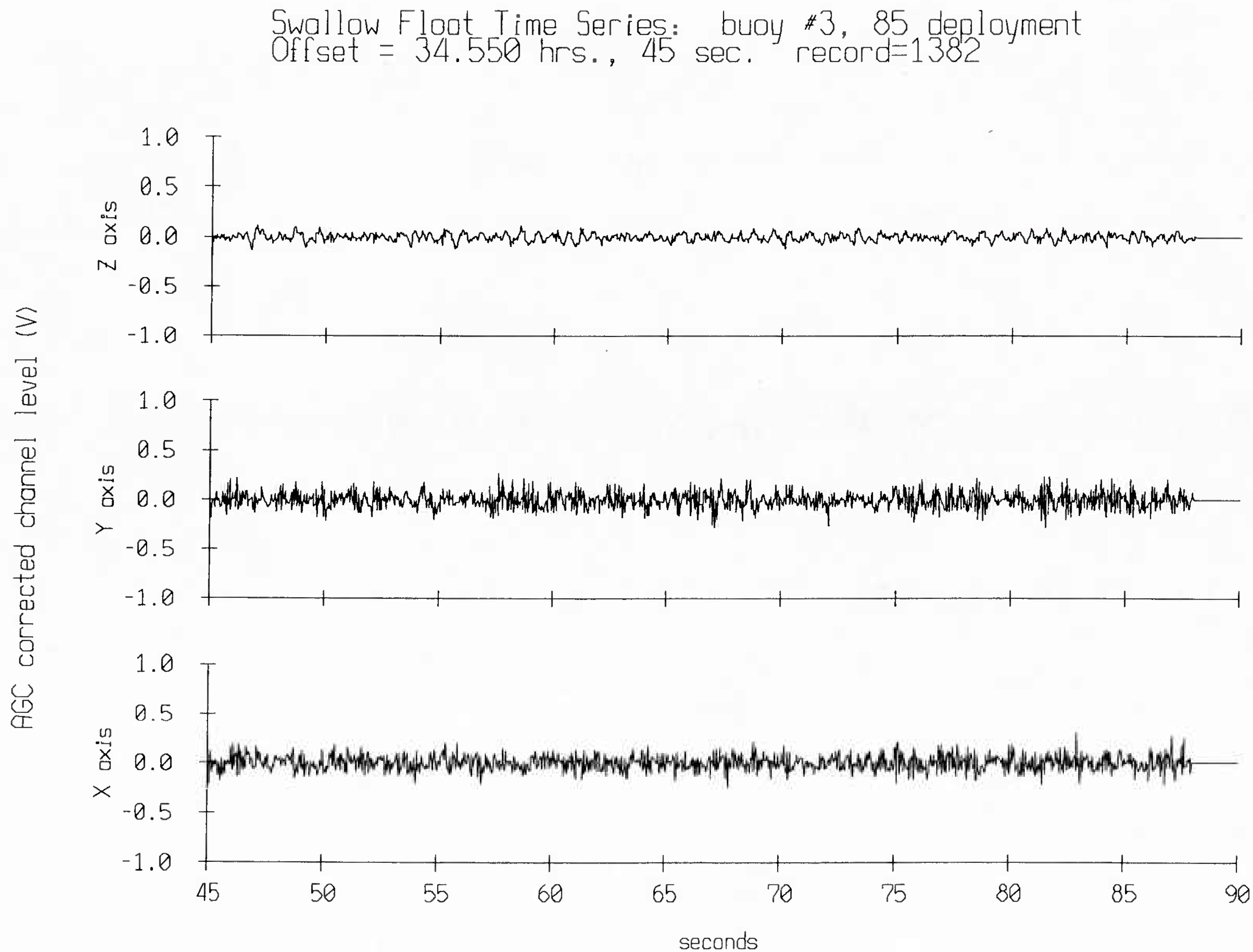


Figure VI.15f

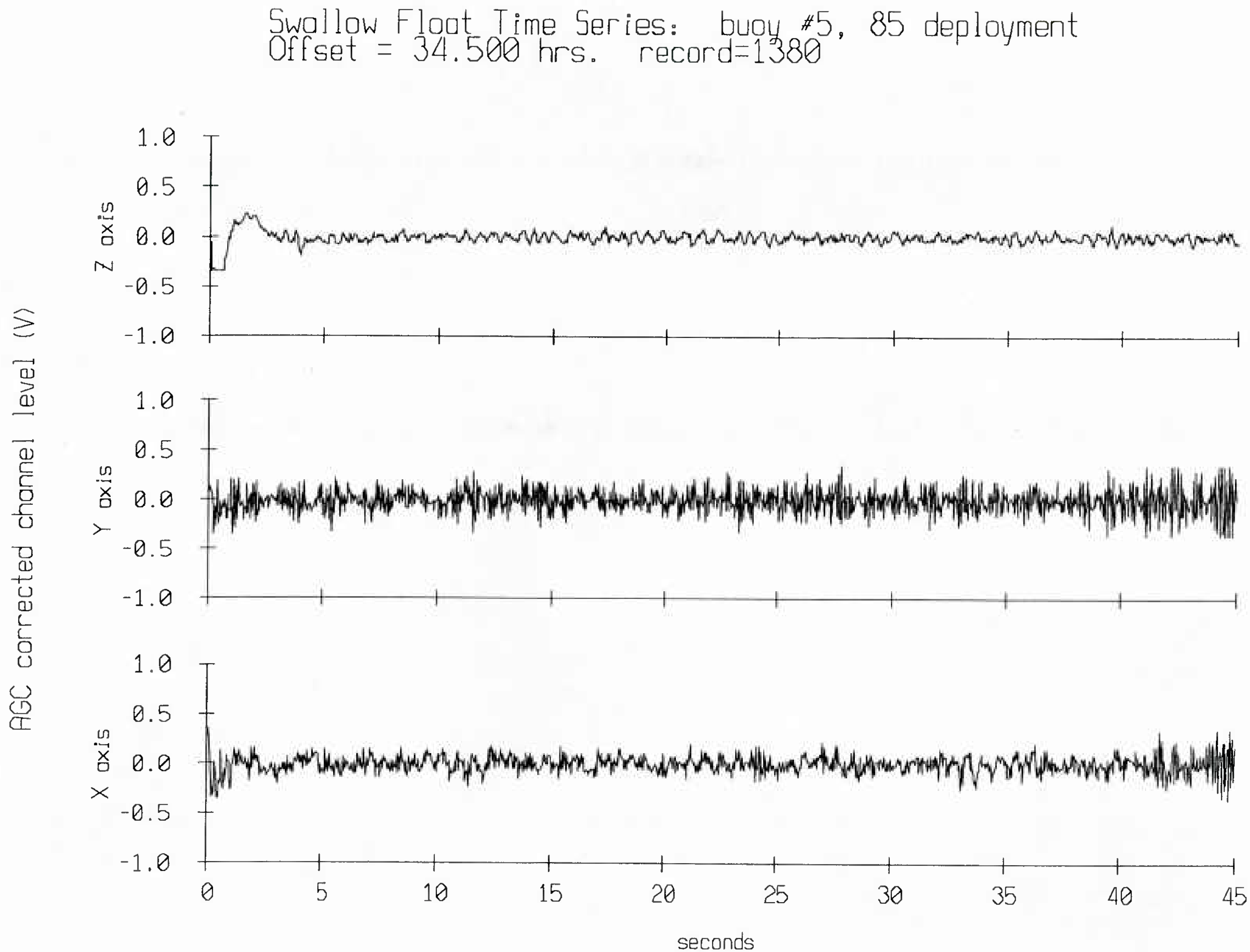


Figure VI.16a

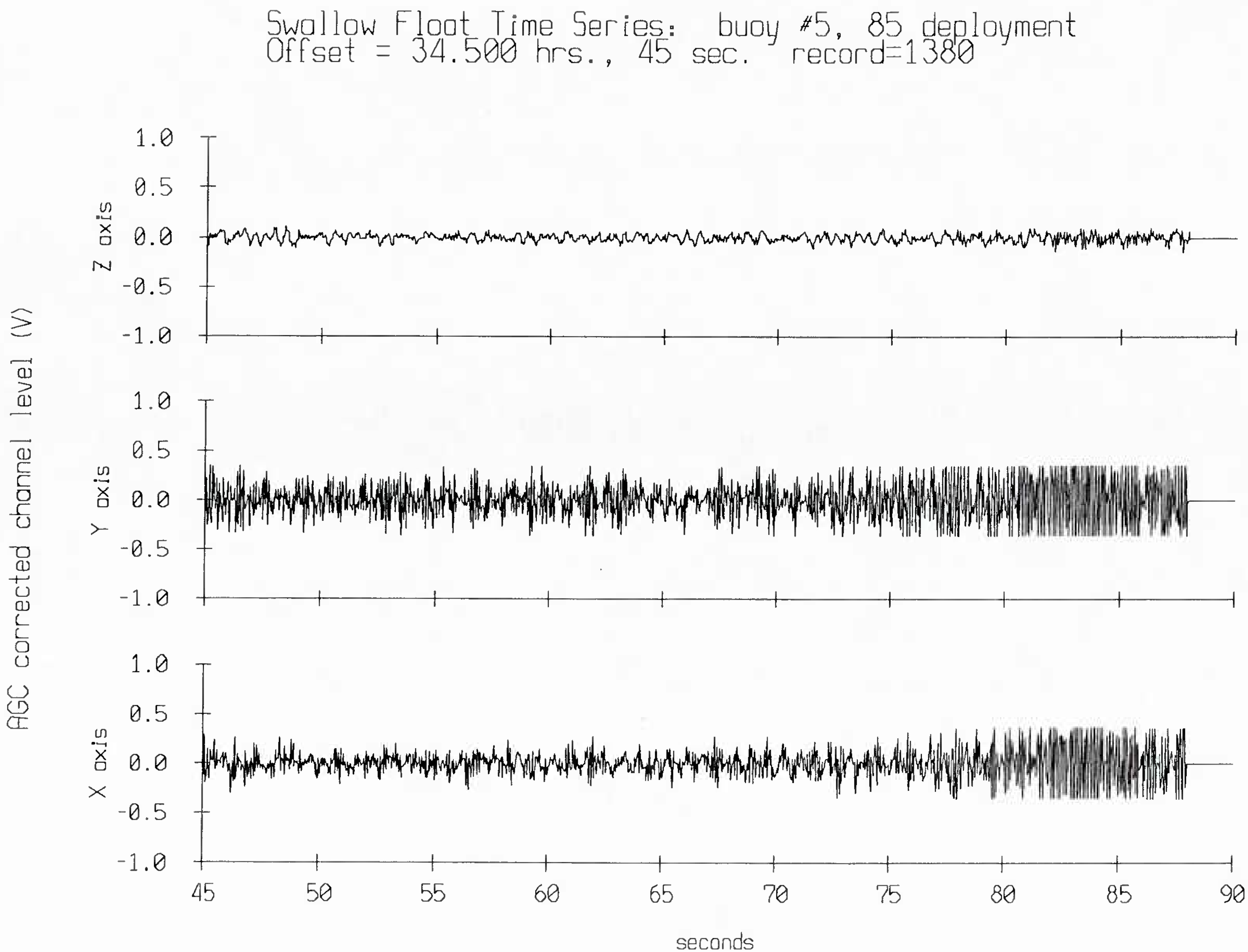


Figure VI.16b

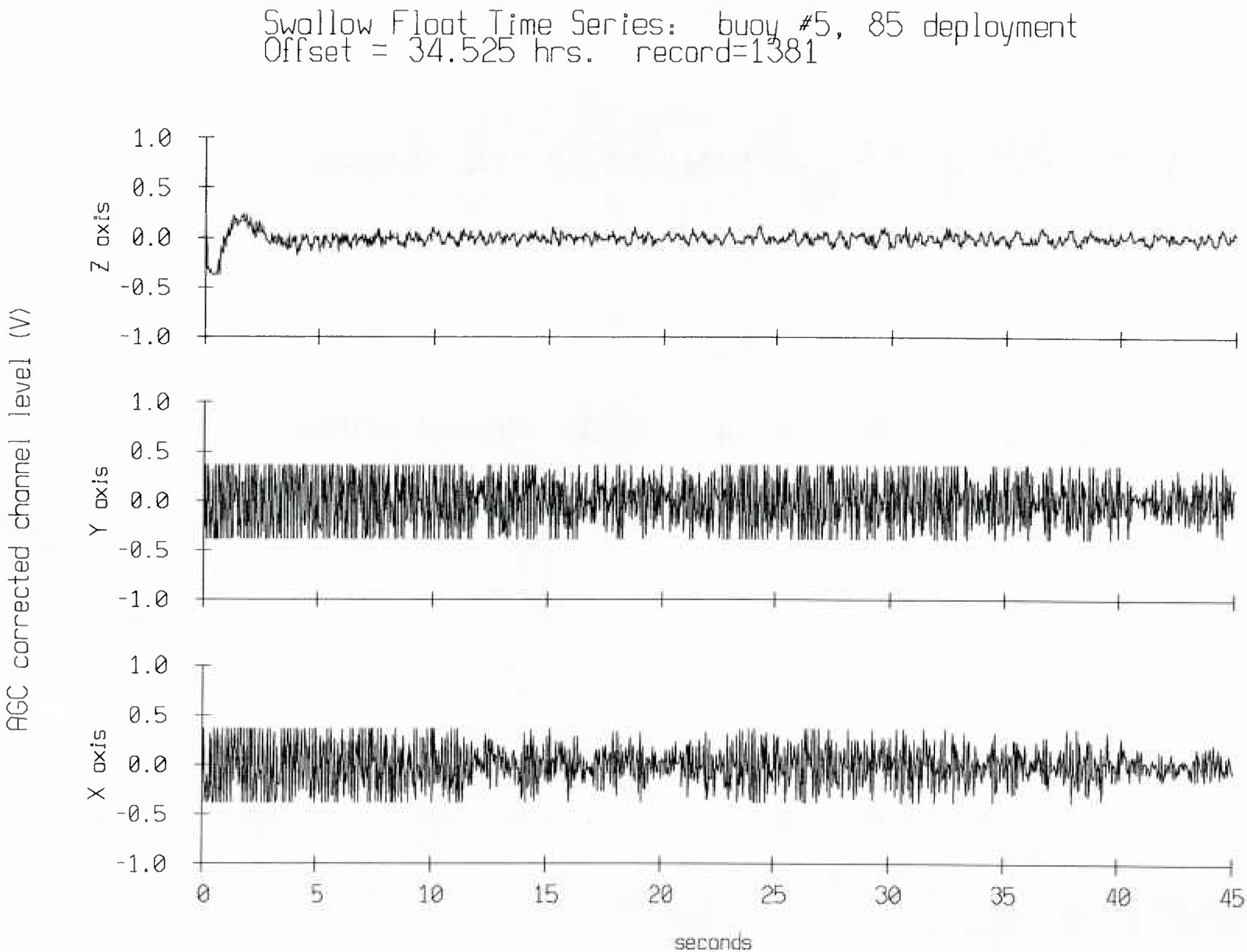


Figure VI.16c

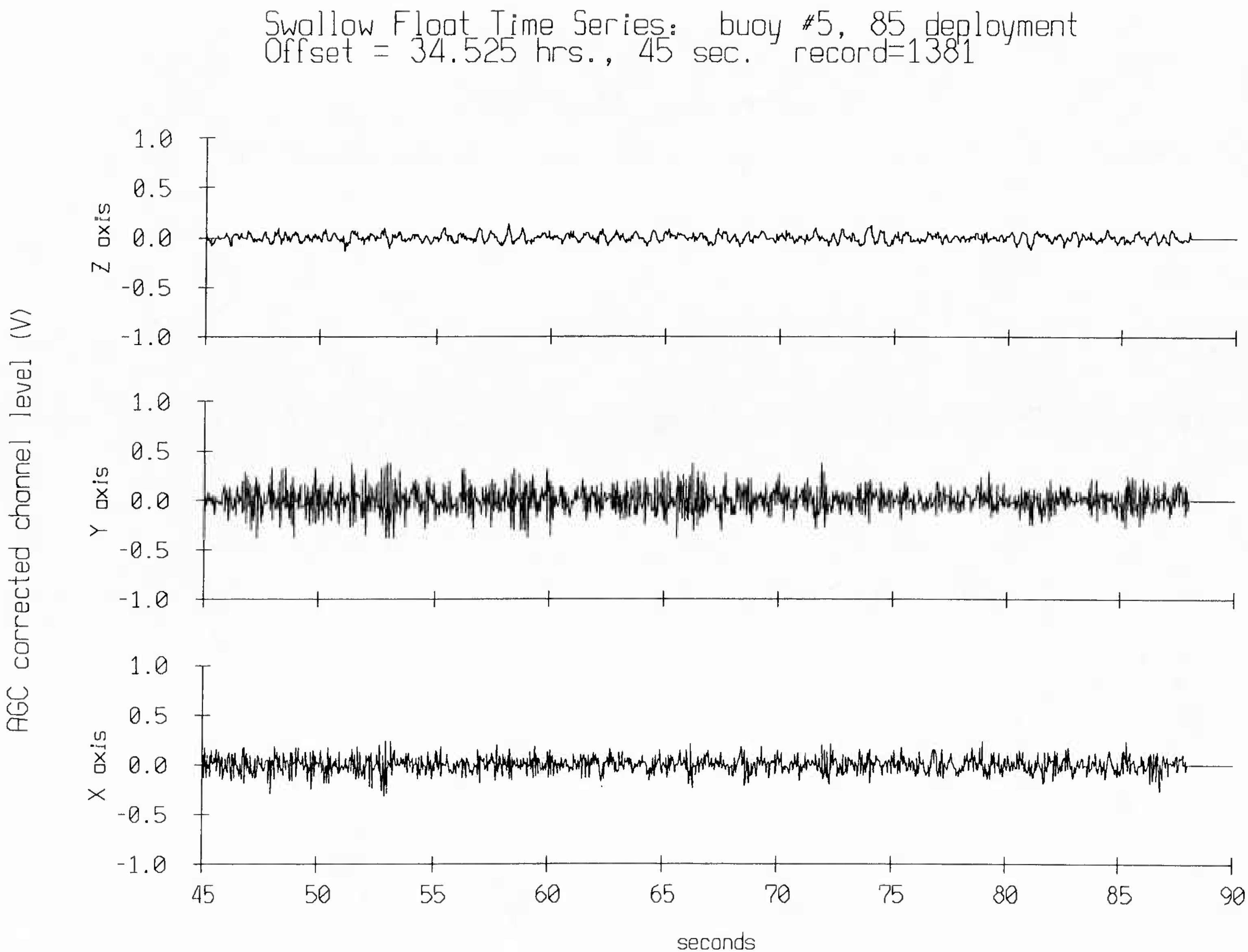


Figure VI.16d

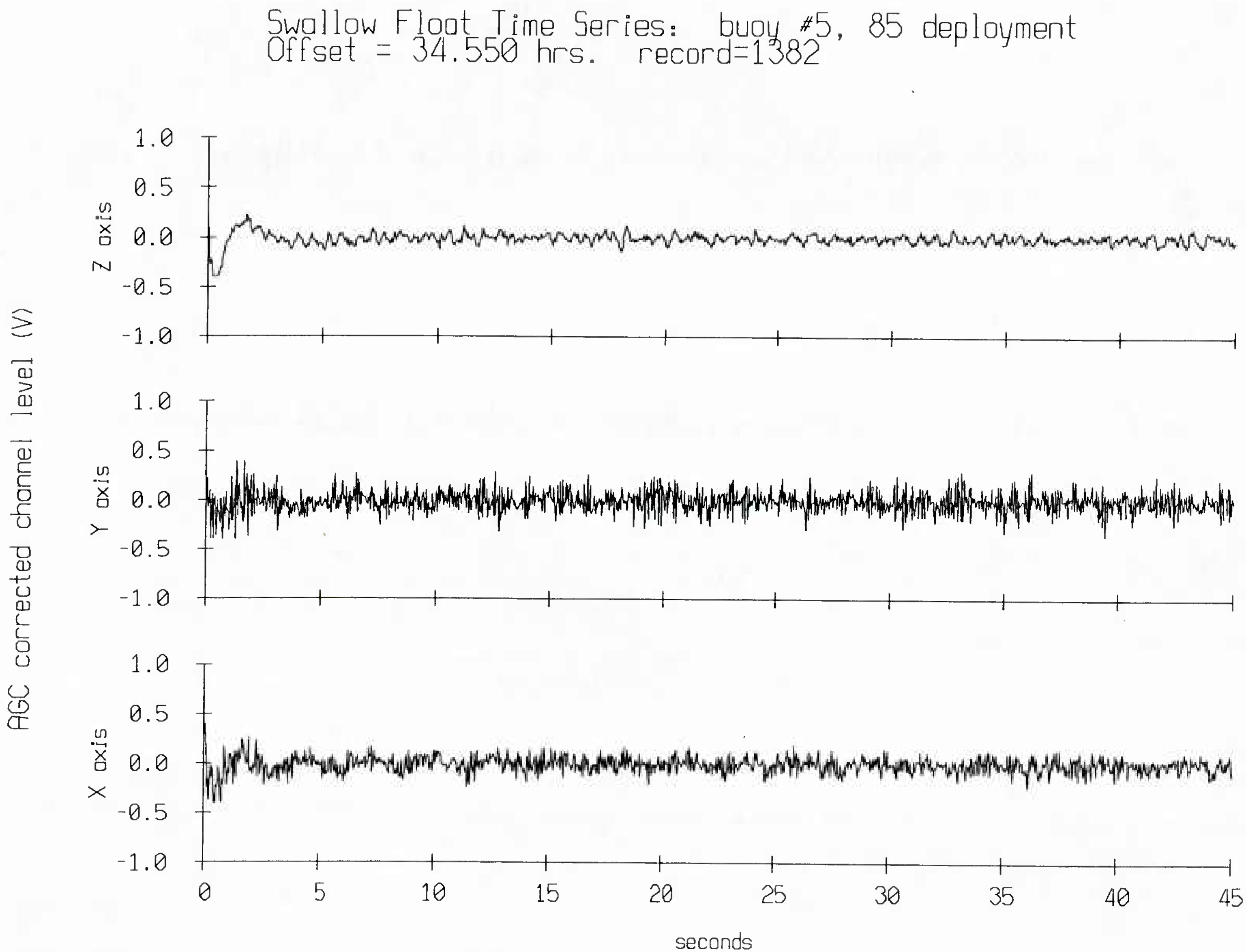


Figure VI.16e

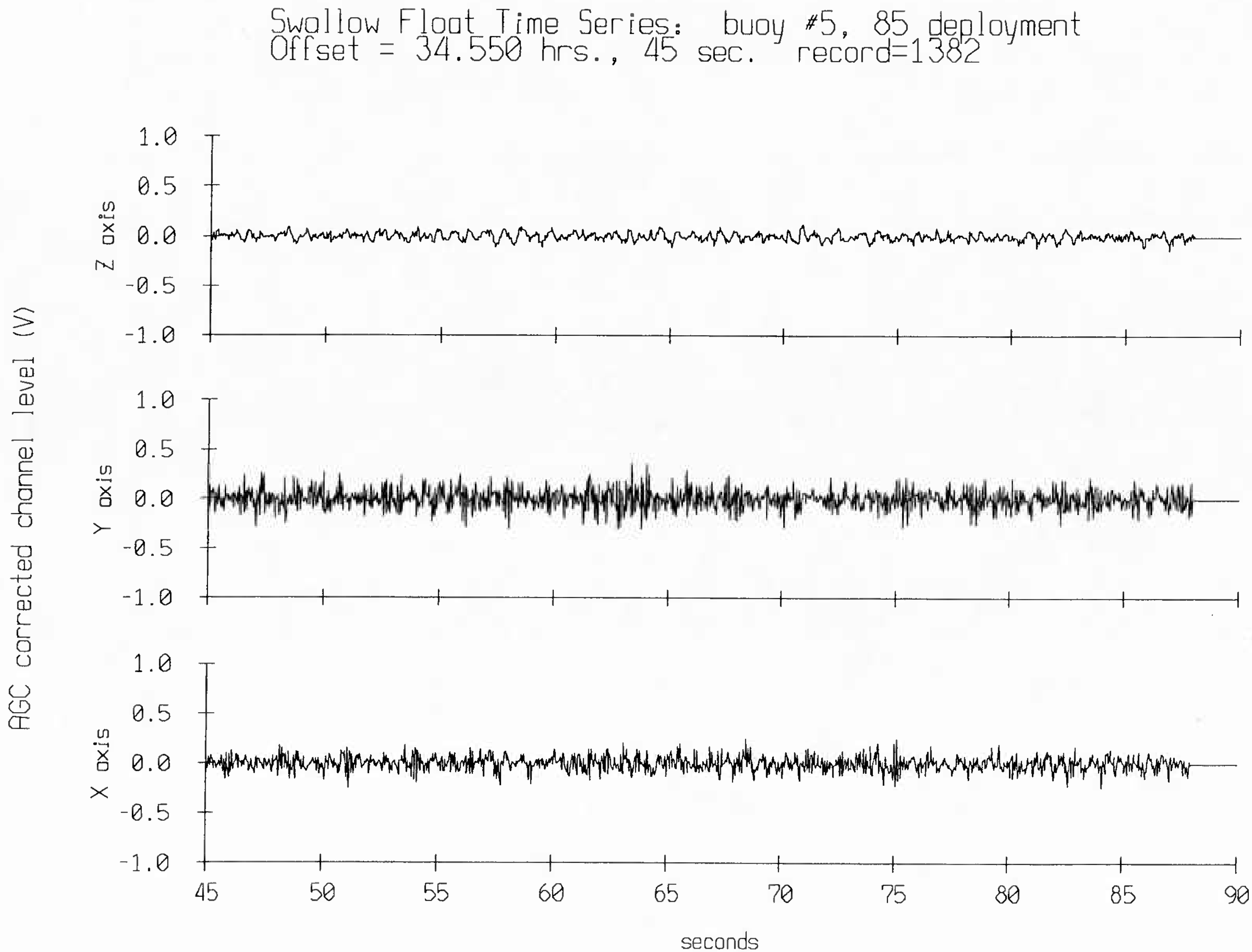


Figure VI.16f

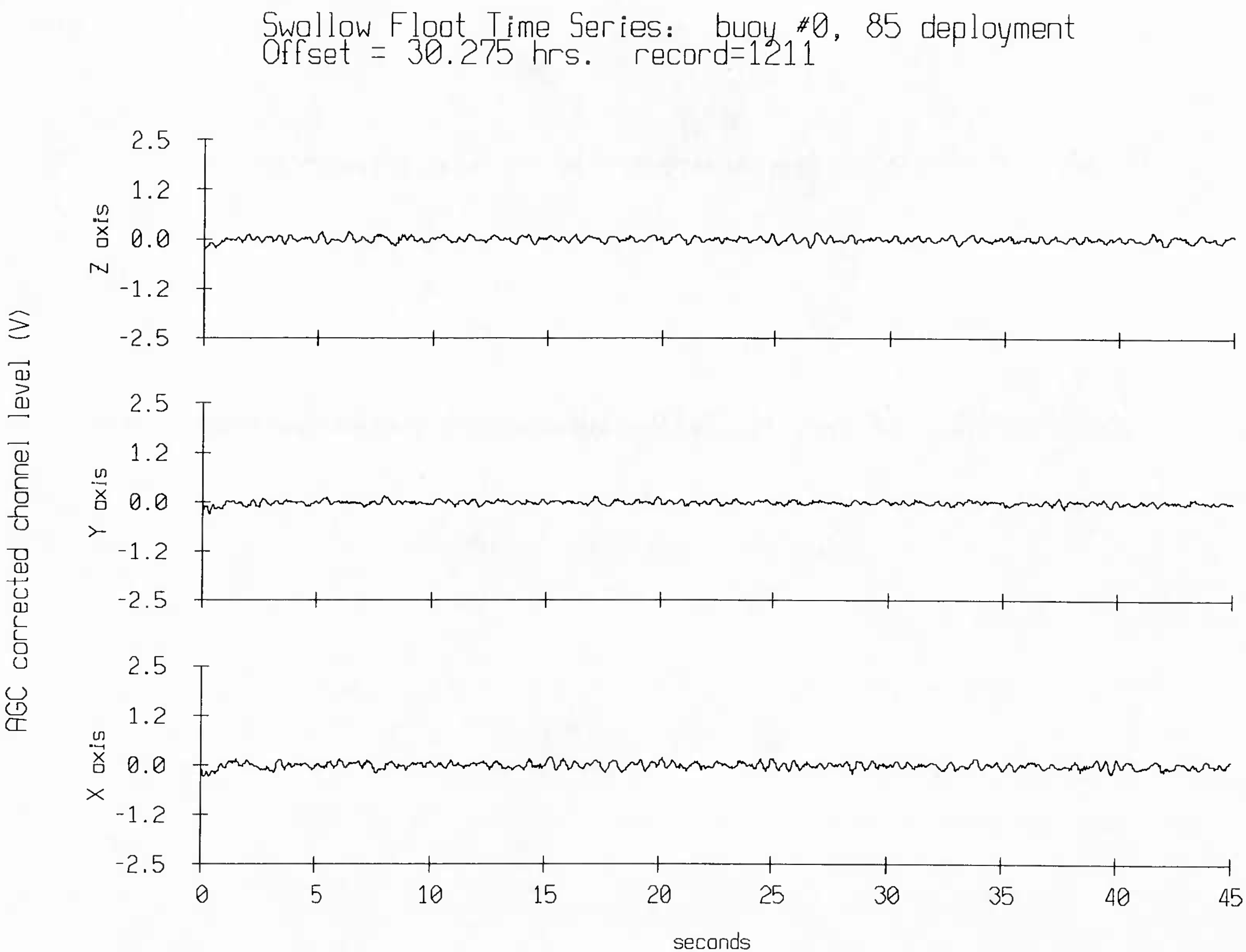


Figure VI.17a

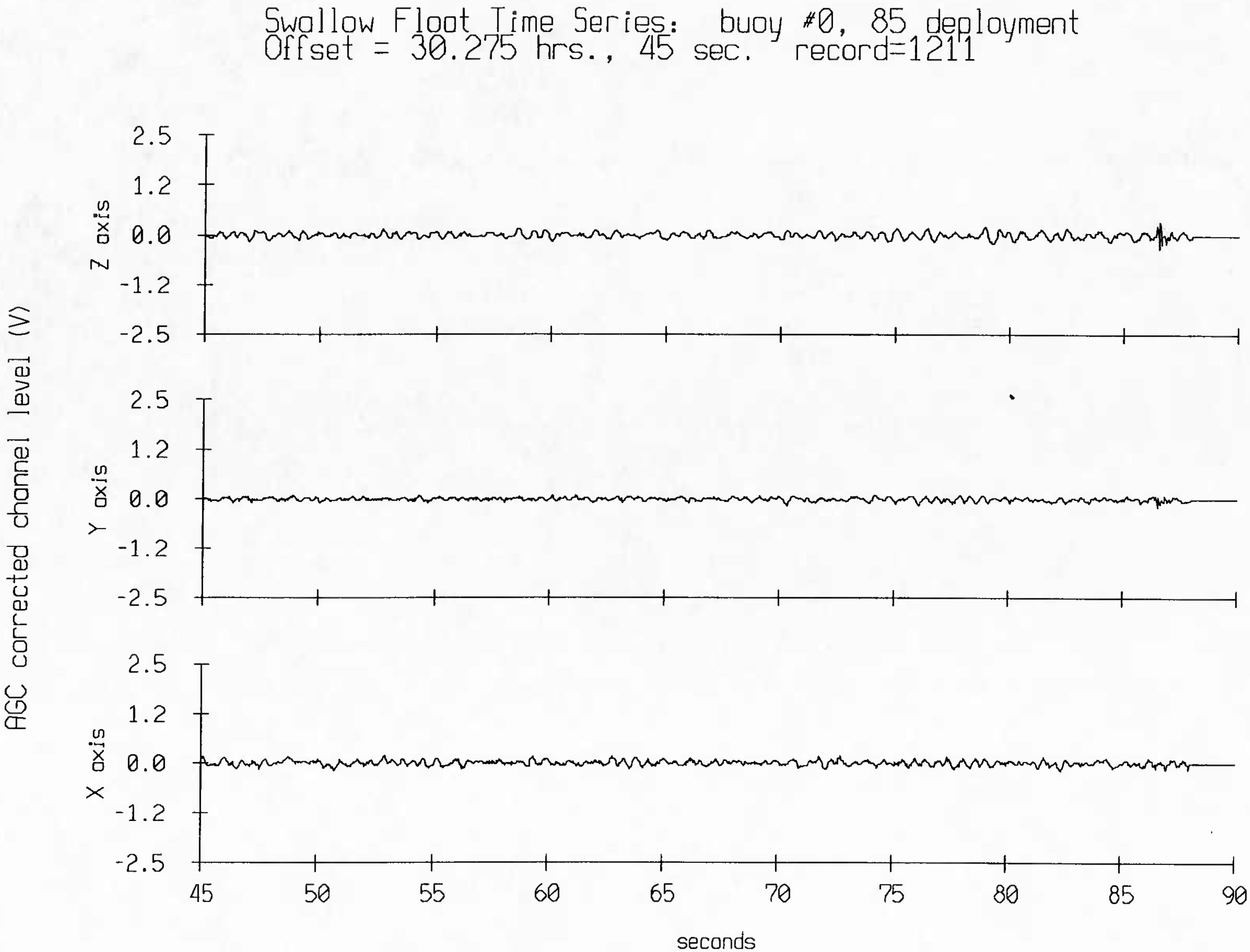


Figure VI.17b

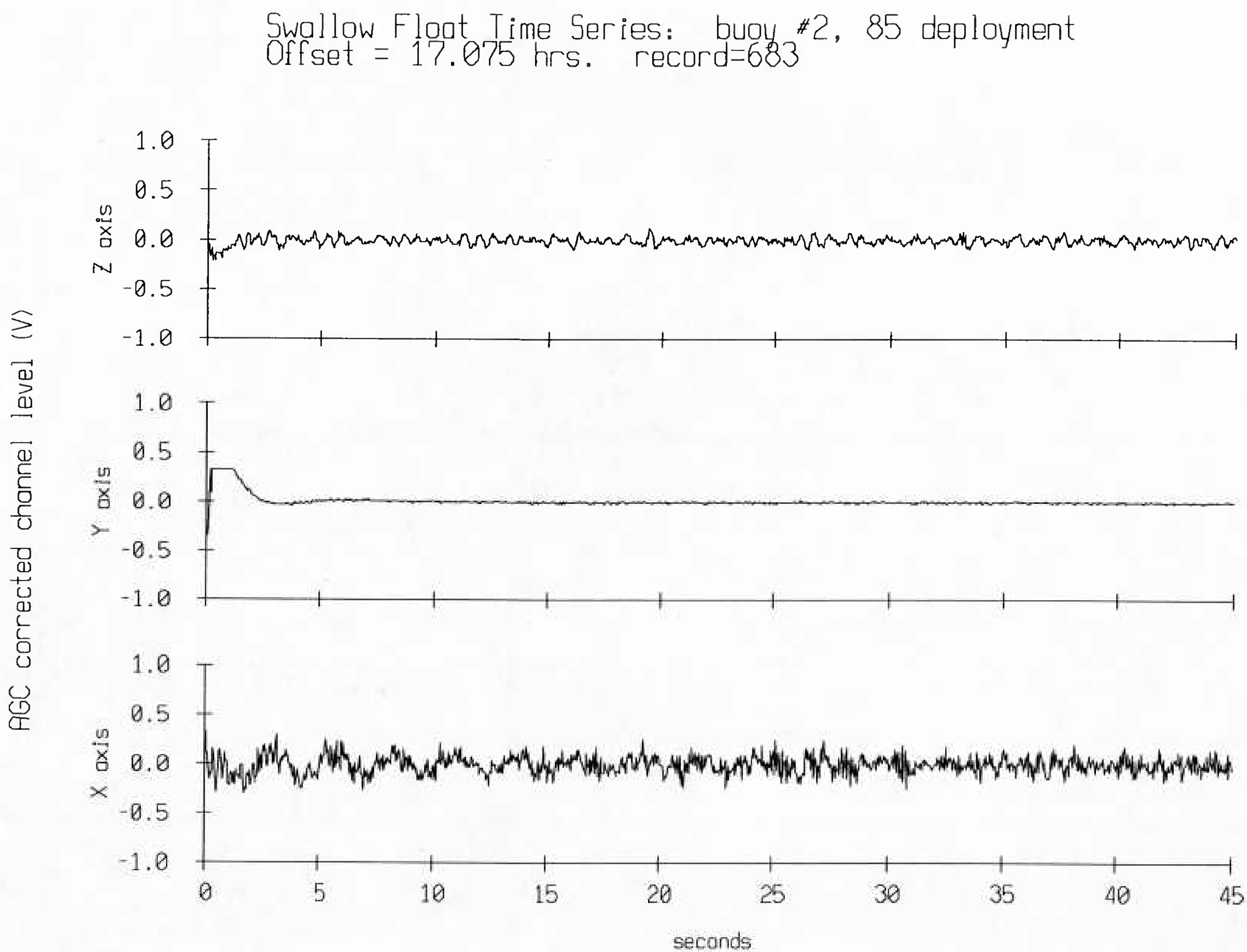


Figure VI.18a

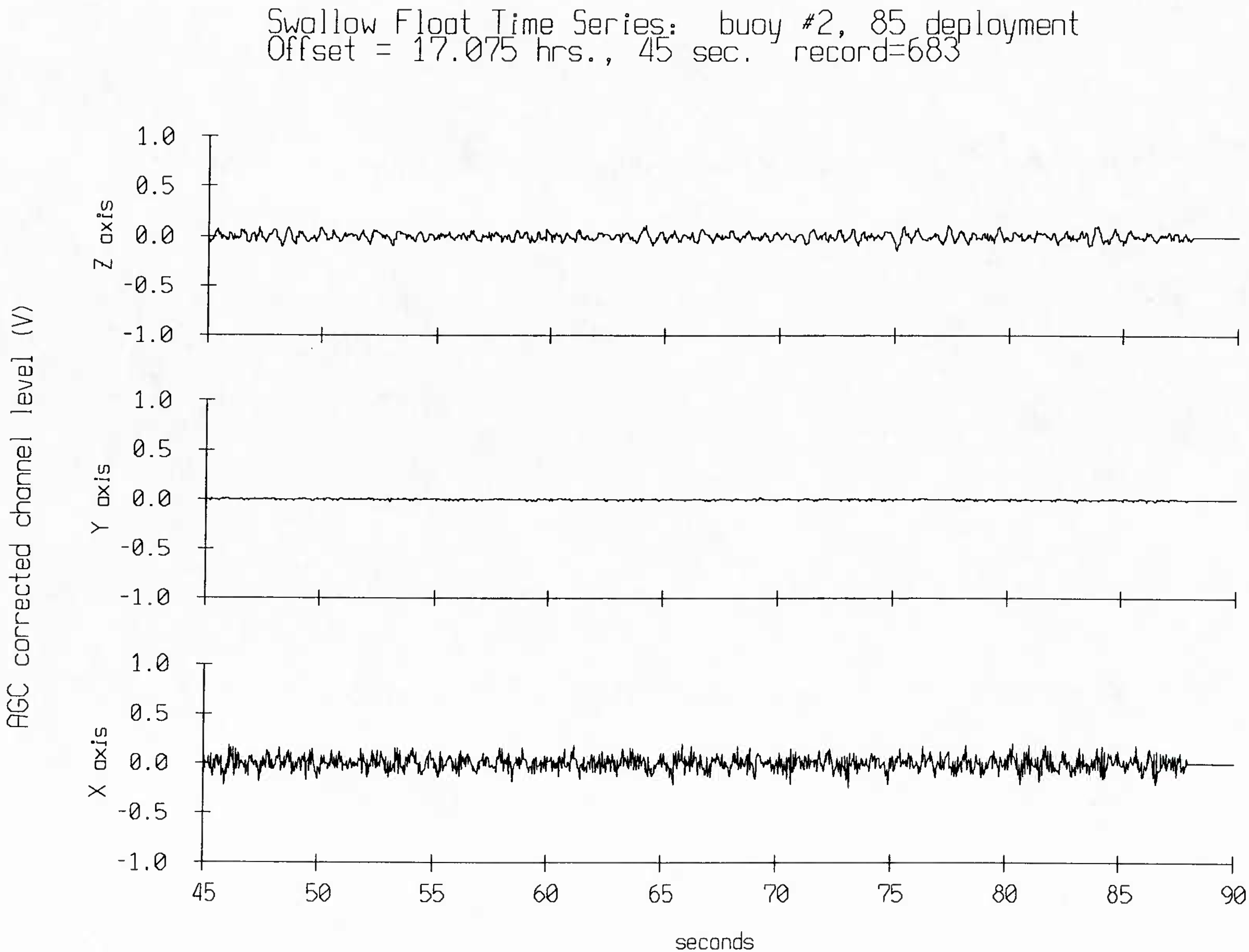


Figure VI.18b

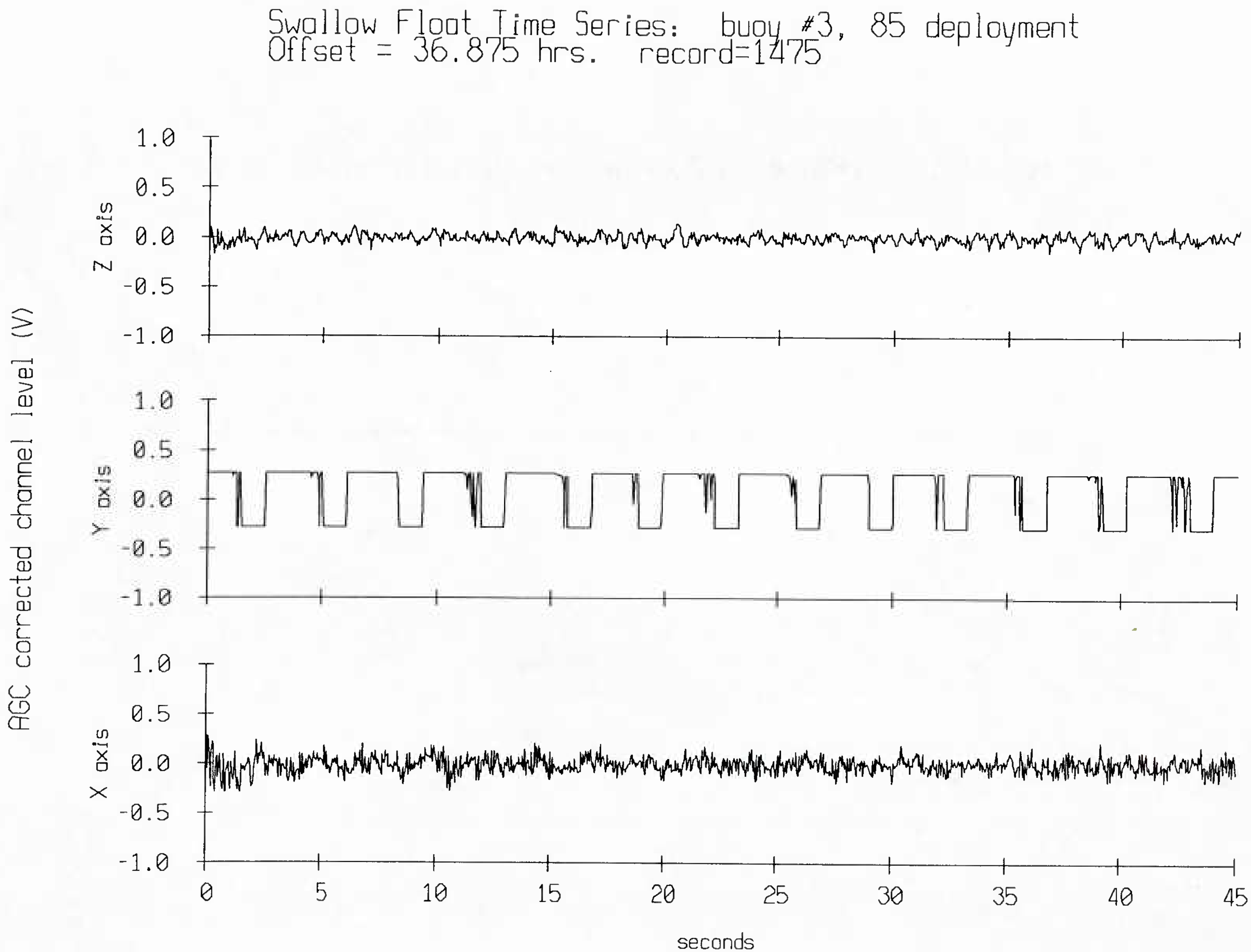


Figure VI.19a

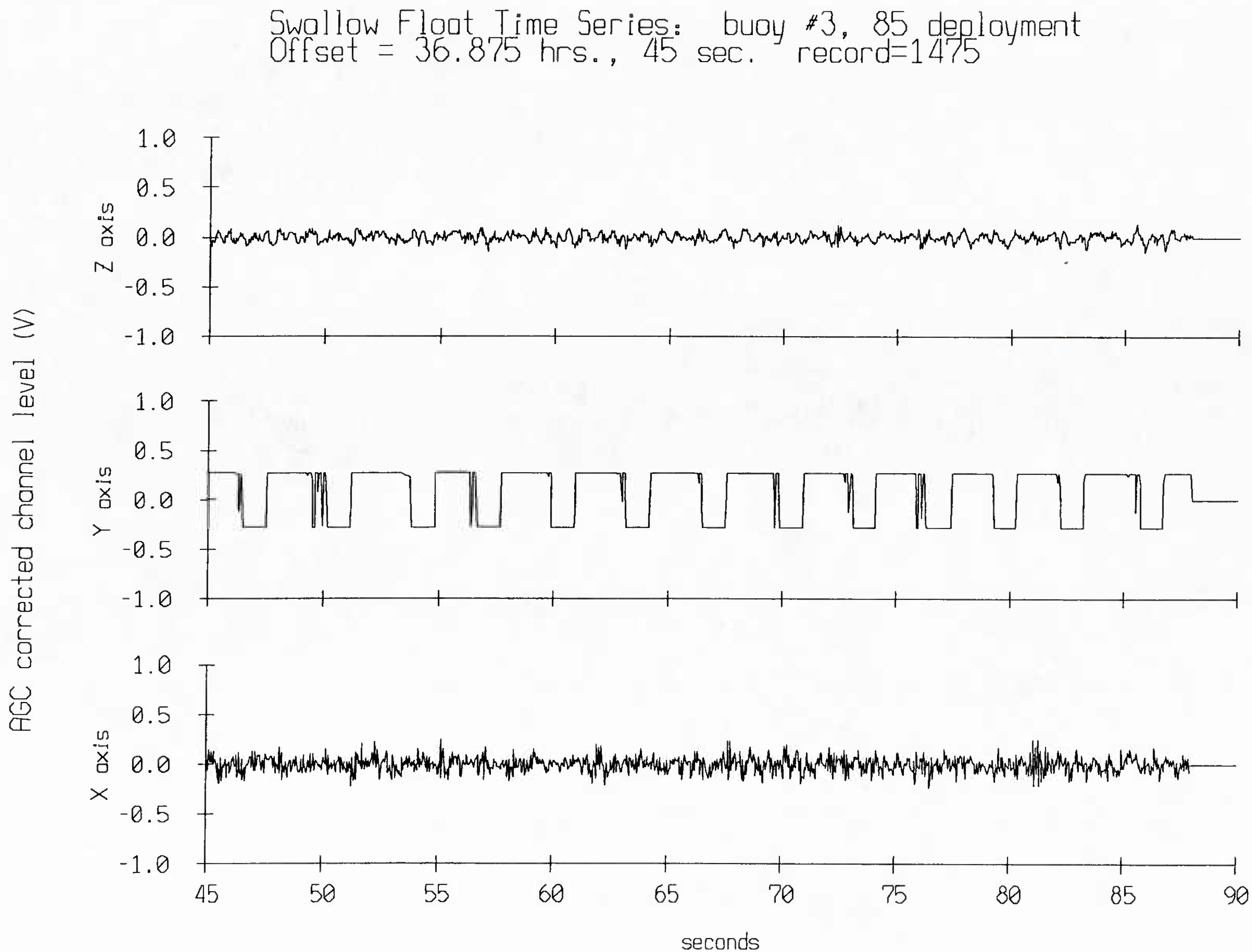


Figure VI.19b

Swallow Float Time Series: buoy #4, 85 deployment
Offset = 36.875 hrs. record=1475

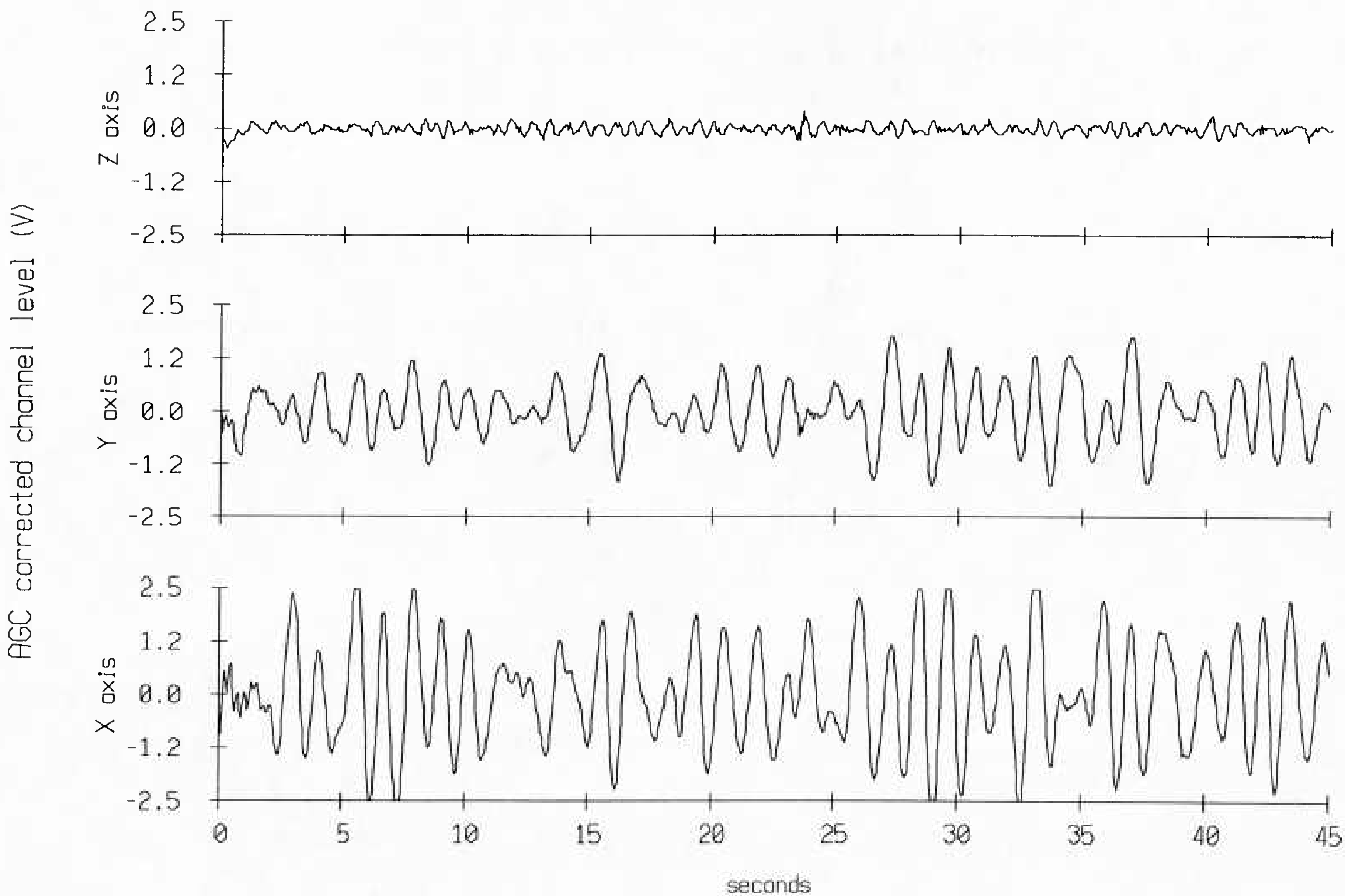


Figure VI.20a

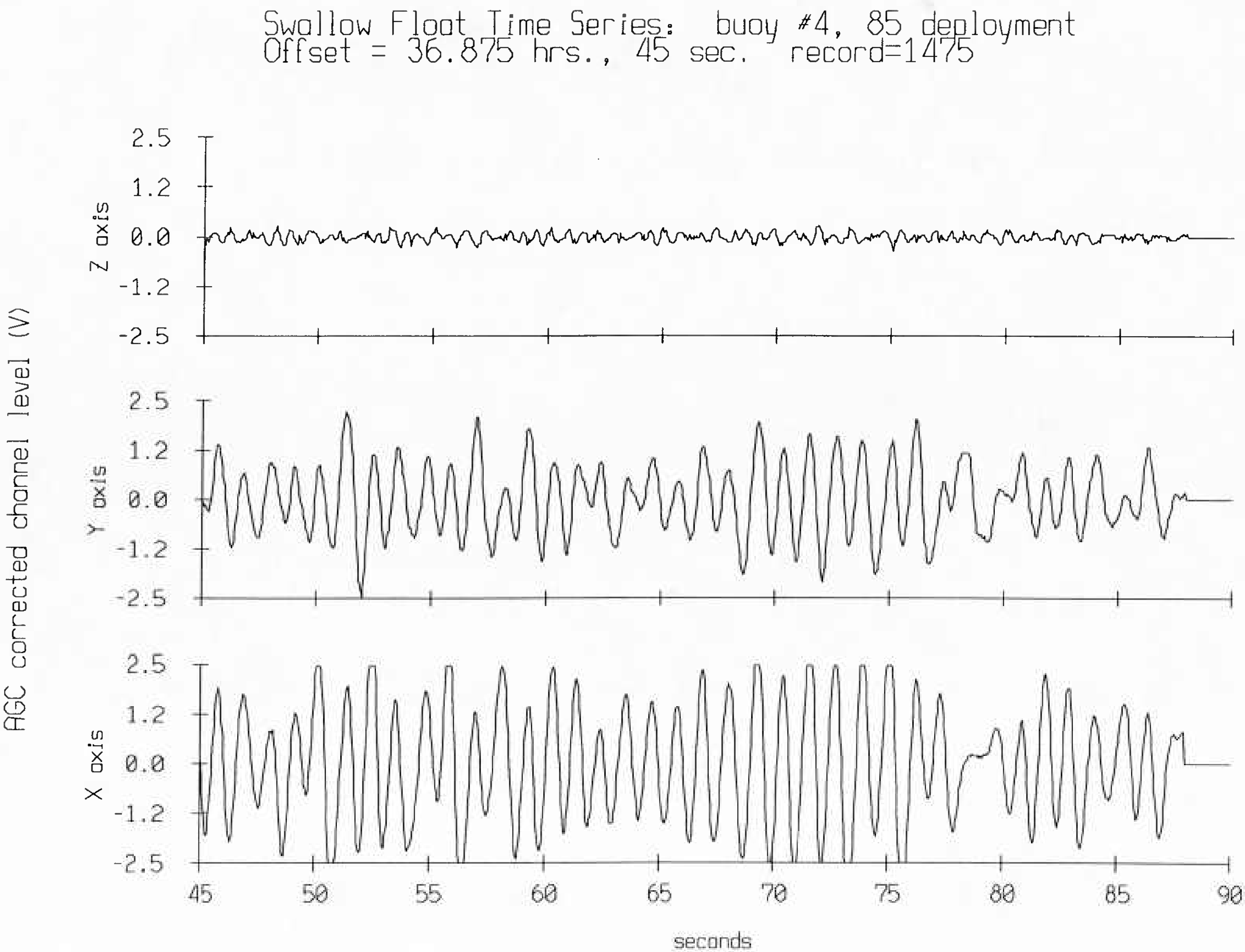


Figure VI.20b

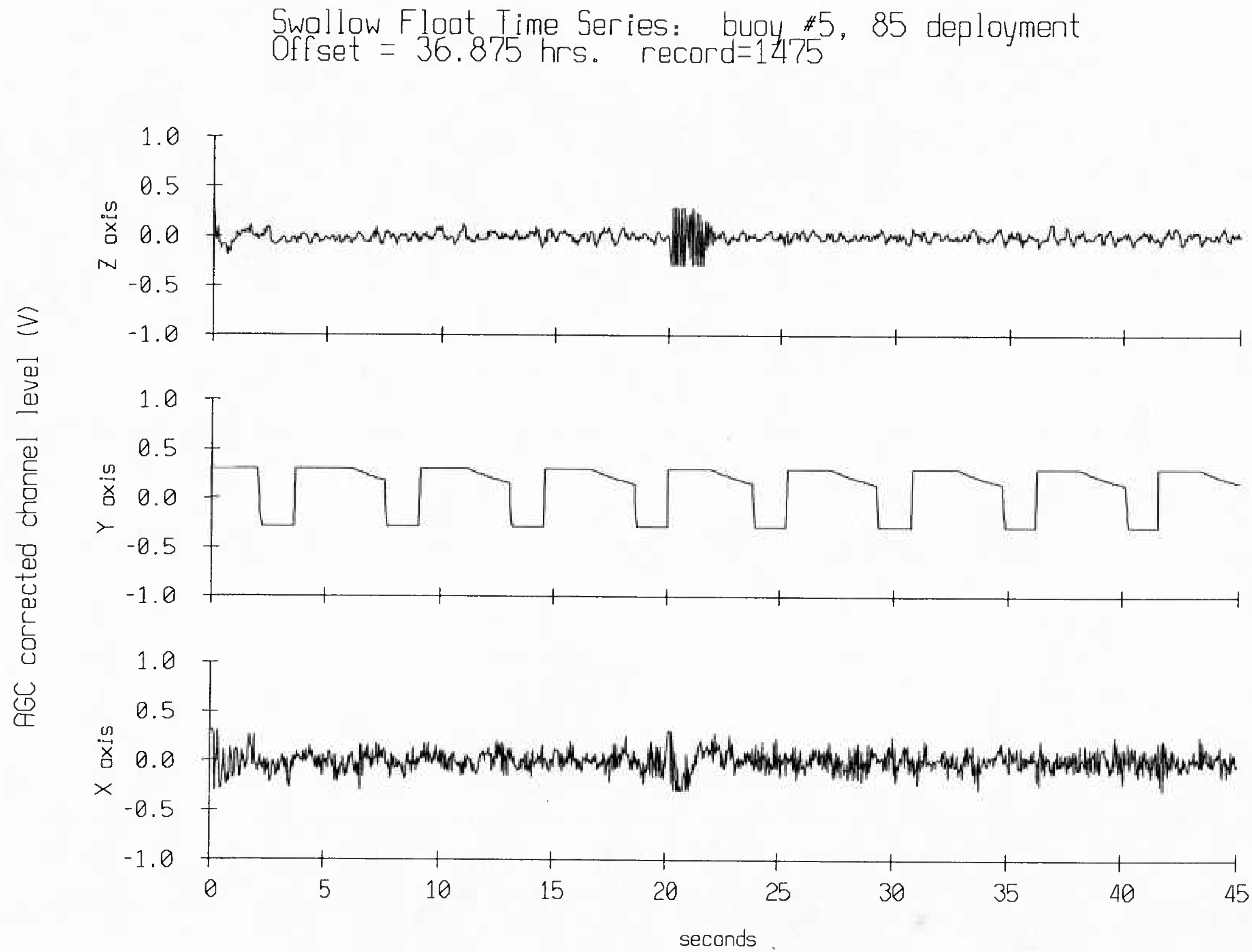


Figure VI.21a

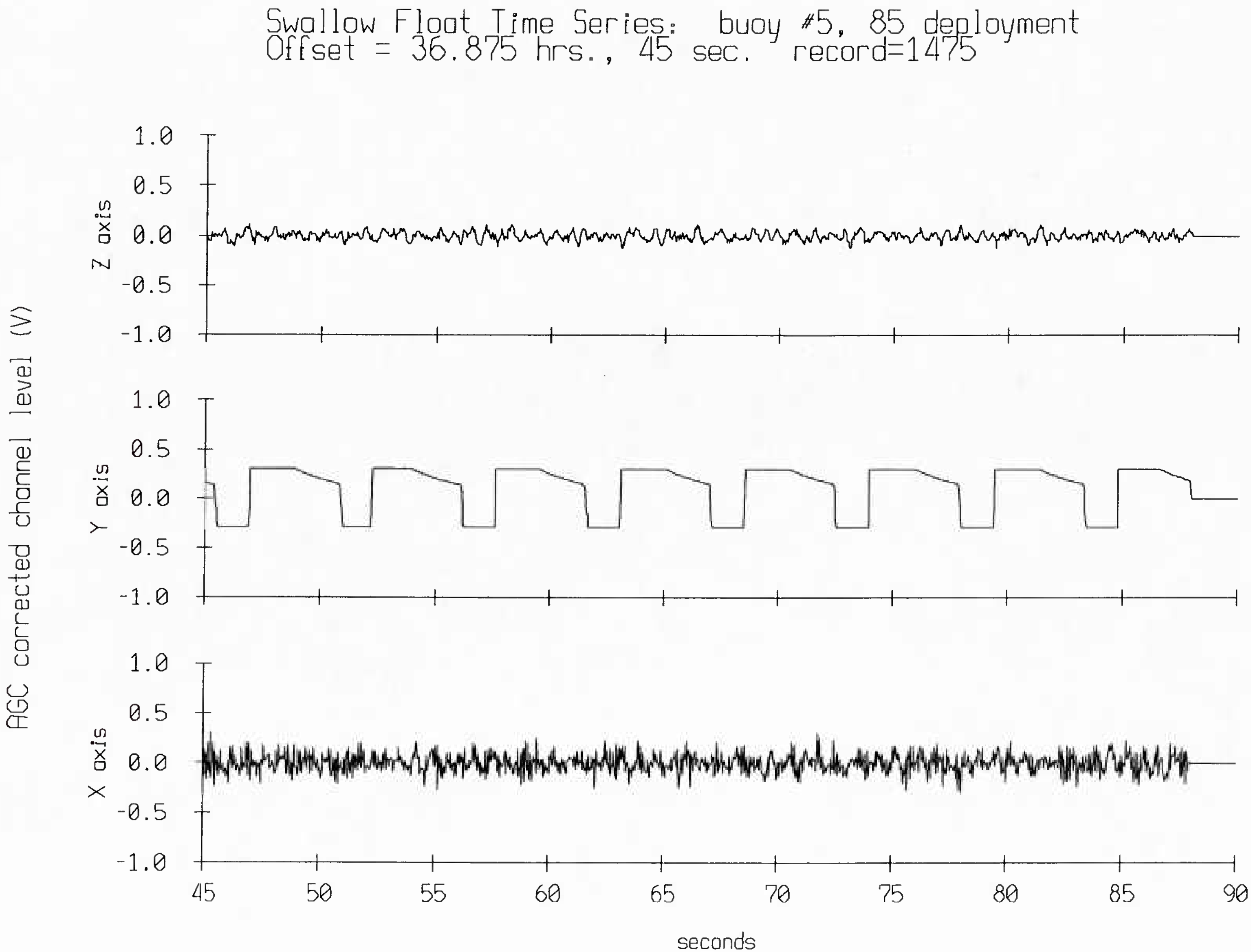


Figure VI.21b

VII. Velocity Power Spectra

As a last step in evaluating particle velocity data, power spectral estimates were made for data presented in the previous section for the floats which deployed to 1200 meters, 2, 3 and 5. Table VII.1 shows the records for which spectral estimates were made and any events which occurred during those records.

Figures	Record Number for: Float 2	Floats 3 & 5	Events Contained
VI.1 - VI.3	233	1025	acoustic interrogation pulses, positioning system pulse
VI.4 - VI.6	286-287	1078-1079	acoustic interrogation pulses, seal bomb explosions, positioning system pulses
VI.7 - VI.9	578-590	1380-1382	y axis clipping (float 2), x and y axis clipping (all floats), positioning system pulse
VI.10 - VI.12	683	1475	y axis clipping (floats 3 and 5), positioning system pulse

Table VII.1: Key to spectal estimates, showing records and events contained.

Fourier transform length was 512 points (20.48 seconds) and consecutive segments were 50% overlapped, yielding 15 spectral estimates from each record which were incoherently averaged to produce the spectra shown in the Figures. The features and events present in some data contaminate their spectra, but many spectra do not contain special events. It has been shown previously that Swallow float directional velocity spectra, when summed and scaled, compare favorably to pressure gradient hydrophone measurements made at similar depths.[1]

Figures VII.1 - VII.3 are contaminated by acoustic interrogation pulses, and in the case of float 5, by an acoustic positioning system pulse. The spectrum from float 2's y axis channel (which is essentially dead) contains peaks at 1 Hz intervals which are thought to be electronic self-noise. Z axis spectra are smooth and rounded in all 3 floats, perhaps because of the acoustic interrogation pulses. All 3 spectra from float 3 are similar and dominated by peaks at 2.7 and 6.2 Hz. Neither of the other two floats display peaks at these frequencies.

Figures VII.4 through VII.6 are contaminated by seal bomb explosions and acoustic interrogation and positioning system pulses. The 1 Hz interval peaks in float 2's y axis spectra are again evident, and the appearance of z axis spectra is again smooth and rounded. Float 3 (Figure VII.5) spectra look very much like those taken 53 records (79.5 minutes) earlier (Figure VII.2). Float 5 spectra contain a peak at about 1.4 Hz but are otherwise featureless.

The first two pages each of Figures VII.7 through VII.9 are contaminated by x and y axix clipping of one kind or another, but there is no acoustic interrogation pulse contamination. As a result, spectral levels are in general lower and in many cases evidence the 1 Hz and harmonics signal seen in other spectra. A spectral line at about 10.2 Hz may be seen in spectra from all 3 floats. The smoothed appearance to z axis spectra in record 590 of float 2 may be attributed with fair certainty to the presence of the acoustic positioning system pulse in that record. With that exception, and except for the 1 Hz self-noise, spectra on page 3 of Figures VI.7 through VII.9 look very good.

Y axis data in Figures VII.11 and VII.12 are contaminated by clipping, and Figure VII.12 contains an acoustic positioning pulse. Note the smoothed appearance of z axis spectra. The 1 Hz and harmonics signal is evident in Figures VII.10 through VII.12.

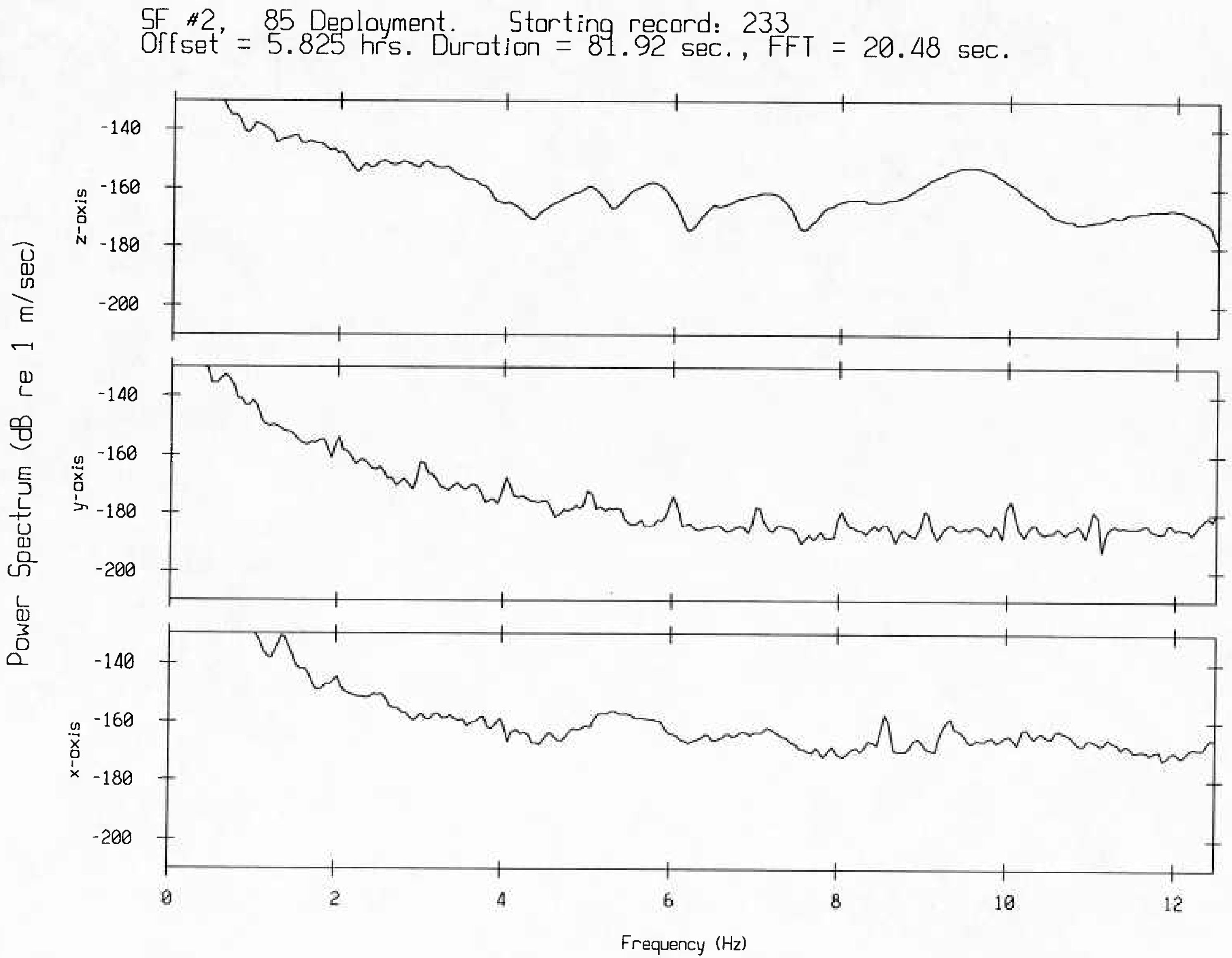

SF #2, 85 Deployment. Starting record: 233
Offset = 5.825 hrs. Duration = 81.92 sec., FFT = 20.48 sec.
Power Spectrum (dB re 1 m/sec)
z-axis
y-axis
x-axis
-140
-160
-180
-200
0
2
4
6
8
10
12
Frequency (Hz)

Figure VII.1

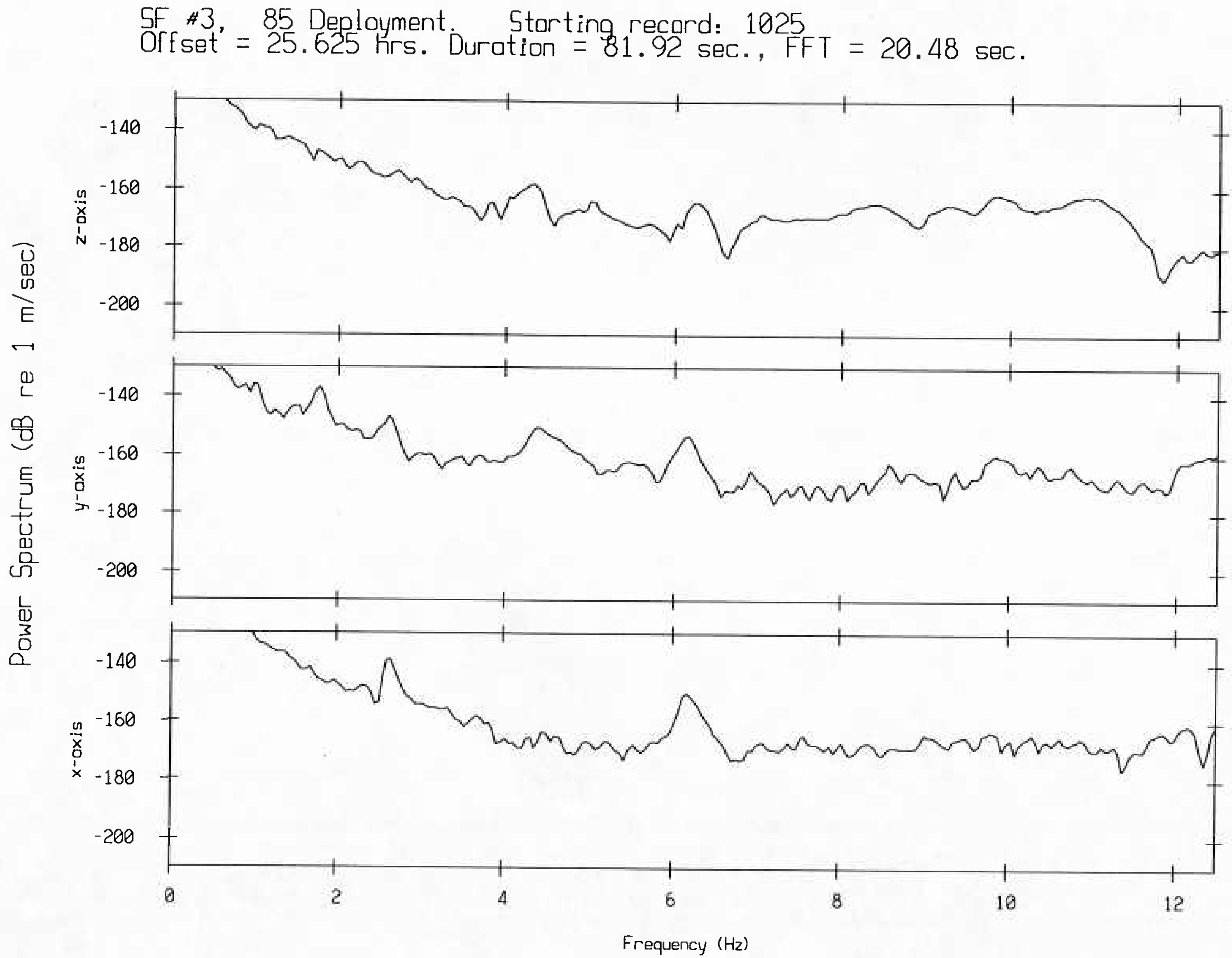
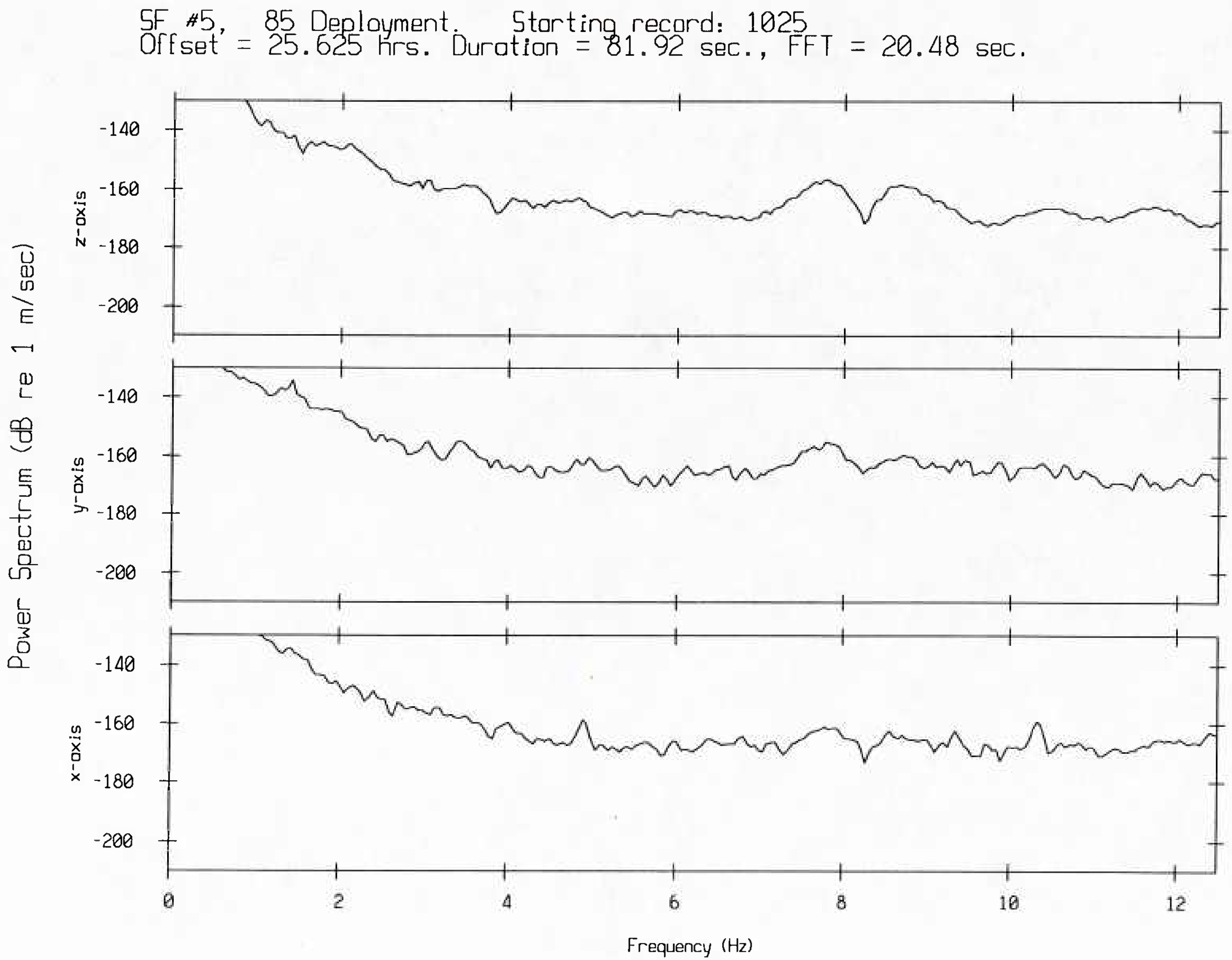

SF #3, 85 Deployment. Starting record: 1025
Offset = 25.625 hrs. Duration = 81.92 sec., FFT = 20.48 sec.
Power Spectrum (dB re 1 m/sec)
z-axis
y-axis
x-axis
-140
-160
-180
-200
0
2
4
6
8
10
12
Frequency (Hz)

Figure VII.2



SF #5, 85 Deployment. Starting record: 1025
Offset = 25.625 hrs. Duration = 81.92 sec., FFT = 20.48 sec.
Power Spectrum (dB re 1 m/sec)
z-axis
y-axis
x-axis
-140
-160
-180
-200
0
2
4
6
8
10
12
Frequency (Hz)

Figure VII.3

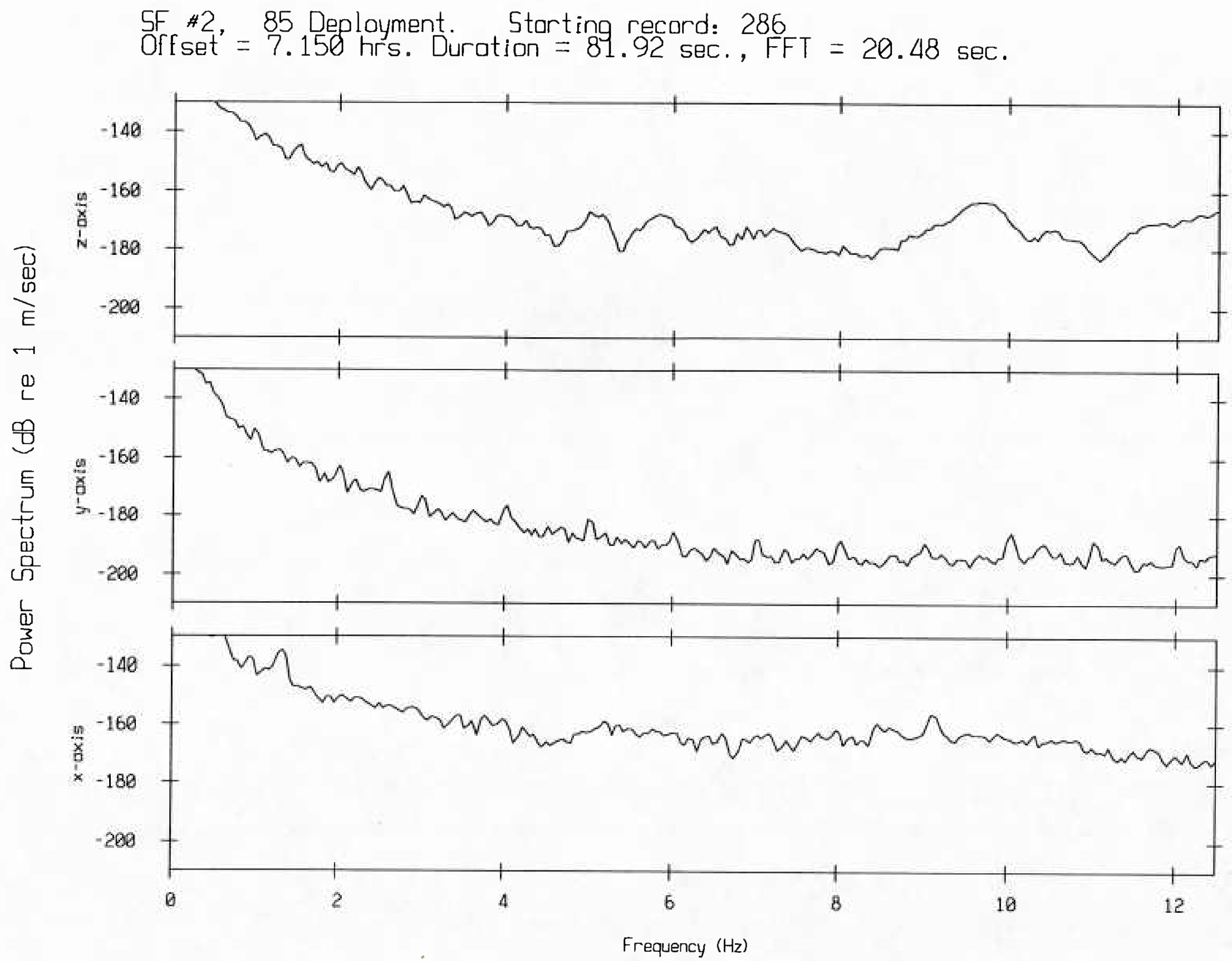


Figure VII.4a

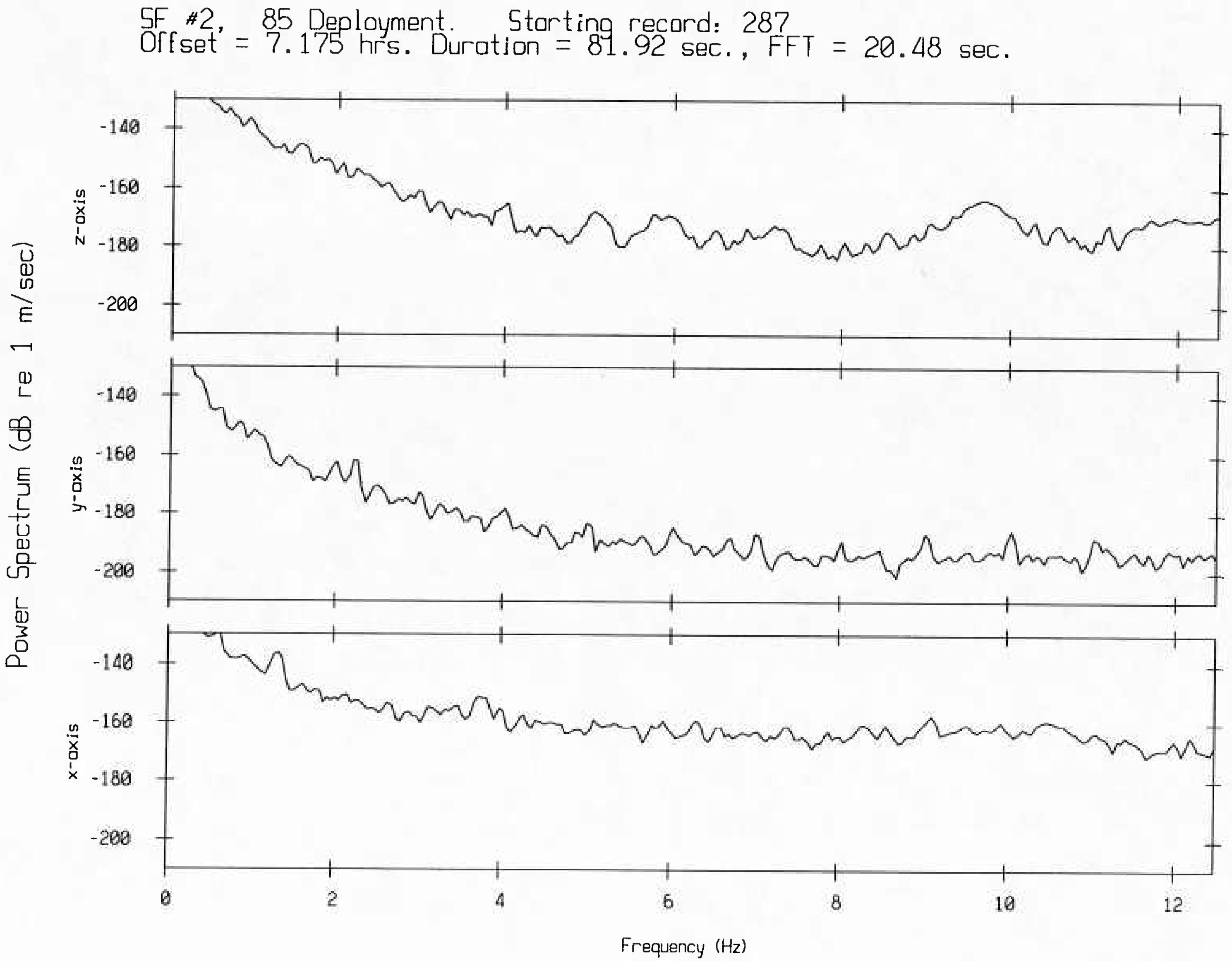


Figure VII.4b

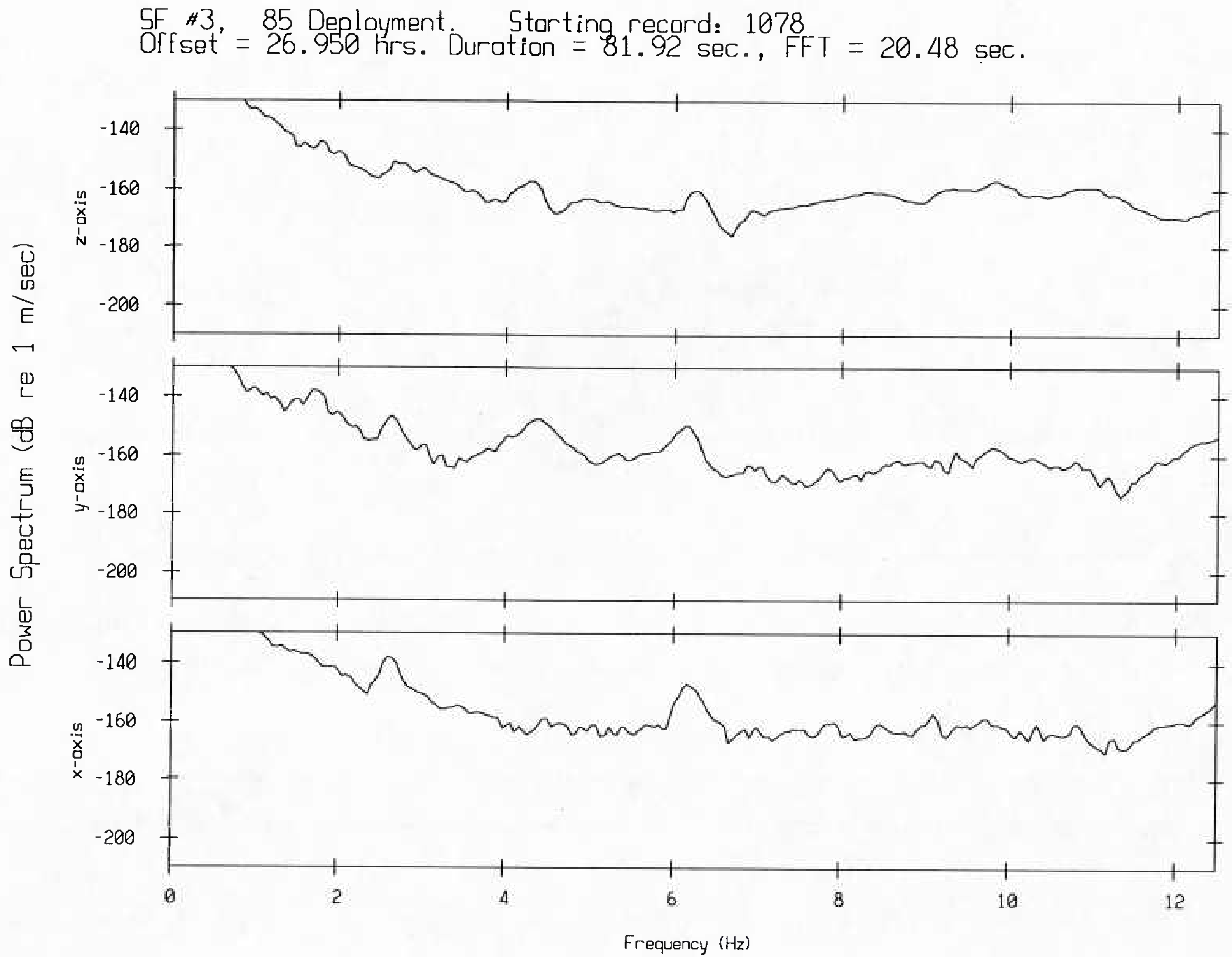


Figure VII.5a

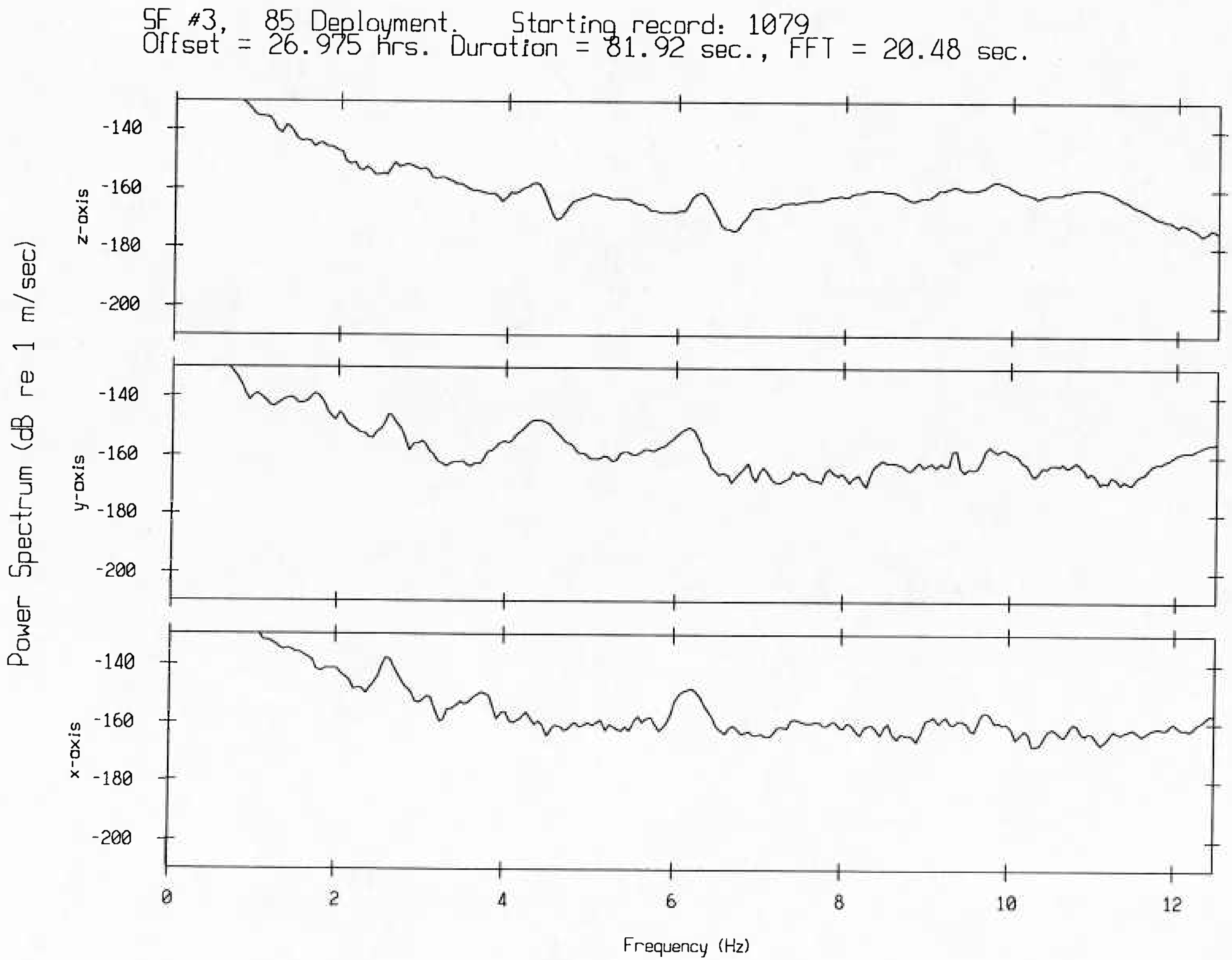


Figure VII.5b

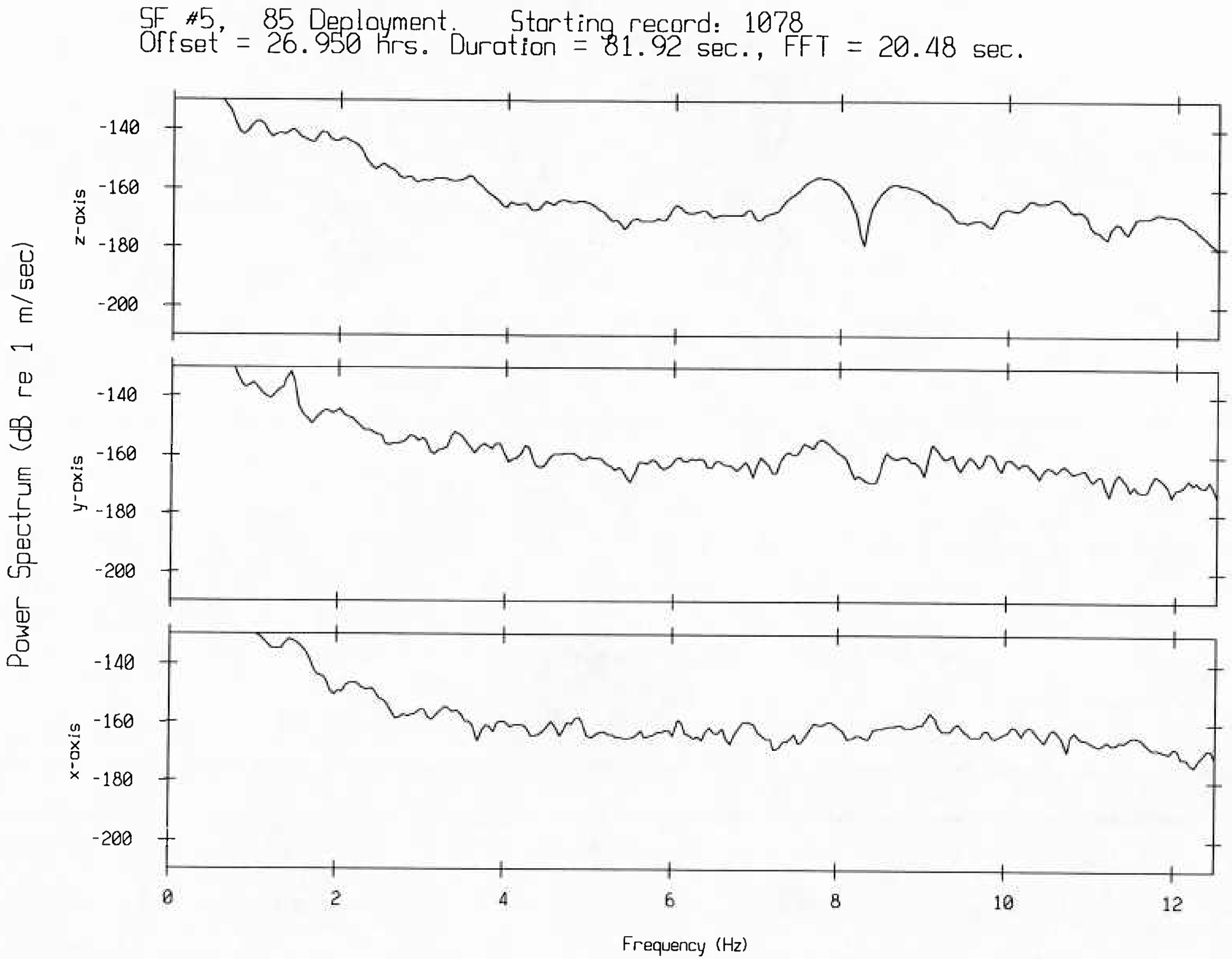


Figure VII.6a

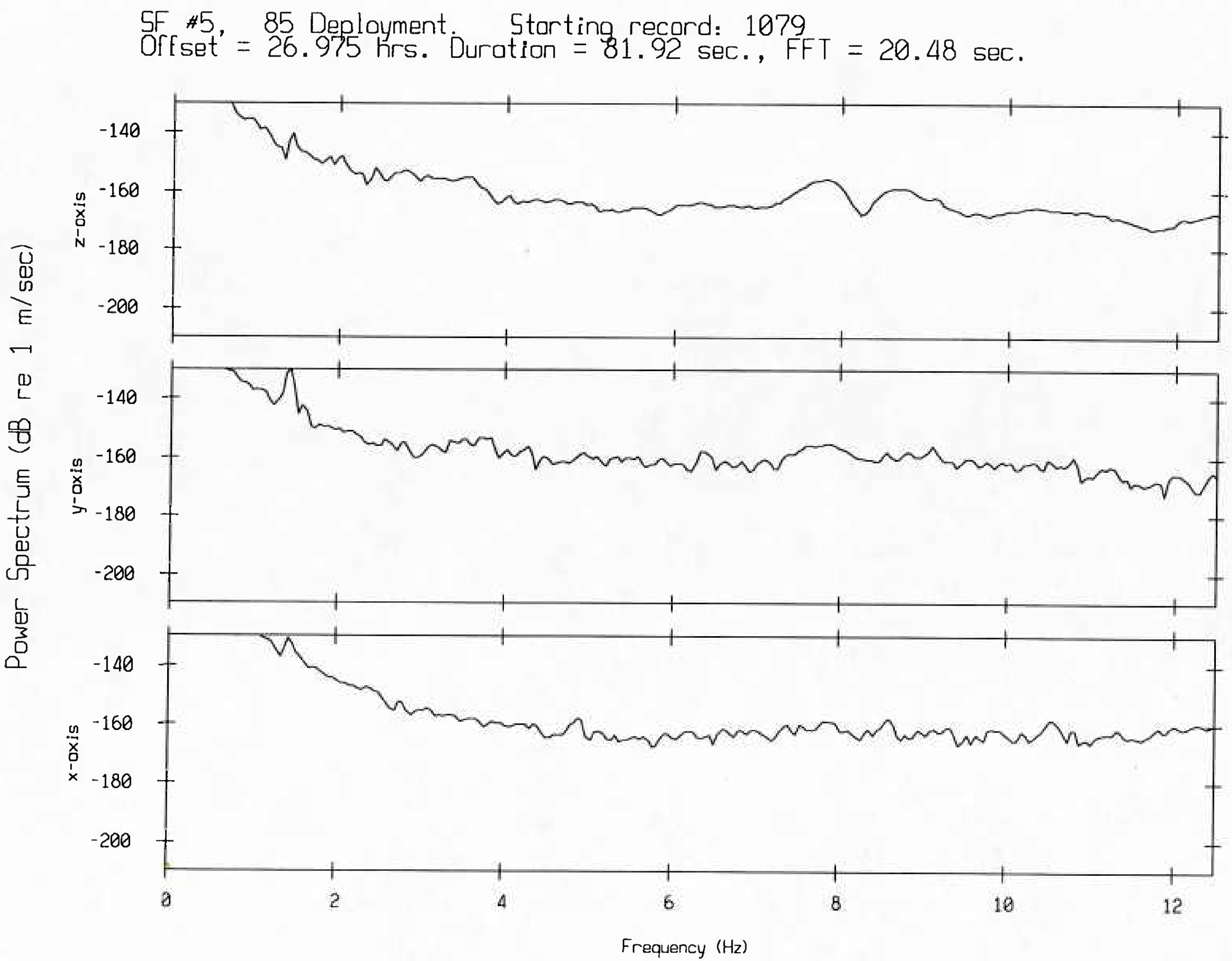


Figure VII.6b

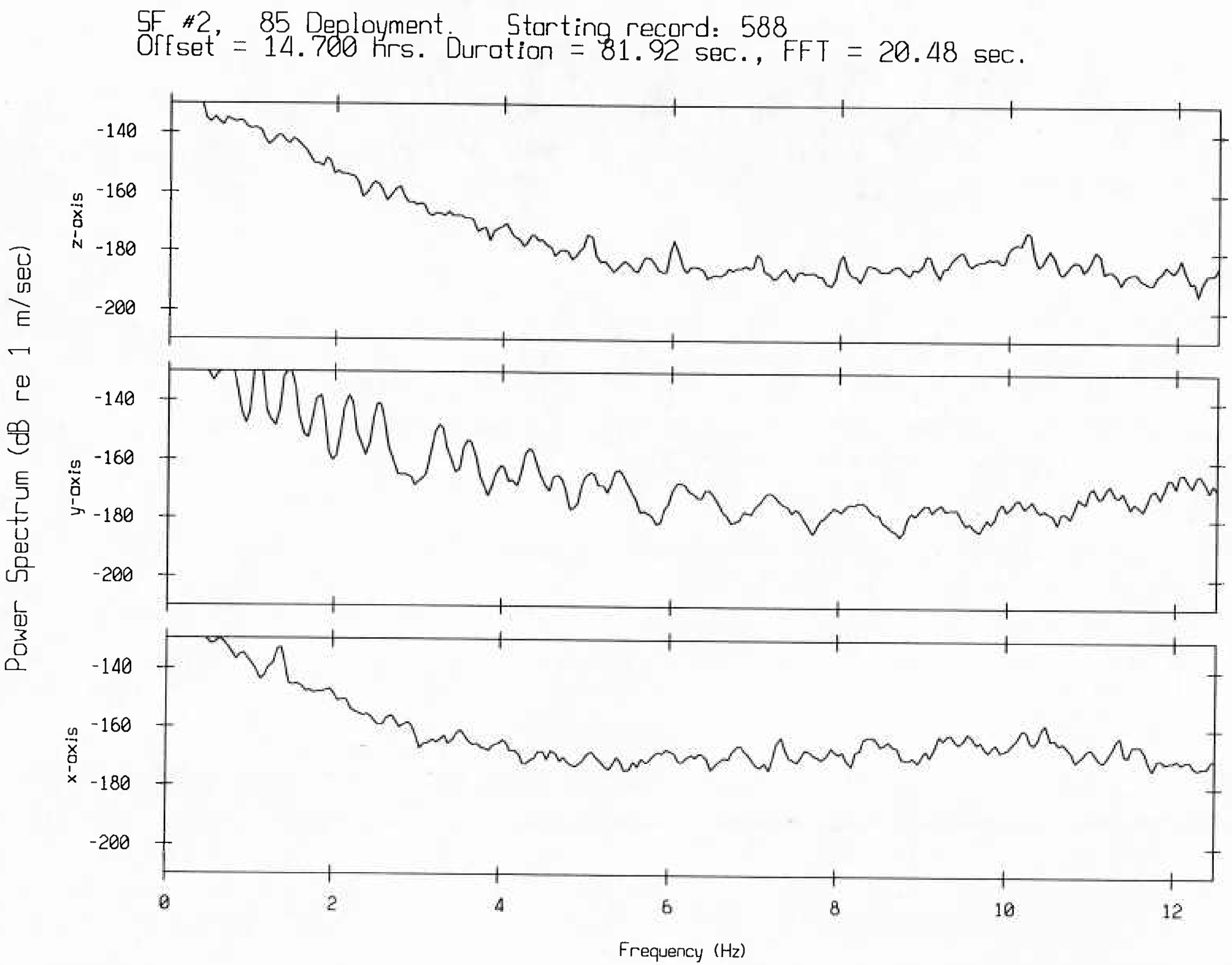


Figure VII.7a

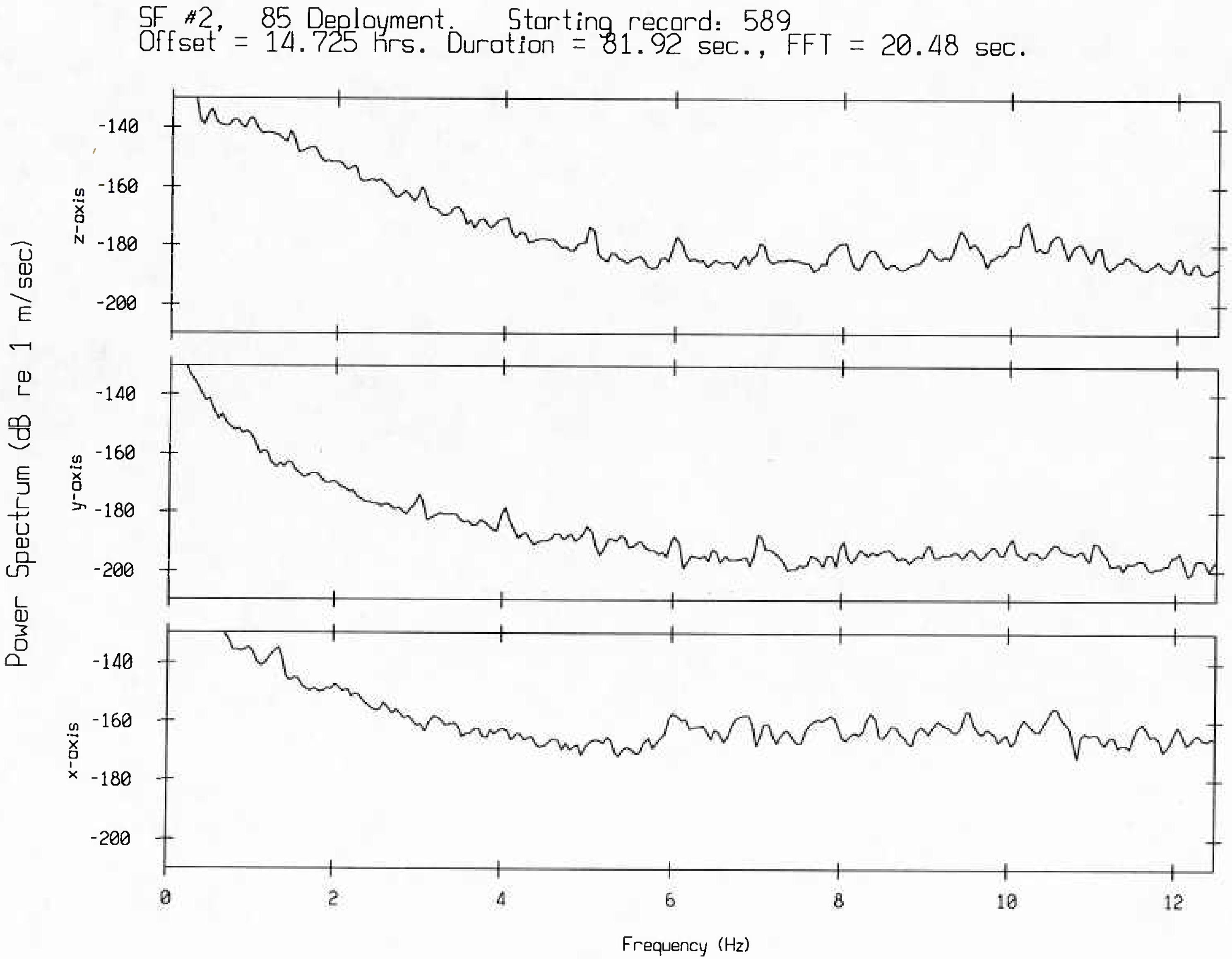


Figure VII.7b

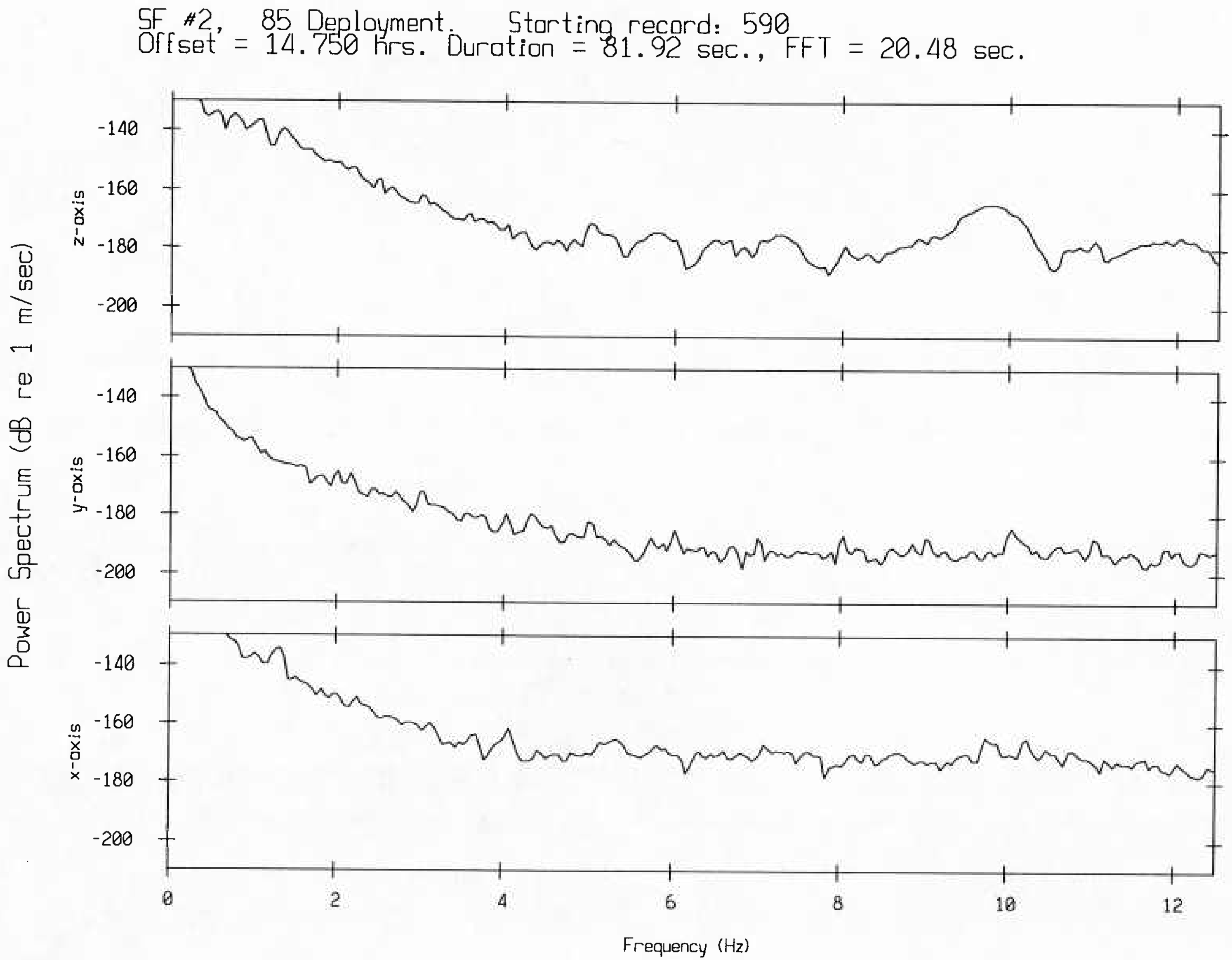


Figure VII.7c

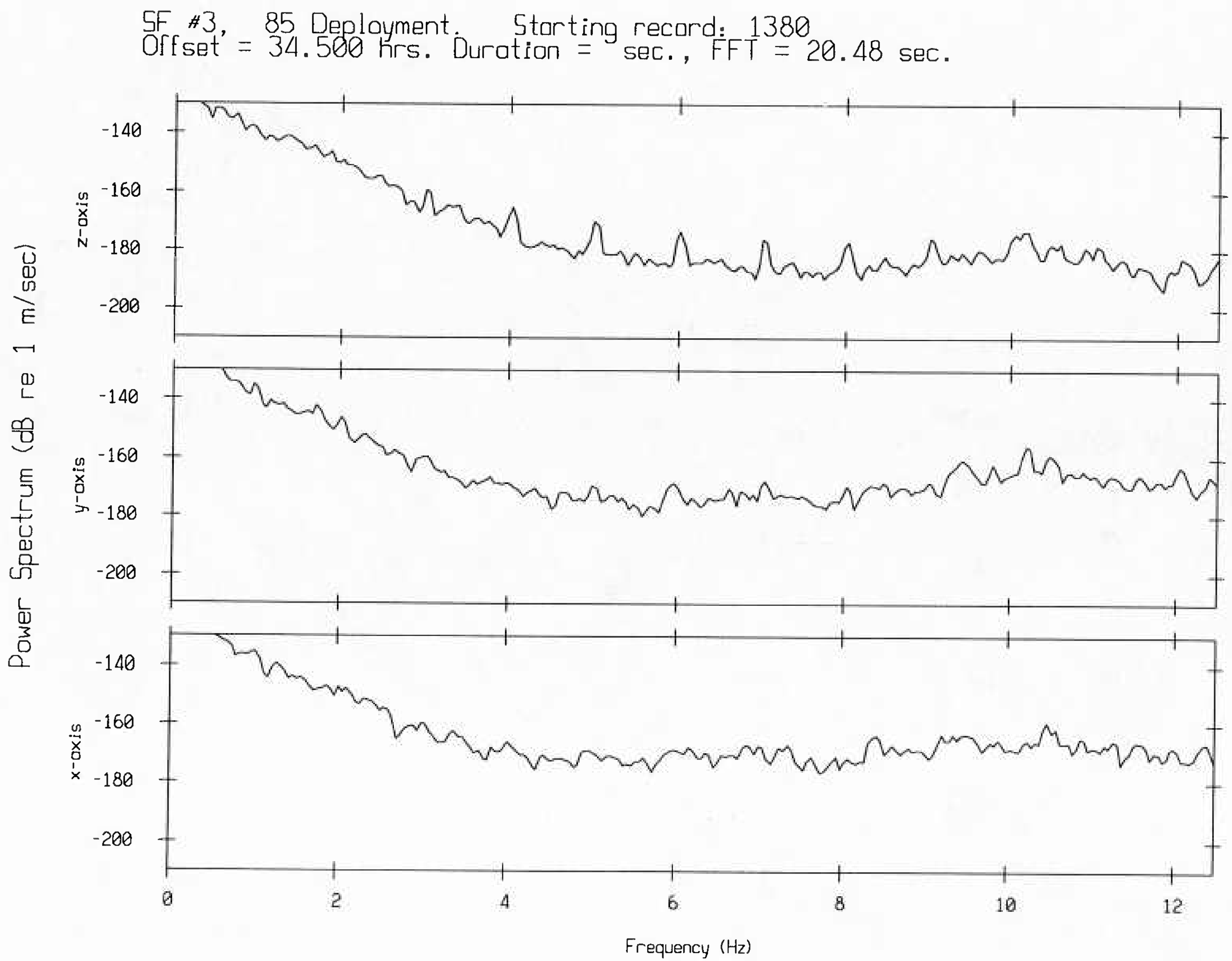


Figure VII.8a

SF #3, 85 Deployment. Starting record: 1381
Offset = 34.525 hrs. Duration = 81.92 sec., FFT = 20.48 sec.

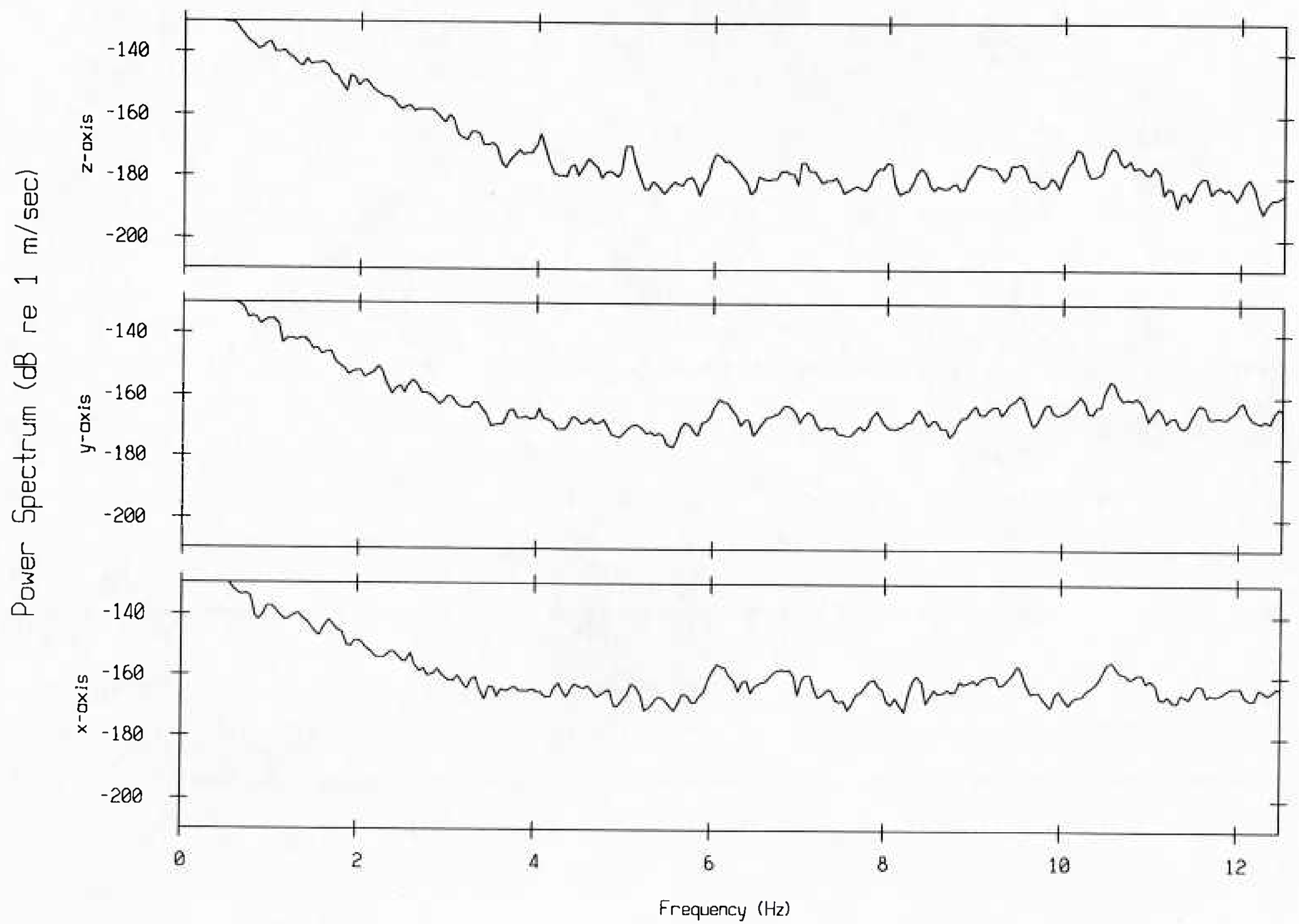


Figure VII.8b

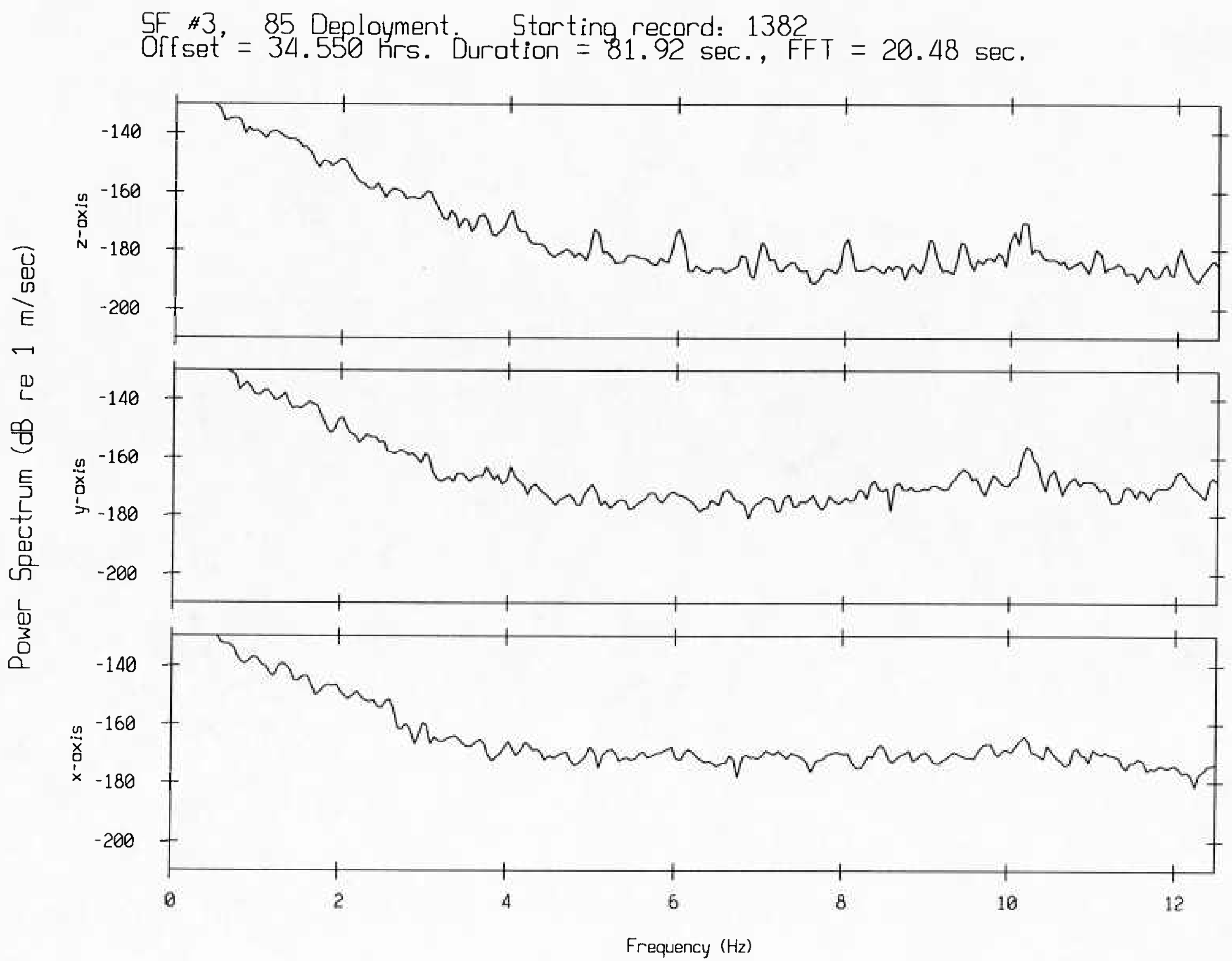


Figure VII.8c

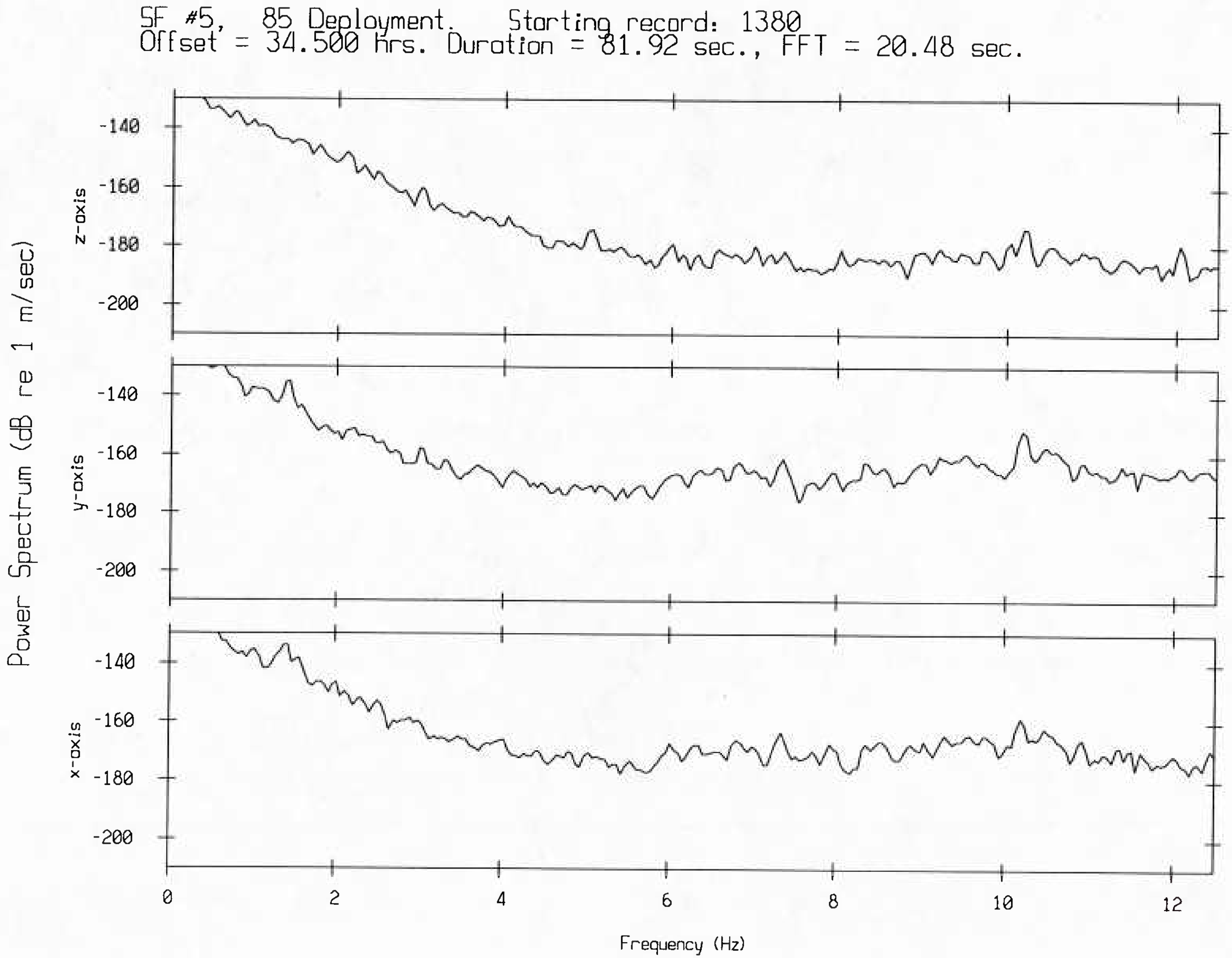


Figure VII.9a

SF #5, 85 Deployment. Starting record: 1381
Offset = 34.525 hrs. Duration = 81.92 sec., FFT = 20.48 sec.

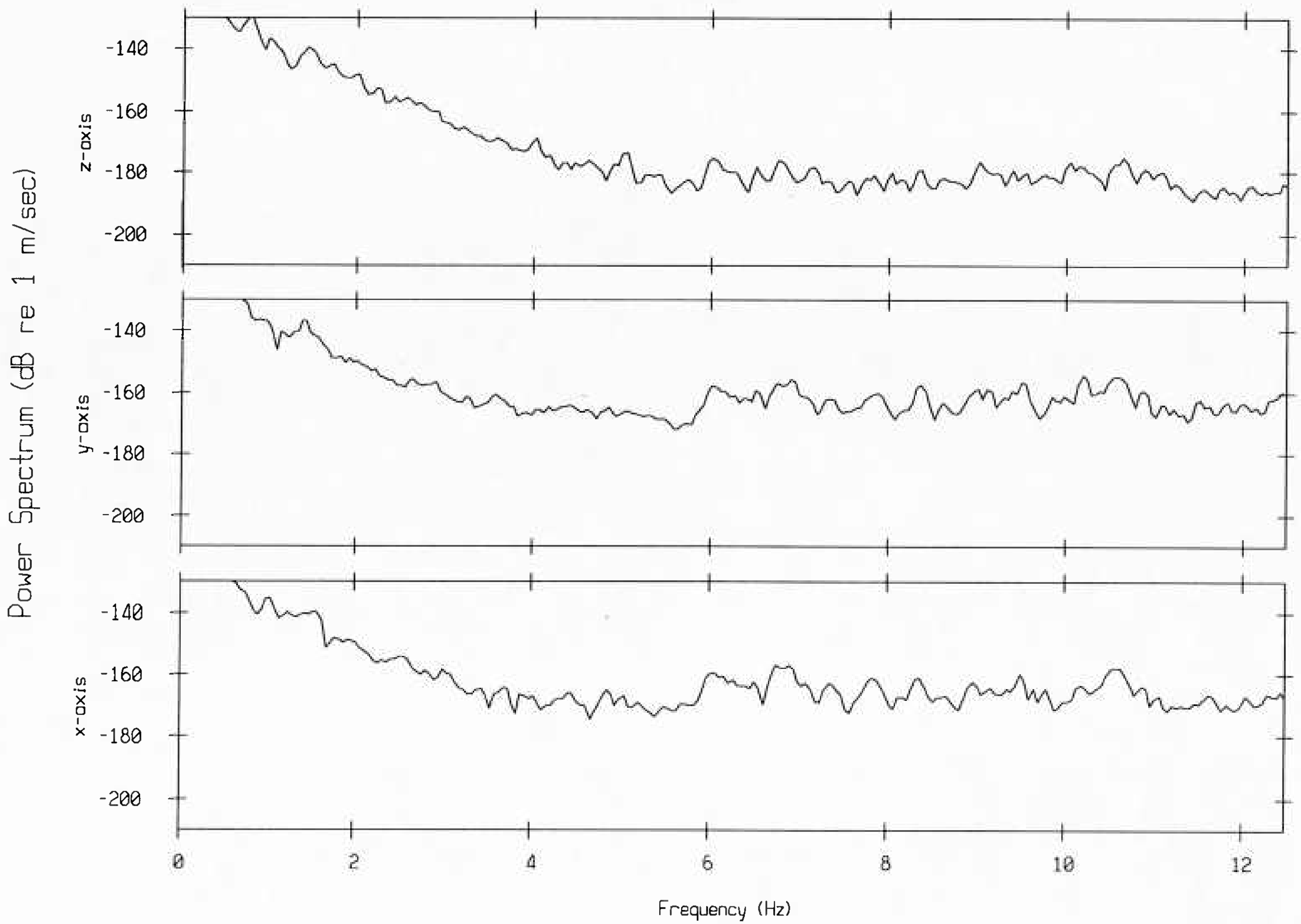


Figure VII.9b

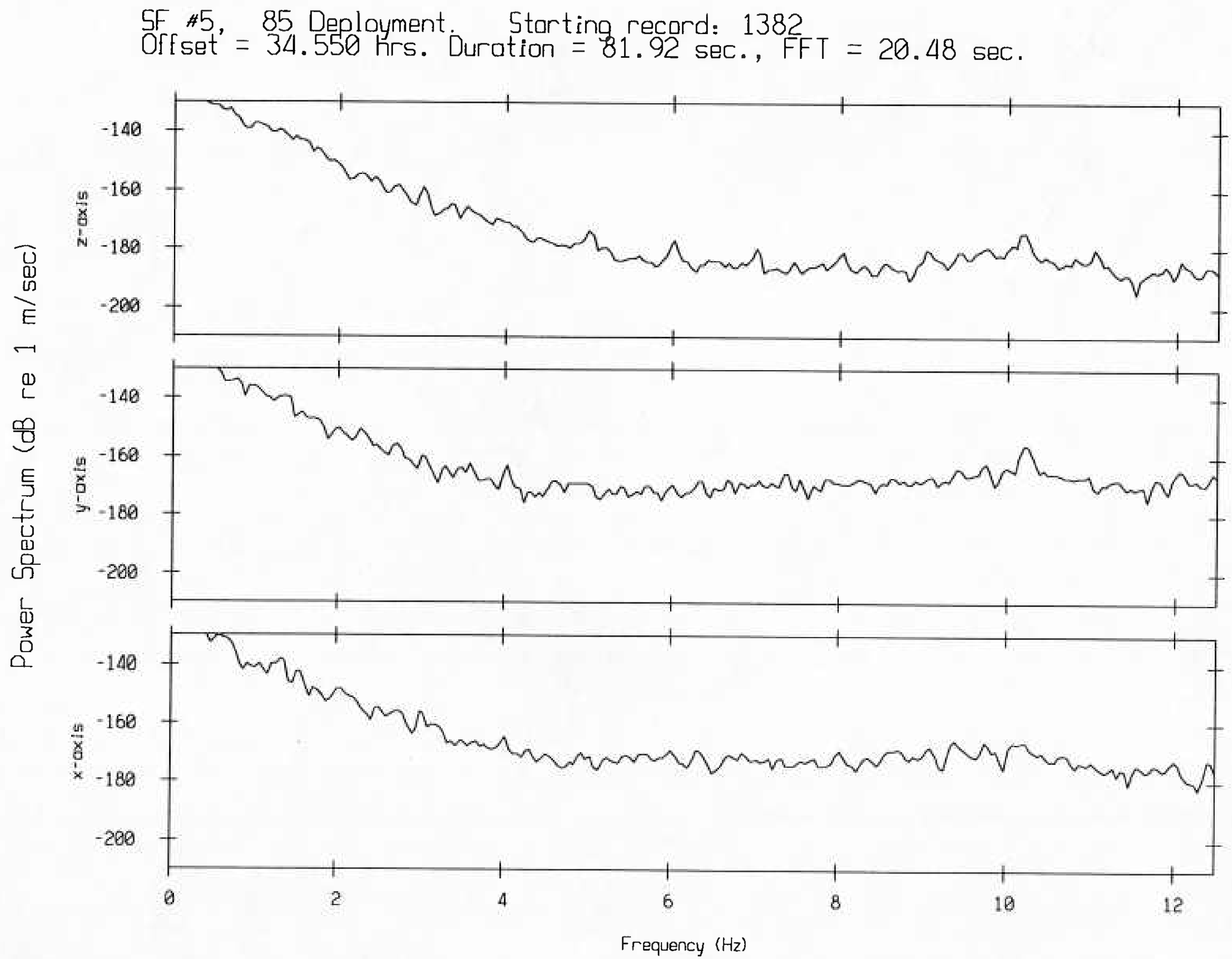


Figure VII.9c

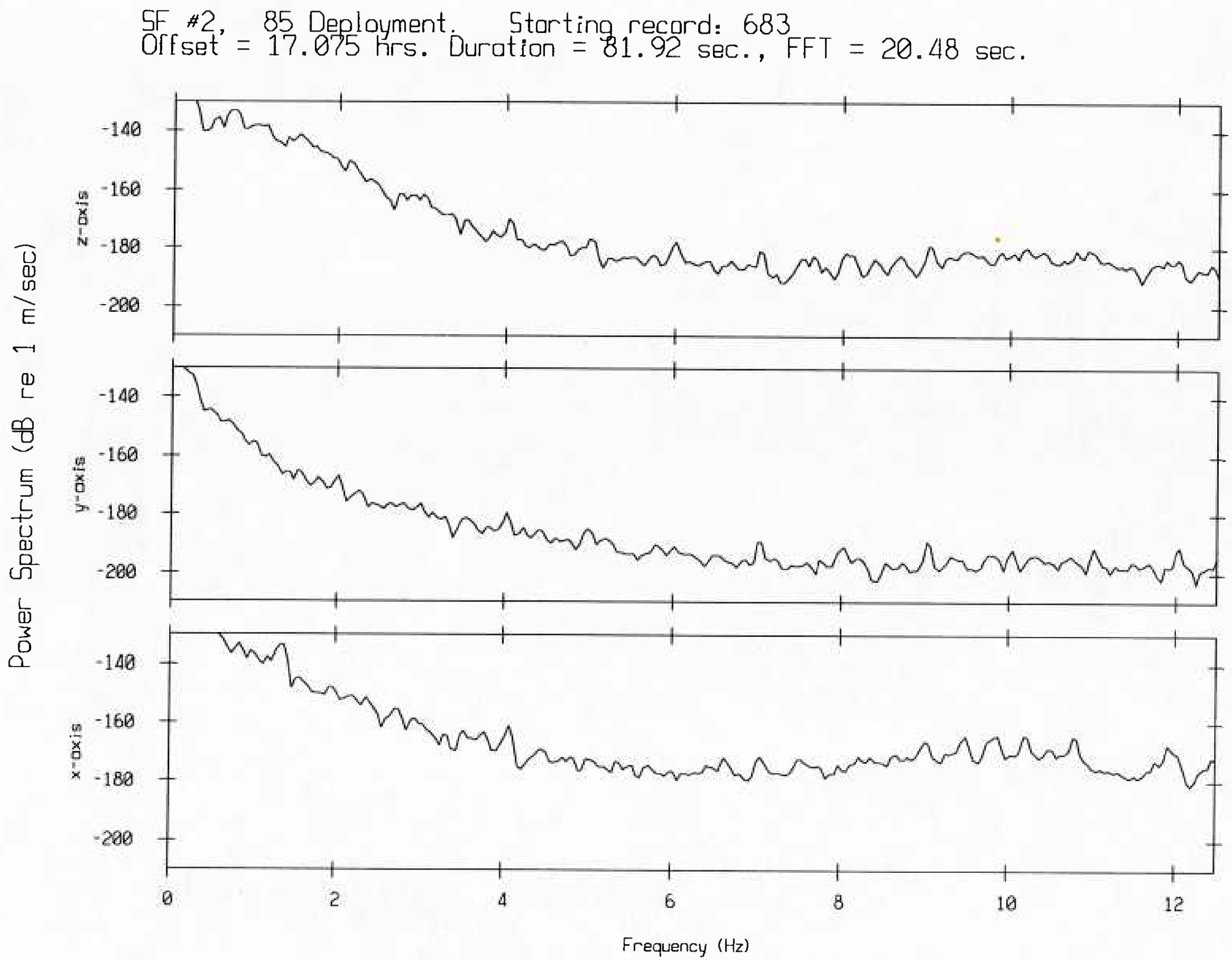


Figure VII.10

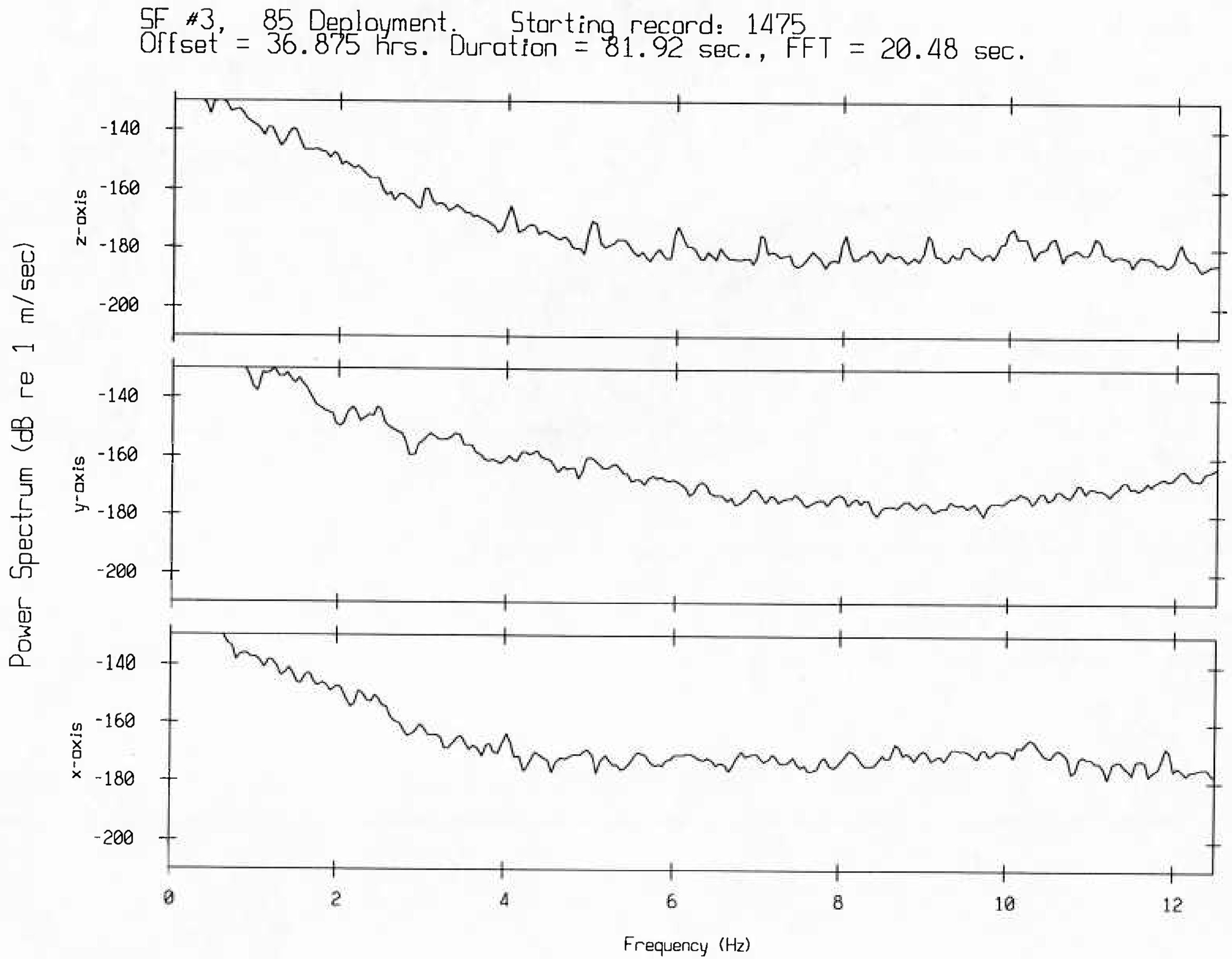


Figure VII.11

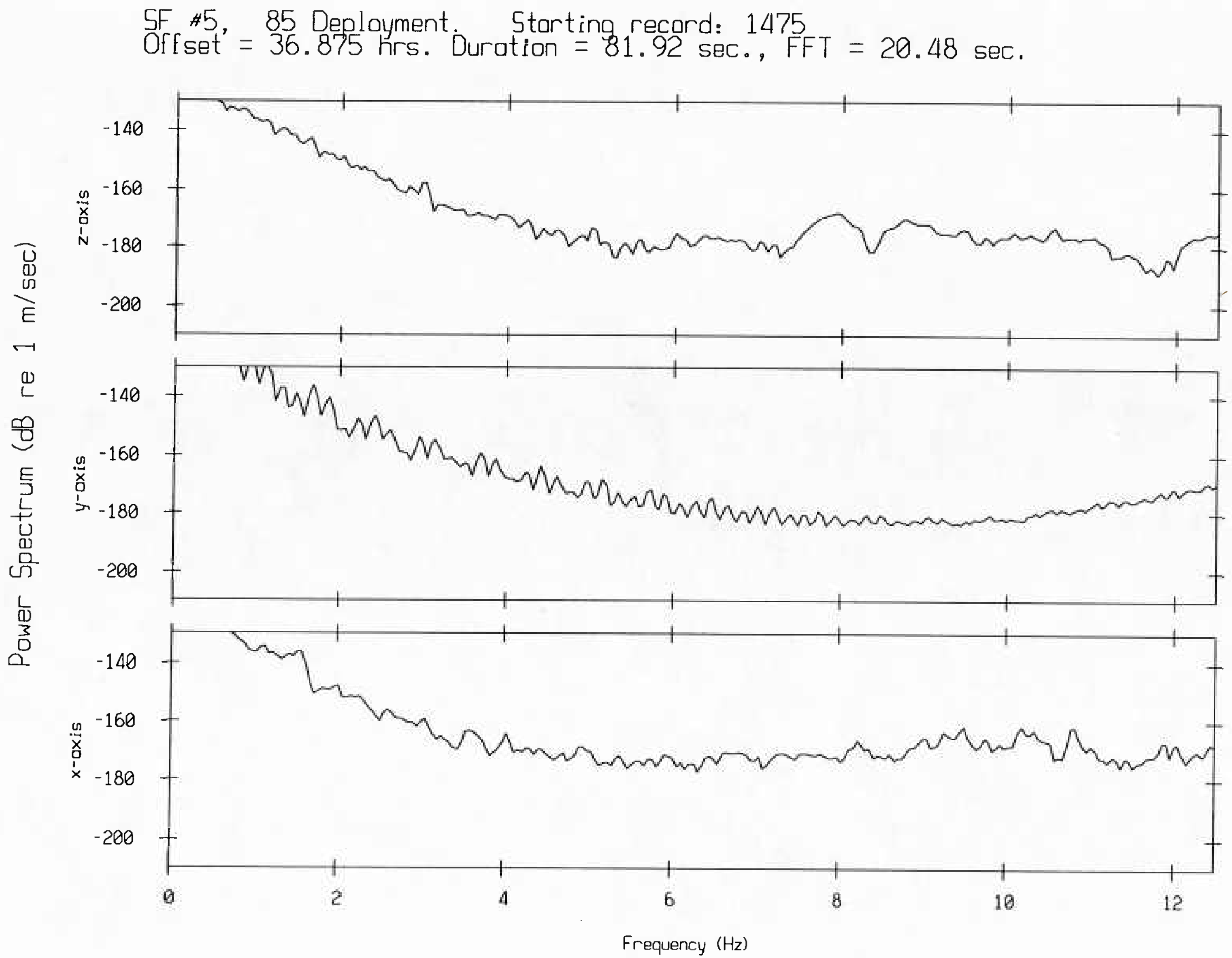


Figure VII.12

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