Highly Compliant Riser
Large Scale Model Test
Joint Industry Project
Data Reduction and Report

Prepared
for
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04 December 1998

PMB Engineering
50 Beale Street
San Francisco, CA 94105

Attention: Robert Grant

Subject: Draft Final Report for HCR-JIP

Dear Bob,

The following are two copies of the draft final report on the base HCR test program, and the Raw Data, Processed Data, and Hard Bottom CD-ROMS that go with it. The hard bottom addendum will follow shortly.

In accordance with your instructions, we have also sent copies to the participants on the list you sent, with the appropriate CDs.

Regards,

Frederick H. Ashcroft
Vice President

encl.: report and CDs

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SMS Project 97-504 4 December 1998

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1 Executive Summary

In order to obtain a better understanding of the dynamic behavior of oil production risers and corroborate existing mathematical models, PMB Engineering contracted with Scientific Marine Services, Inc. (SMS) to design and construct three $^1/_3$ scale riser models and to provide force excitation, instrumentation, and data acquisition for the tests. The purpose of the instrumentation was to measure tension at the riser top and tension and bending moment at eight instrumented "pup" joints as well as barge 5 degree of freedom motions.

The tests were performed at the U. S. Navy Acoustic Research Detachment (ARD) facilities at Lake Pend Oreille, Bayview, Idaho. The test fixtures and equipment were installed aboard the ARD barge, "Kamloops" and operational support was provided by ARD personnel.

To accomplish these tasks, special instrumented pup joints were designed and manufactured by SMS. Each pup had strain gages to measure tension and bending strains as well as accelerometers to determine the pup orientation in space, allowing the bending moments to be translated from the pup coordinate system to the in plane and out of plane coordinate system. A load cell was used to measure top tension in the riser. A five degree of freedom motions package was used to measure barge motions during the tests. A high resolution GPS system was used to provide information for determining the positions of the riser anchor and riser top after the installation of each riser configuration. An ROV was used to assist with riser anchor placement, inspect the riser after installation, and act as a video platform during selected tests.

Three riser configurations were tested: the Combined Vertical Axis Riser (CVAR), Lazy Wave Steel Catenary Riser LWSCR), and the Steel Catenary Riser (SCR). The SCR was tested on the natural mud bottom of the lake and on an artificial hard bottom. Excitation was sinusoidal at constant amplitude for a range of periods. Three directions of excitation were tested: vertical, transverse horizontal, and 45° horizontal.

Test data was collected , reduced to engineering units, and presented for further analysis by other parties. A sample of the reduced data is presented in this report and all the raw data is included on the accompanying CD-ROM.

These data provide information from large scale physical model tests to correlate mathematical models and provide a great deal of insight into the dynamic behavior of different riser configurations.

2 Introduction

Large scale physical model tests were performed on three different riser configurations between 10 August and 2 October 1998 at Lake Pend Oreille, Bayview, Idaho. The tests were executed by Scientific Marine Services, Inc., under the direction of personnel from PMB Engineering. SMS designed, manufactured, and installed the forcing actuator, the riser model pipes, and specialized test instruments. Installation of the risers was accomplished in accordance with configurations provided by PMB personnel. The artificial hard bottom used during the SCR horizontal and 45° tests was conceived by SMS and designed and manufactured by PMB. Installation of the hard bottom was accomplished by ARD personnel supported by SMS under direct supervision from PMB senior engineers.

The purpose of these tests was to provide greater insight into the behavior of risers and corroborate mathematical models. Each riser model was excited through several vertical amplitudes and a range of frequencies. At each frequency, the steady state response was recorded for riser top tension, pup tension and bending at each pup, riser leaving angle, the vertical acceleration of the actuator mechanism, and the five degree of freedom motions of the Kamloops barge (yaw was not measured).

High accuracy GPS units were used to determine the location of the riser anchor during placement and the riser top while assembling the riser configuration. This allows precise determination of the location of the ends of each configuration so that the riser geometry may be determined.

The results of these tests have provided a large amount of information which may be analyzed for comparison to various mathematical models of riser behavior.

3 Test Instrumentation

3.1 Data Acquisition system

3.1.1 Overview

The data acquisition system for this project consisted of two separate computers. One was used only to acquire, store and process Global Positioning System (GPS) information. The second was used for all other data collection and storage. Both computers are PC compatible with 100 MHz Pentium processors.

Signal conditioning and amplification for the analog data, actuator, and barge motions, was provided by a Scientific Marine Services proprietary IAF-01 electronics unit. Signal conditioning for the riser data was accomplished by an EDC electronic unit located in each of the 2 foot long instrumented "pup" joints. Communications with the EDC units was via an IEEE 485 serial link to the DAS. Data from all steady state tests was collected at 40 samples per second with 10 Hz filtering. Whack test data were collected at 80 samples per second with a 20Hz filter.

Raw data was stored on the hard drive of the data acquisition computer and archived daily onto a 2.3 gigabyte magneto optical disk.

3.1.2 Resolution, Accuracy, and Repeatability

System, accuracy, resolution, and repeatability are affected by all components of the system. Data being collected for the project was all analog and required conversion to digital format for computer interfacing and storage. Analog circuits, including the sensors, determine the accuracy and repeatability while the digital format sets the resolution of the data being collected. The analog values for gain and offset are determined during calibration.

Resolution of the data being collected is determined by the number of bits in the Analog to Digital converters used in the system. A/D converter resolution is defined as:

$$\text{Resolution} = \text{One LSB} = V_{fsr}/2^n.$$

Where:

LSB	=	least significant bit
Vfsr	=	full scale input voltage range
n	=	number of bits.

The IAF-01 electronics unit uses 12 bit A/D converters giving a resolution of Vfsr/4096. Data in the riser units, "PUPS" use 10 bit A/D converters that are multiplied by 4 to give a pseudo 12 bit range while the resolution is Vfsr/1024. The Accuracy of the A to D converters is ± ½ LSB.

Review of the processed data indicate PUP mean tension (static) values that are somewhat scattered. It was determined that the tensions not only had to be corrected for the effects of hoop stress and end cap pressure, but also cross talk from both X and Y bending moment into tension. Even after correcting for cross talk the tensions measurements are still somewhat scattered. Since the PUP tension measurements seem to be good at the surface, we have not been able to determine the cause of this scatter.

Regardless of the apparent scatter observed in the static data, the dynamic portion of the data will conform to the accuracy limits outlined in Section 3.1.2.

Table 3-1: Sensor Accuracy

Sensor	Scale Maximum Value	Accuracy
Top Tension Load Cell	± 5000 lb	± 0.05% FS
Actuator Roll/Pitch	± 30°	± 2% FS
Actuator Accelerometer	± 64.3 ft/s^2	± 0.628 ft/s^2
Barge Roll/Pitch	± 30°	± 2% FS
Barge Accelerometers	± 64.3 ft/s^2	± 0.628 ft/s^2
Pup Accelerometers	± 120 ft/s^2	± 0.469 ft/s^2
Pup Tension	± 5000 lb	± 1.13% FS
Pup Bending	± 600 ft-lb	± 2.3438 ft-lb

A typical calibration plot for pup tension is given in Figure 3-1. All sensor calibration data are provided on the Raw Data CD-ROM.

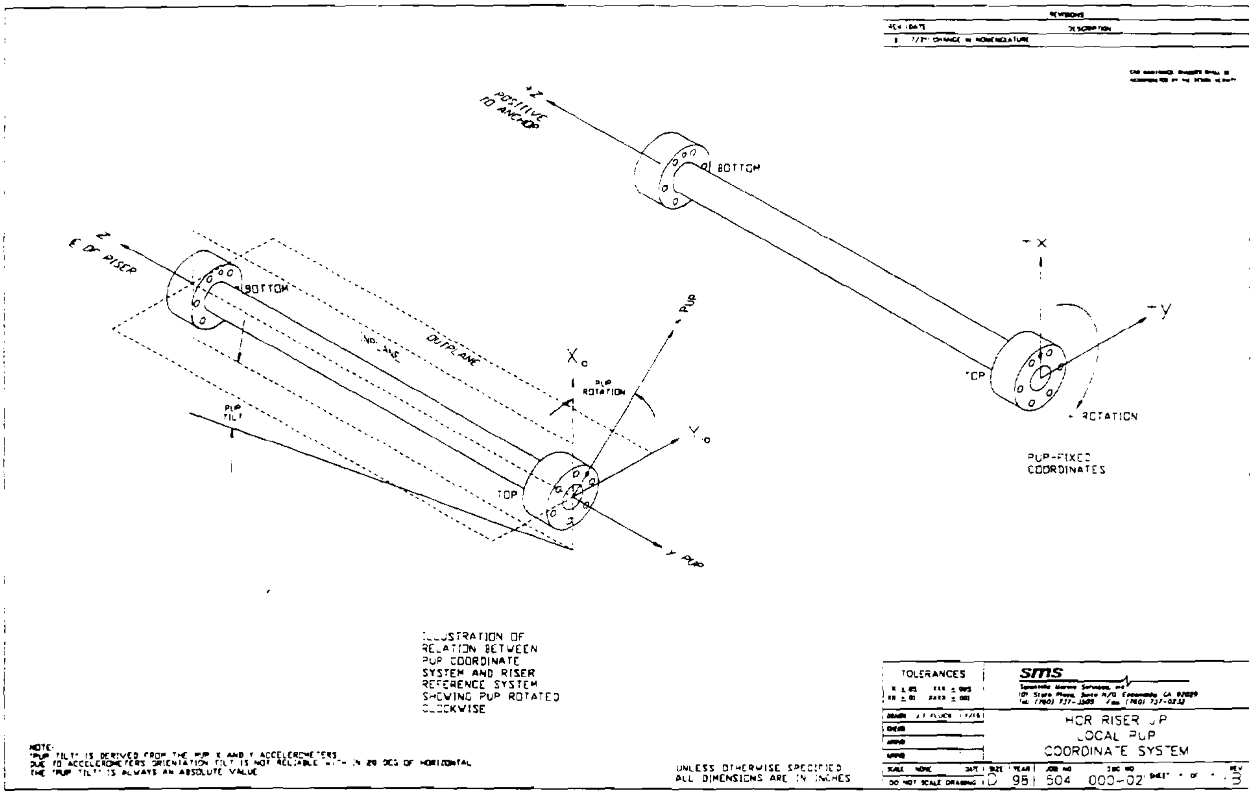


Figure 3-2: Local Pup Coordinate System

3.2.2 Barge and Actuator Coordinate System

The barge and actuator also employ a right hand rule coordinate system as shown in Figure 3-3. This system is defined as follows:

+ X (surge) points forward in the line of actuation.
+ Y (sway) is normal to X and points to port.
+ Z (heave) is normal to X and Y and points up.

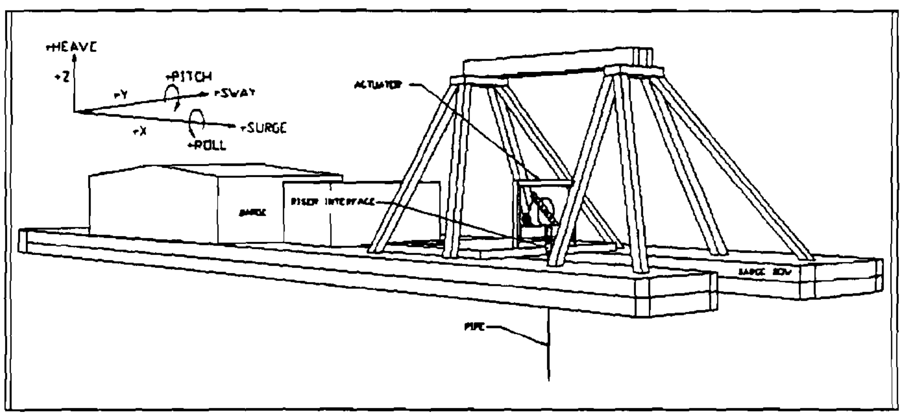


Figure 3-3: Barge Coordinate System

3.3.2 Pup Tension

Pup tension was measured using uniaxial strain gages. These gages were temperature compensated, using bridge completion strain gages mounted on an unstrained aluminum block. Poisson gages were not used, instead, the Poisson correction has been made to each pup tension based on the hoop stress at the theoretical nominal static pup depth for each riser configuration during the post test data reduction. Post test data reduction was also required to correct for the effects water pressure on the end caps and the cross talk effects of both X and Y bending moments. These corrections are handled by an additional set of derived channels and is discussed in the Data Reduction Section. Since the derived channels for tension used in the field tests did not contain these corrections, some negative tensions were displayed during the tests.

3.3.3 Bending

Bending stresses were measured using pairs of opposing uniaxial strain gages. These gages are self compensating and no correction for hoop stress or end pressure is required. Note that, as described in Section 3.2.1, the out of plane bending derived during the actual experiments was positive in the – Y direction. As requested during the tests, this has been modified to be positive in the +Y direction in the final data reduction using additional derived channels. The original channels used during the tests have been retained so that direct comparison with notes made in the field may be made if desired.

3.3.4 Accelerometers

The pup also contains four accelerometers, one orthogonal pair at each end of the pup. All accelerometers are oriented normal to the pup centerline. The accelerometers are used to provide twist information to allow the transformation of bending strains in the pup coordinate system to in and out of plane in the riser reference coordinate system. In addition, the accelerometers provide tilt information, but are not accurate within 20° of the horizontal.

3.3.5 Temperature

A temperature sensor was included on one of the instrumentation boards to allow for temperature compensation of the accelerometers. It was determined during our calibration that the temperature correction was not necessary for this application and it was not used for the data reduction.

3.4 Actuator Instruments

3.4.1 Vertical Accelerometer

A vertical accelerometer was mounted on the actuator subcarriage. This accelerometer provided data on the actuator motion during operation. The location of the accelerometer is shown in Figure 3-5.

Prior to testing the CVAR and LWSCR riser configurations, the stinger was rotated minimize out of plane bending stresses in the pups, which necessitates correction of the leaving angle for rotation. The rotation is corrected for in the post test derived channel set. No correction was required for the SCR configuration.

3.4.3 Top Tension

The top tension of the riser was measured by a load cell mounted between the top of the stinger and the bottom of the actuator subcarriage assembly. The location of this load cell is shown in Figure 3-7.

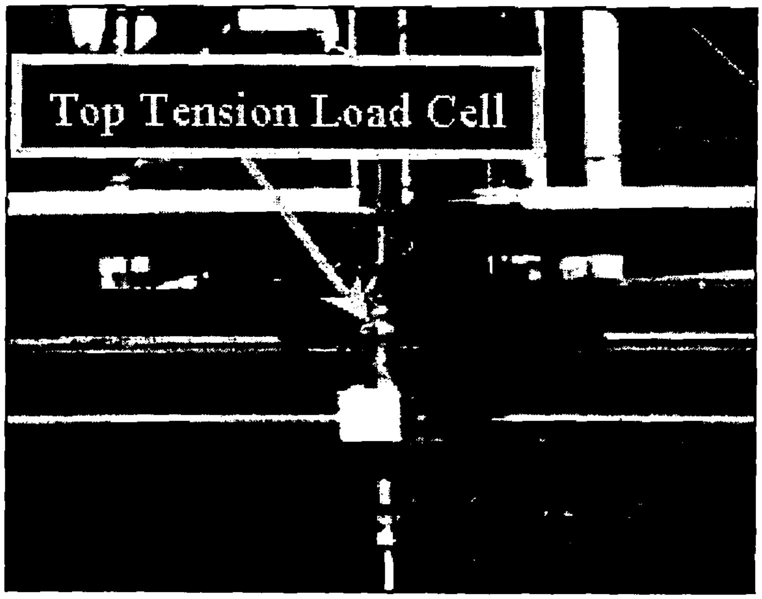


Figure 3-7: Location of Top Tension Load Cell

3.5 Barge Motions

3.5.1 5 Degree of Freedom Package

Barge motions were monitored during the tests using a 5 degree of freedom sensor package located on the actuator centerline under the reduction gear at the level of the actuator base. This package contained a triaxial accelerometer for surge, sway, and heave and a solid state roll – pitch gyro. Yaw was not measured. It should be noted that the sway accelerometer failed during the SCR tests.

3.5.2 GPS

Two GPS antennas were mounted on the barge. One was located on the aft end of the A frame above the actuator and the other on the roof of the test shack. A third unit was used as a differential truthing station. This GPS was mounted on a tripod at Leiber Point on a bluff overlooking the mooring site. Data from this GPS was transmitted to the

A special frame with adapters for the pups was fabricated for calibration of both tension and X-Y bending. A picture of the calibration frame is shown in Figure 3-8.

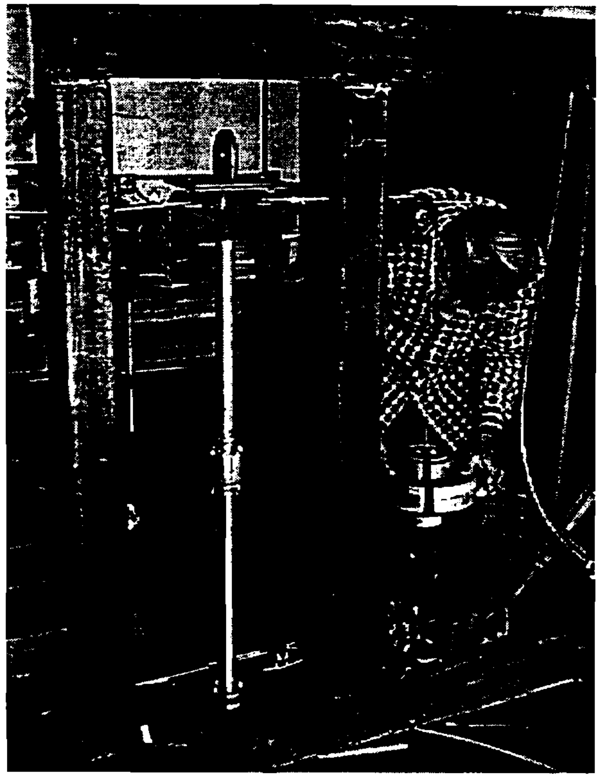


Figure 3-8: Pup Calibration Frame

The calibration data for each of the Pups is on the Raw Data CD-ROM.

3.6.1.1 Bending

Certified weights were used to calibrate the X-Y bending. Twenty-one positions were used starting at zero and returning to zero. Pup data was collected for X and Y bending as well as Tension to check for cross talk. The resulting data collected was used for calibrating each of the corresponding channels in the pups.

3.6.1.2 Tension

The certified calibrated load cell, used for the actuator load, was used for the measuring standard. A turnbuckle was used to adjust the tension so that loads in excess of 4000 pounds could be achieved. For each pup, a total of 17 different tensions were used, starting at zero and returning to zero. Pup data was collected for Tension as well as X and Y bending to check for cross talk.

calibrated as a unit, using the SMS angular position test fixture described previously copy of the calibration plots is located on the Raw Data CD-ROM in files ***Bar_Pitch_Cal.xls*** and ***Bar_Roll_Cal.xls***.

3.7 Current Measurement

During the field work, a surface current was observed. Measurements made using wood chips and a stop watch gave a surface velocity of approximately 15 cm/s (0.5 ft/s). An ADCP was obtained and used to check for the presence of subsurface currents. An Acoustic Doppler Current Profiler sends out three acoustic pulses arranged at 120° intervals around the vertical axis, with one beam pointing forward (in the +X barge coordinate system). The angle of the beams is about 30° to the vertical axis. The instrument works on the Doppler shift in the sound pulse as it reflects off particulate matter suspended in the water column. The ADCP was controlled by a laptop computer. Commands were passed to the ADCP and data received using an RS-232 serial link. Current profiles were displayed on the laptop screen.

The RD Instruments Work Horse ADCP that was used for these tests produced a 300 kHz pulse which results in a maximum profile depth of 100 m (328 feet). The water column is divided into depth "cells". The ADCP will fire a "ping" along each of the three beam axes and listen for a return at the appropriate time for each depth cell. The velocities from the three beams are averaged to produce a single velocity for each depth along the vertical axis of the instrument.

For these experiments, the ADCP was suspended on a rope cradle approximately 2 m below the water surface. This unit was operated on two occasions during the move from the CVAR anchor position to the LWSCR anchor position (when the barge was not moving) and on one occasion during the deployment of the SCR. Observation of the velocity profile on the computer screen showed that the maximum subsurface current was approximately 5 cm/s and that there was virtually no current indicated at depths greater than 30 m down to the instrument limit of 100 m. The conclusion from these measurements and additional visual observations was that these currents were wind generated and did not extend below 30 m.

3.8 ROV and Underwater Video

3.8.1 ROV

A Deep Ocean Engineering Phantom HDII remote operated vehicle was used to perform inspections and provide video of selected riser tests. The ROV was invaluable as an inspection tool, ensuring correct positioning and imbedment of the riser anchor as well as checking the riser before beginning tests. A photograph of the ROV ready for deployment is shown in Figure 3-9.

is supplied with a 60 HP variable frequency controller which permits absorption of essentially full power over a speed range of 3 RPM to 20 RPM at the reduction gear output shaft (fly wheel). The controller was equipped with an oversized dynamic breaking resistor bank, which eliminated over-speeding during the part of the riser displacement cycle, which caused power to be put into the motor. The result was a truly constant speed apparatus with a low harmonic distortion of 0.2 %, based on power. By selecting the attitude of the actuator support structure the riser top could be excited with both vertical and horizontal displacements.

4.2 Tubing

The risers were constructed from 1.25" ID X 0.125" wall 6061-T6511 extruded aluminum tube. Three lengths, 24', 12', 6' of riser pipe sections were constructed. The instrumented pups were also constructed of this material.

The material properties are as follows:

Material:	6061-T6 T651	
Ultimate Strength:	45,000	psi
Yield Strength:	40,000	psi
E:	1.000E+07	psi
Endurance Limit:	14,000	psi
O.D.:	1.50	inches
I.D.:	1.25	inches
I:	0.1287	in^4
SM:	0.1716	in^3

4.3 Joint Connections

The end flanges were machined from 6061-T6 aluminum bar stock and welded to the tubing. The sections of riser were bolted together with 5/16-18 SAE grade 5 bolts torqued to 17 ft-lb dry using a "star pattern" torque sequencing order.

4.4 Welds and Quality Assurance

The API 1104 welding standard was used to check every weldment. The radiographic review was performed by Decisive Testing, Inc. and the welds judged on a pass/fail basis. Any weld which did not pass the standard was completely redone and then rechecked for compliance to the standard.

Flange face angular tolerance was specified to be less than 0.3° from normal to the tube longitudinal (z) axis. Each joint was checked on a pass/fail basis. Joints which did not pass were faced to 0°.

The instrumented pups were pressure tested at 550 psi for 10 hours. Riser pipe segments were self-flooding.

Table 4-1: Pipe Joint As Built Weights and Dimensions

X-denotes High Strength Pipes							
Pipe	Color	Pipe	Measured	Pipe	Measured	Electrical	Remarks
				Desired			
Number	Code	Length	Length	Weight	Weight	Cable	
				in air	in air		
		ft	ft	lb	lb		
X6-001		6	6.000	10.72	10.718	NONE	
X6-002		6	6.000	10.72	10.710	NONE	
.							
X12-001		12		21.192		24-M-F	
X12-002	green	12	11.969	21.192		12-F-F	21.192
X12-003	green	12	11.988	21.192	20.878	12-F-F	Wt. without cable
X12-004	green	12	12.000	21.192		12-F-F	
X12-005	green	12	12.000	21.192		12-F-F	
X12-006	green	12	11.996	21.192		12-F-F	
X12-007	green	12	11.979	21.192		12-F-F	
X12-008	green	12	11.979	21.192		12-F-F	
X24-001	blue	24	24.016	42.384		24-F-M	42.384
X24-002	blue	24		42.384		24-F-M	
X24-003	blue	24	24.01	42.384	41.006	24-F-M	40.951
X24-004	blue	24	24.021	42.384	40.224	24-F-M	
X24-005	blue	24	24.010	42.384	40.973	24-F-M	
X24-006	pink	24	24.016	42.384		24-F-F	Cable 6
X24-007	pink	24	24.010	42.384	42.406	24-F-F	Cable 2
X24-008	pink	24	24.010	42.384	42.384	24-F-F	Cable 4
X24-009	pink	24	24.010	42.384	42.428	24-F-F	Cable 5, short
X24-010	pink	24	24.000	42.384	42.384	24-F-F	Cable 1
24-011	yellow	24	24.010	42.384	40.951	24-F-M	No cable
24-012	yellow	24	24.010	42.384	40.944	24-F-M	No cable
24-013	yellow	24	24.010	42.384	40.940	24-F-M	No cable
24-014	yellow	24	24.010	42.384	40.951	24-F-M	No cable
24-015	yellow	24	24.000	42.384	40.940	24-F-M	No cable
24-016	yellow	24	24.000	42.384	40.874	24-F-M	No cable
24-017	yellow	24	24.010	42.384	40.940	24-F-M	No cable
24-018	yellow	24	24.010	42.384	40.984	24-F-M	No cable
24-019	yellow	24	24.000	42.384	42.483	24-F-M	Cable 5, short
24-020	yellow	24	24.000	42.384	43.810	24-F-M	Cable 31, short
24-021	yellow	24	24.016	42.384	42.433	24-F-M	Cable 29
24-022	yellow	24	24.010	42.384	42.441	24-F-M	Cable 26
24-023	yellow	24	24.010	42.384	42.444	24-F-M	Cable 17
24-024	yellow	24	24.010	42.384	42.448	24-F-M	Cable 4
24-025	yellow	24	24.005	42.384	42.355	24-F-M	Cable 18
24-026	yellow	24	24.010	42.384	42.538	24-F-M	Cable 30, short
24-027	yellow	24	24.010	42.384	42.516	24-F-M	Cable 37, short

5 Test Configurations

5.1 General Assembly and Deployment Methods

All the riser configurations were assembled in using the same basic technique. Pipe handling was accomplished using an overhead trolley running along the I beams connecting the tops of the two A frames on the Kamloops barge. A line from one of the barge's 15,000 lb winches was rove through a block on the trolley and was attached to an elevator which held the top end of each riser section while it was being raised. A certified digital scale was placed in the path between the block and the trolley attachment to provide a direct reading of the tension on the top of the riser during installation and removal. The procedure was as follows:

1 Bring the next riser section to be attached out of the pipe rack. If buoyancy modules are needed on this section, they must be put in place prior to placing the top end in the riser.

  1.1 If buoyancy modules are attached, it is important to leave off the top section, to allow room to install the connection bolts. The last buoyancy section is put in place after the bolts are tightened and the riser lifted from the slips in Step 7.

2 Raise the section to the vertical position and align the flange face with the section below.

3 Be sure that the alignment pin is facing forward and is aligned with the hole in the lower flange face.

4 If there is an electrical connection at this joint, it must be made here.

  4.1 Check the connection for dirt, debris, or water.
  4.2 Ensure that the power to the pups is off.
  4.3 Make the connection, ensuring that it is tight.
  4.4 Power up the system and verify that all pups below are reading.

5 The riser section was attached to the section below by 6 bolts. Insert the bolts and tighten them to the specified torque using a star pattern.

6 Raise the assembled unit to allow the pipe slips to disengage.

7 Remove the pipe slips and lower the riser until about two feet of pipe remains above the level of the slips. If the electronics are connected, monitor the pup bending moments during the lowering process.

8 Put the slips back around the pipe and lower the riser until the slips engage.

9 If there is an electrical connection at this joint, it must be broken here.

5.2 Configuration Descriptions

Three different riser configurations were tested. These are the CVAR, LWSCR, and SCR. The CVAR and LWSCR have buoyancy modules on some joints, the SCR had no buoyancy modules, but was tested on both the natural mud bottom of the lake and an artificial hard bottom deployed for this purpose. The details of the risers are given in the following sections.

In each riser configuration, pups were always numbered from 1 to 8, starting at the end nearest the actuator. It is important to know which physical calibration file corresponds to which pup. Table 5-1 provides the pup order reference data:

Table 5-1: Pup Order Reference Numbers

Order No.	CVAR	LWSCR	SCR
1	2	2	10
2	3	3	2
3	4	4	3
4	5	5	4
5	6	6	5
6	7	7	6
7	8	8	7
8	9	9	9

5.2.1 CVAR

The CVAR configuration was deployed in accordance with the layout is given in Figures 5-1 and 5-2. The pipe joint installation schedule is given in Table 5-2.

Table 5-2: CVAR Joint Schedule

Joint #	Pipe No.	Distance from anchor to top of member	Nominal Length	Actual Length	Actual Distance From Anchor to Top of Member	Number of Auxiliary Buoyancy Modules
		ft	ft	ft	ft	
0	on anchor	5.5		5.50	5.50	0
1	24-048	29.5	24	24.02	29.52	10
2	24-049	53.5	24	24.01	53.53	10
3	24-050	77.5	24	24.01	77.54	10
4	24-051	101.5	24	24.01	101.55	10
5	24-052	125.5	24	24.01	125.56	10
6	24-053	149.5	24	24.01	149.57	10
7	24-054	173.5	24	24.01	173.58	10
8	24-055	197.5	24	24.01	197.59	10
9	24-056	221.5	24	24.01	221.60	10
10	24-057	245.5	24	24.01	245.61	10
11	24-058	269.5	24	24.01	269.62	10
12	24-059	293.5	24	24.01	293.63	10
13	**X24-009**	317.5	24	24.01	317.64	10
14	**X12-003**	329.5	12	11.98	329.62	5
15	pup 8	331.5	2	2.00	331.62	1
16	**X24-006**	355.5	24	24.02	355.64	10
17	pup 7	357.5	2	2.00	357.64	1
18	**X12-002**	369.5	12	11.97	369.61	5
19	pup 6	371.5	2	2.00	371.61	1
20	**X12-007**	383.5	12	11.99	383.59	5
21	pup 5	385.5	2	2.00	385.59	0
22	**X12-004**	397.5	12	12.00	397.59	0
23	pup 4	399.5	2	2.00	399.59	0
24	**X12-005**	411.5	12	12.00	411.59	0
25	pup 3	413.5	2	2.00	413.59	0
26	**X12-006**	425.5	12	12.00	425.59	0
27	pup 2	427.5	2	2.00	427.59	0
28	**X24-007**	451.5	24	24.01	451.60	0
29	pup 1	453.5	2	2.00	453.60	0
30	**X24-004**	477.5	24	24.02	477.62	0
31	**X24-005**	501.5	24	24.01	501.63	0
32	24-036	525.5	24	24.01	525.64	0
33	24-022	549.5	24	24.01	549.65	0
34	24-023	573.5	24	24.01	573.66	0
35	24-024	597.5	24	24.01	597.67	0
36	24-025	621.5	24	24.01	621.68	0
37	24-028	645.5	24	24.01	645.69	0
38	24-029	669.5	24	24.01	669.70	0
39	24-030	693.5	24	24.01	693.70	0
40	24-031	717.5	24	24.02	717.72	0
41	24-032	741.5	24	24.01	741.73	0
42	24-033	765.5	24	24.01	765.74	0
43	24-034	789.5	24	24.01	789.75	0
44	24-039	813.5	24	24.02	813.76	0
45	24-021	837.5	24	24.02	837.78	0
46	X12-001	849.5	12	12.00	849.78	0

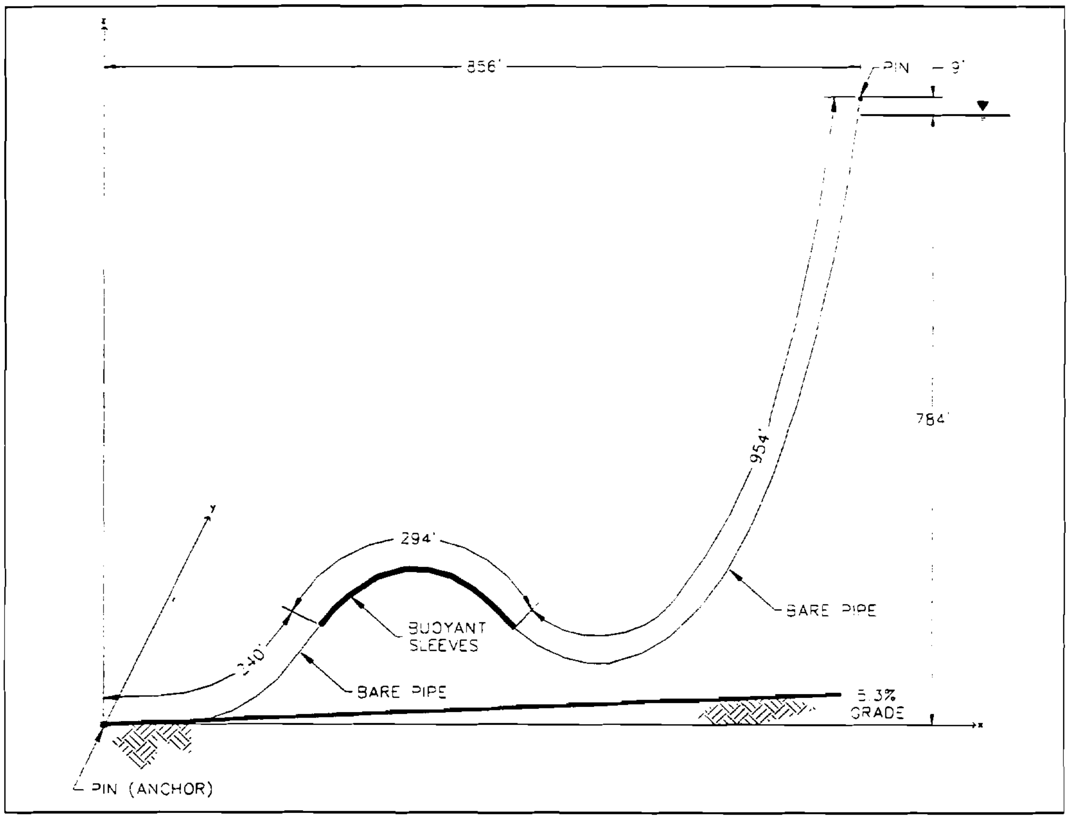


Figure 5-4: LWSCR Profile and Dimensions

Table 5-3: LWSCR Pipe Joint Schedule

Joint #	Pipe #	Distance From Anchor to Top of Member ft	Nominal Length ft	Actual Length ft	Actual Distance From Anchor to Top of Member ft	Number of Auxiliary Buoyancy Modules
0	on anchor	5.5	5.5	5.5	5.5	0
1	24-049	29.5	24	24.01	29.51	0
2	24-051	53.5	24	24.01	53.52	0
3	24-052	77.5	24	24.01	77.53	0
4	24-053	101.5	24	24.01	101.54	0
5	24-060	125.5	24	24.01	125.55	0
6	24-061	149.5	24	24.01	149.56	0
7	24-062	173.5	24	24.01	173.57	0
8	24-063	197.5	24	24.01	197.58	0
9	24-064	221.5	24	24.01	221.59	0
10	24-065	245.5	24	24.021	245.611	0
11	24-048	269.5	24	24.021	269.632	10
12	24-056	293.5	24	24.01	293.642	10
13	24-050	317.5	24	24.01	317.652	10
14	24-057	341.5	24	24.01	341.662	10
15	24-058	365.5	24	24.01	365.672	10
16	24-059	389.5	24	24.01	389.682	10
17	24-054	413.5	24	24.016	413.698	10
18	24-055	437.5	24	24.01	437.708	10
19	**X24-009**	461.5	24	24.01	461.718	10
20	**X24-010**	485.5	24	24.016	485.734	10
21	pup8	487.5	2	2	487.734	1

installation, due to an error, instrumented pups numbers 5 and 6 (also known as pup physical reference numbers 5 and 6) were installed upside down. This will result in the sign of the Y bending and Y axis accelerations being reversed from the standard sign convention in the raw data. This problem was addressed in the SCR2MAT and SCR2CSV programs, so that after running either program, the derived channels for the final corrected out of plane bending for these pups have the correct sign, consistent with the standard reference system and all the other pups. It should be noted that the raw data is not altered in any way, therefore people who wish to manipulate these data themselves should be aware that the signs for the raw Y axis bending and accelerometers are reversed. All other pups were installed in the correct orientation.

Also for this configuration, one pup (pup order number 1, physical reference number 10) was installed near the top attachment. In order to maintain the total number of eight instruments, one was removed from the sag bend region, therefore for the SCR, there are 7 pups in the sag bend region and 1 pup close to the top attachment point. When pup 10 was installed in the line, the calibration factor was altered to increase the sensitivity as requested for all other pups after the CVAR tests. Unfortunately, the Command Data Word (CDW: the programming command which sets the properties of the A/D converter on each pup) was never altered in the pup, so the electronic gain remained as originally set. This problem has been corrected in the post test reduction by correctly matching the calibration factor to the electrical gain. The result is that the tension readings for this pup have half the resolution of the other 7 pups in the string. Since this pup was located near the top where the tension readings are the highest, this should not be a significant problem.

Pipe joints 9 through 28 had fairing cones bolted on at the flanges to prevent the flange from becoming stuck on the hinged joints of the hard bottom. The cones were not removed during the SCR tests in mud. A photograph of a typical cone installation is given in Figure 5.8.

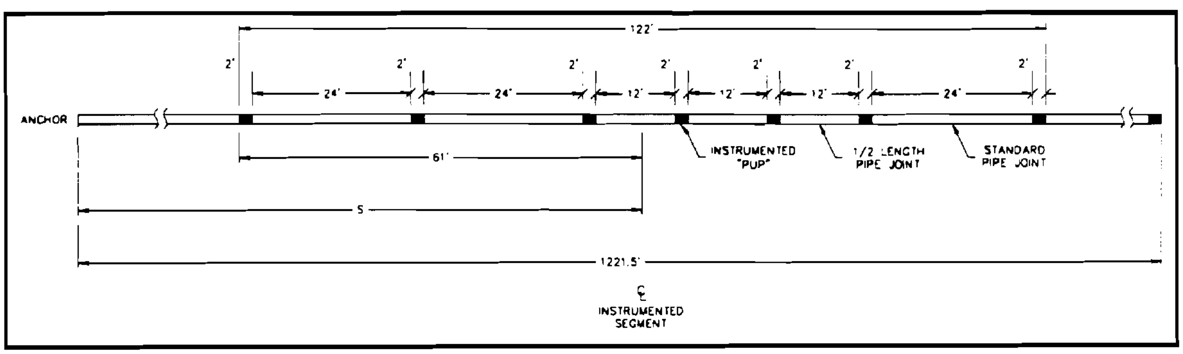


Figure 5-5: Pup Location Drawing for SCR

Table 5-4: SCR Pipe Joint Schedule

Joint #	Pipe #	Distance from anchor to top of member	Nominal Length	Actual Length	Actual dist. From anchor to top of member	cone?
0	on anchor	5.5	anchor arm	5.5	5.5	
1	24-049	29.5	24	24.01	29.51	
2	24-051	53.5	24	24.01	53.52	
3	24-052	77.5	24	24.01	77.53	
4	24-053	101.5	24	24.01	101.54	
5	24-060	125.5	24	24.01	125.55	
6	24-061	149.5	24	24.01	149.56	
7	24-062	173.5	24	24.01	173.57	
8	24-063	197.5	24	24.01	197.58	
9	**X24-008**	221.5	24	24.01	221.59	c
10	**X24-010**	245.5	24	24.016	245.606	c
11	**X12-003**	257.5	12	12	257.606	c
12	pup8	259.5	2	2	259.606	c
13	**X24-006**	283.5	24	24.016	283.622	c
14	pup7	285.5	2	2	285.622	c
15	**X12-002/X12-006**	309.5	24	24.01	309.632	c
16	pup6	311.5	2	2	311.632	c
17	**X12-007**	323.5	12	11.979	323.611	c
18	pup5	325.5	2	2	325.611	c
19	**X12-004**	337.5	12	12	337.611	c
20	pup4	339.5	2	2	339.611	c
21	**X12-005**	351.5	12	12	351.611	c/Tape
22	pup3	353.5	2	2	353.611	c
23	**X24-007**	377.5	24	24.01	377.621	c
24	pup2	379.5	2	2	379.621	c
25	**X24-001**	403.5	24	24.021	403.642	c
26	**X24-005**	427.5	24	24.01	427.652	c
27	**X24-003**	451.5	24	24.01	451.662	c
28	**X24-004**	475.5	24	24.021	475.683	c
29	24-016	499.5	24	24	499.683	
30	24-018	523.5	24	24.01	523.693	
31	24-019	547.5	24	24.01	547.703	
32	24-020	571.5	24	24	571.703	
33	24-022	595.5	24	24	595.703	
34	24-023	619.5	24	24.016	619.719	
35	24-024	643.5	24	24.01	643.729	
36	24-025	667.5	24	24.01	667.739	
37	24-026	691.5	24	24.01	691.749	
38	24-027	715.5	24	24.005	715.754	
39	24-031	739.5	24	24.01	739.764	
40	24-030	763.5	24	24.01	763.774	
41	24-032	787.5	24	24.01	787.784	
42	24-033	811.5	24	24.01	811.794	
43	24-034	835.5	24	24.005	835.799	
44	24-035	859.5	24	24.016	859.815	
45	24-036	883.5	24	24.01	883.825	
46	24-037	907.5	24	24.01	907.835	
47	24-038	931.5	24	24.01	931.845	
48	24-039	955.5	24	24.016	955.861	
49	24-043	979.5	24	24.005	979.866	
50	24-044	1003.5	24	24.01	1003.876	
51	24-042	1027.5	24	24.01	1027.886	
52		1051.5	24	24.005	1051.891	
53		1075.5	24	24.016	1075.907	
54	24-046	1099.5	24	24.021	1099.928	
55	24-047	1123.5	24	24.021	1123.949	
56	24-045	1147.5	24	24.01	1147.959	
57	24-041	1171.5	24	24.01	1171.969	
58	24-021	1195.5	24	24.01	1195.979	
59	24-040	1219.5	24	24.01	1219.989	
60	pup1	1221.5	2	2	1221.989	
61	X12-001	1233.5	12	12	1233.989	

6.3 Data Collection

While the actuator control was operated by an SMS engineer, the data collection was initiated and terminated by a PMB engineer. During some runs, data was collected during ramp up or ramp down as well as during the steady state portion of the tests. The determination of steady state was made by the engineer operating the DAS based on his observations of the real time data displays.

During the CVAR and LWSCR tests, kinematic GPS data was collected. This collection was initiated by an SMS engineer prior to the start of the actuator. The purpose of the GPS data was to provide a record of barge movement during the tests. However, due to the relatively high horizon masking due to the surrounding mountains, the GPS conditions were not good enough to produce centimeter level accuracy track plots which are required for precise motion tracking. The GPS data were good enough to produce sub-meter level accuracy positions which were used to determine the locations of the riser anchor and top. By direction from PMB personnel, kinematic GPS data was not taken during the SCR tests. GPS data converted to latitude, longitude, and elevations for the data that was taken are included on the Raw Data CD-ROM.

6.4 ROV Operation

All ROV operations were conducted by SMS personnel with some umbilical tending assistance from ARD personnel.

At depths greater than about 100 feet, visibility through the ROV video camera was, at best, on the order of 15 – 20 feet. The Phantom HD II vehicle leased for this project was not equipped with a sonar, so if the ROV pilot lost sight of the riser and became disoriented, the standard procedure was to fly back along the umbilical to the surface, re-acquire the riser visually, and then return to the current task. This procedure minimized the chance of tangling the umbilical around the riser or any of the mooring lines, which would cause problems retrieving the ROV.

The ROV was deployed prior to each riser anchor imbedment to inspect the riser, anchor, and the bottom where penetration would take place to verify that it was free from obstructions. The ROV was also used to verify proper deployment of the hard bottom and assist with its placement on the mud. Typically, a video tape record was made of each ROV deployment from the time the ROV left the surface until the start of the return trip to the surface. The original video tapes have been retained for the record by PMB.

Prior to the beginning of the large amplitude test sequence for each riser configuration, the ROV was deployed and flown to a location on the riser specified by PMB personnel, where the motion was expected to be interesting. For the CVAR and LWSCR this was in mid-water at the region of curvature. For the SCR, the location was on the bottom near the touch down point.

Table 7-1: CVAR Data Runs

Date	File Name	Test Name	Motor RPM	Actuator RPM	Amplitude (Feet)	Riser Period (s)
8/20/98	H201601	C1	450	6.00	0.5	10.00
8/20/98	H201605	C1	500	6.67	0.5	9.00
8/20/98	H201608	C1	563	7.51	0.5	7.99
8/20/98	H201609	C1	643	8.57	0.5	7.00
8/20/98	H201612	C1	750	10.00	0.5	6.00
8/20/98	H201614	C1	900	12.00	0.5	5.00
8/20/98	H201616	C1	1125	15.00	0.5	4.00
8/20/98	H201618	C1	1286	17.15	0.5	3.50
8/20/98	H201623	C1	1500	20.00	0.5	3.00
8/20/98	H201625	C1	1600	21.33	0.5	2.81
8/20/98	H201809	C2	1500	20.00	0.5	3.00
8/20/98	H201817	C2	1200	16.00	0.5	3.75
8/20/98	H201818	C2	1000	13.33	0.5	4.50
8/20/98	H201820	C2	900	12.00	0.5	5.00
8/20/98	H201822	C2	818	10.91	0.5	5.50
8/20/98	H201823	C2	692	9.23	0.5	6.50
8/20/98	H201825	C2	600	8.00	0.5	7.50
8/20/98	H201827	C2	529	7.05	0.5	8.51
8/21/98	H210931	C3	450	6.00	3	10.00
8/21/98	H210939	C3	500	6.67	3	9.00
8/21/98	H210942	C3	563	7.51	3	7.99
8/21/98	H210945	C3	643	8.57	3	7.00
8/21/98	H210949	C3	750	10.00	3	6.00
8/21/98	H210953	C3	900	12.00	3	5.00
8/21/98	H210958	C3	1125	15.00	3	4.00
8/21/98	H211002	C3	1286	17.15	3	3.50
8/21/98	H211005	C3	1500	20.00	3	3.00
8/21/98	H211214	C4	450	6.00	2	10.00
8/21/98	H211218	C4	500	6.67	2	9.00
8/21/98	H211220	C4	563	7.51	2	7.99
8/21/98	H211221	C4	643	8.57	2	7.00
8/21/98	H211224	C4	750	10.00	2	6.00
8/21/98	H211227	C4	900	12.00	2	5.00
8/21/98	H211230	C4	1125	15.00	2	4.00
8/21/98	H211234	C4	1286	17.15	2	3.50
8/21/98	H211237	C4	1500	20.00	2	3.00
8/21/98	H211406	C5	1000	13.33	2	4.50
8/21/98	H211410	C5	818	10.91	2	5.50
8/21/98	H211414	C5	783	10.44	2	5.75
8/21/98	H211418	C5	766	10.21	2	5.87
8/21/98	H211420	C5	750	10.00	2	6.00
8/21/98	H211422	C5	735	9.80	2	6.12
8/21/98	H211425	C5	720	9.60	2	6.25
8/21/98	H211428	C5	692	9.23	2	6.50
8/21/98	H211432	C5	667	8.89	2	6.75
8/21/98	H211435	C5	621	8.28	2	7.25
8/21/98	H211438	C5	600	8.00	2	7.50
8/21/98	H211442	C5	529	7.05	2	8.51
8/21/98	H211445	C5	514	6.85	2	8.75
8/21/98	H211451	C5	487	6.49	2	9.24
8/21/98	H211456	C5	474	6.32	2	9.49

Date	File Name	Test Name	Motor RPM	Actuator RPM	Amplitude (Feet)	Riser Period (s)
9/18/98	H181848	SV1	450	6.00	0.5	10.00
9/18/98	H181851	SV1	500	6.67	0.5	9.00
9/18/98	H181854	SV1	563	7.51	0.5	7.99
9/18/98	H181858	SV1	643	8.57	0.5	7.00
9/18/98	H181901	SV1	750	10.00	0.5	6.00
9/18/98	H181905	SV1	900	12.00	0.5	5.00
9/18/98	H181909	SV1	1125	15.00	0.5	4.00
9/18/98	H181912	SV1	1500	20.00	0.5	3.00
9/18/98	H181915	SV1	1600	21.33	0.5	2.81
9/19/98	H191110	SV2	450	6.00	2	10.00
9/19/98	H191113	SV2	500	6.67	2	9.00
9/19/98	H191116	SV2	563	7.51	2	7.99
9/19/98	H191120	SV2	643	8.57	2	7.00
9/19/98	H191124	SV2	750	10.00	2	6.00
9/19/98	H191126	SV2	900	12.00	2	5.00
9/19/98	H191129	SV2	1125	15.00	2	4.00
9/19/98	H191133	SV2	1500	20.00	2	3.00
9/19/98	H191136	SV2	1600	21.33	2	2.81
9/19/98	H191221	SV3	474	6.32	2	9.49
9/19/98	H191224	SV3	529	7.05	2	8.51
9/19/98	H191226	SV3	600	8.00	2	7.50
9/19/98	H191229	SV3	692	9.23	2	6.50
9/19/98	H191231	SV3	818	10.91	2	5.50
9/19/98	H191232	SV3	947	12.63	2	4.75
9/19/98	H191235	SV3	973	12.97	2	4.62
9/19/98	H191237	SV3	1000	13.33	2	4.50
9/19/98	H191239	SV3	1059	14.12	2	4.25
9/19/98	H191242	SV3	1091	14.55	2	4.12
9/19/98	H191244	SV3	1161	15.48	2	3.88
9/19/98	H191246	SV3	1200	16.00	2	3.75
9/19/98	H191248	SV3	1286	17.15	2	3.50
9/19/98	H191251	SV3	1385	18.47	2	3.25
9/19/98	H191254	SV3	1440	19.20	2	3.13
9/19/98	H191256	SV3	1550	20.67	2	2.90
9/19/98	H191347	SV4	450	6.00	3	10.00
9/19/98	H191351	SV4	500	6.67	3	9.00
9/19/98	H191409	SV4	563	7.51	3	7.99
9/19/98	H191412	SV4	643	8.57	3	7.00
9/19/98	H191415	SV4	750	10.00	3	6.00
9/19/98	H191417	SV4	900	12.00	3	5.00
9/19/98	H191420	SV4	1125	15.00	3	4.00
9/19/98	H191422	SV4	1500	20.00	3	3.00
9/19/98	H191442	SV5	474	6.32	3	9.49
9/19/98	H191509	SV5	529	7.05	3	8.51
9/19/98	H191513	SV5	581	7.75	3	7.75
9/19/98	H191516	SV5	600	8.00	3	7.50
9/19/98	H191519	SV5	667	8.89	3	6.75
9/19/98	H191522	SV5	692	9.23	3	6.50

Table 7-4: SCR on Hard Bottom Horizontal Data Runs

7.2 Description of Reduction Methods and Algorithms: During Tests

7.2.1 Raw Data Conversion

All data is collected and stored as raw digital voltage counts (ADACS) from the analog to digital converters. The system also stores a calibration file along with every raw data file. These calibration files are used to convert the raw data to engineering units.

7.2.2 Real Time Data Analysis

For real time display, all measured channels are first converted to engineering units. Derived channels are calculated in real time. All derived channel calculations are performed on a point by point bases. The derived channels are grouped as Actuator and Barge Motions; Pup Motions and Bending.

7.2.3 Actuator and Barge Motions

Four derived channels have been created that remove the effect of gravity from the accelerometers on the barge and on the actuator using the roll/pitch sensor located on the barge. These derived channels are appended with NOG which stands for (No Gravity). The following is a code segment that shows the calculations:

```
case -1:  // D-1  Actuator Heave Acc NOG
    cos_roll = cos(ddata[BARROLL] * RADPERDEG);
    cos_pitch = cos(ddata[BARPITCH] * RADPERDEG);
    return(ddata[ACTHEAVEACC] + GRAVITY * (1.0 - cos_pitch * cos_roll));
case -2:  // D-2  Barge Surge Acc NOG
    cos_roll = cos(ddata[BARROLL] * RADPERDEG);
    cos_pitch = cos(ddata[BARPITCH] * RADPERDEG);
    return(ddata[BARSURGEACC] + GRAVITY * sin(ddata[BARPITCH] * RADPERDEG));
case -3:  // D-3  Barge Sway Acc NOG
    return(ddata[BARSWAYACC] - GRAVITY * (sin(ddata[BARROLL] * RADPERDEG) * cos_pitch));
case -4:  // D-4  Barge Heave Acc NOG
    return(ddata[BARHEAVEACC] + GRAVITY * (1.0 - cos_pitch * cos_roll));
```

7.2.4 Pup Motions and Bending

Ten derived channels were created for each pup for use during the test program.

The first four derived channels are corrected top and bottom, X and Y accelerations. Each pup accelerometer is first corrected for temperature drift (not required in this installation). Next the pup accelerometers are corrected for axis misalignment. There are two misalignments that are corrected. The first is misalignment between the X and Y axis This correction is accomplished by computing a new Y axis that is orthogonal to the

```
        // average Y acceleration
        p1y = (p1ty + p1by) / 2.0;
        // filter Y acceleration
        p1y = FILTER_nextsample(p1y, &p1yfilt);
        return(p1y);
    case -10:  //  D-10 PUP 1 Static X Acc
        // average X acceleration
        p1x = (p1tx + p1bx) / 2.0;
        // filter X acceleration
        p1x = FILTER_nextsample(p1x, &p1xfilt);
        return(p1x);
```

The next derived channel calculates the pup rotation based on the static X and Y accelerations calculated above. This quasi static rotation was used for rotations displayed during the testing, however the mean rotation value determined from the 5 minute statistics file prior to the start of each test was used for the final post test processing in cases above -85 The following is a code segment that shows the calculations used during the field work:

```
    case -11:  //  D-11 PUP 1 Rotation
        if (p1y == 0.0 && p1x == 0.0)
          p1rot = 0.0;
        else
          p1rot = -atan2(p1y, p1x);
                p1rotdeg = DEGPERRAD * (p1rot * -1); // changed sign of p1rot to + so rotation is correct
    if (p1rotdeg < 0.0)
          p1rotdeg += 360.0;
        return(p1rotdeg);
```

The next derived channel calculates the pup tilt. The static X and Y accelerations calculated above are using for this calculation. **Please Note: this derived channel is not accurate when the pup is within 20 degrees of the horizontal plane.** The following is a code segment that shows the calculations:

```
    case -12:  //  D-12 PUP 1 Tilt Inplane
        temp = sqrt(p1y * p1y + p1x * p1x) / GRAVITY;
        if (temp > 1.0)
          temp = 1.0;
        if (temp < -1.0)
          temp = -1.0;
        return(DEGPERRAD * acos(temp));
```

This resulted in the creation of 6 derived channels for each pup. The equations (shc for Pup 1) are as follows:

```
case -85: // D-85 Pipe Pitch COR        - rotate pitch & roll using input pipe top rotation
    return(ddata[PIPEPITCH] * cos(piperot * RADPERDEG) - ddata[PIPEROLL] * sin(piperot *
                    RADPERDEG));
case -86: // D-86 Pipe Roll COR        - rotate pitch & roll using input pipe top rotation
    return(ddata[PIPEROLL] * cos(piperot * RADPERDEG) + ddata[PIPEPITCH] * sin(piperot *
                    RADPERDEG));
case -87: // D-87 PUP 1 Static Rotation
    return(p1rotcst);
case -88: // D-88 PUP 1 Static Tilt Inplane
    return(p1tiltcst);
case -89: // D-89 PUP 1 Bend Inplane COR - rotate bending using input rotation
    return(ddata[PUP1BENDX] * cos(-p1rotcst * RADPERDEG) - ddata[PUP1BENDY] * sin(-p1rotcst *
                    RADPERDEG));
case -90: // D-90 PUP 1 Bend Outplane COR - rotate bending using input rotation
    return-1*(ddata[PUP1BENDY] * cos(-p1rotcst * RADPERDEG) + ddata[PUP1BENDX] * sin(-
                    p1rotcst * RADPERDEG));
    // Added -1 * to change the sign for "Bend Outplane COR" 23 Nov. 98 GCF all pups //
```

7.3.2 Correction of Measured Tension for Hoop Stress, End Pressure and Cro Talk

The tension data measured by the pups was affected by the water pressure at the submerged depth of each pup. This pressure caused the air filled pups to compress creating a false tension reading, due to the z axis component of hoop stress, and a real compression due to end cap pressure. These forces were calculated based on the theoretical mean depth of the individual pups in each riser configuration, which was provided by PMB. The correction was reduced to a single value function based on depth and a subroutine was written to provide the corrected tension due to pressure for each pup. The water pressure correction function is as follows:

```
Function description: Corrects for water pressure. This includes correction for end pressure and hoop
                    stress.

  Input: tension in lbs.
       depth in feet
  Output: corrected tension in lbs.
double correcttension(double tension, double depth)
{
  return(tension + depth * 0.23382);
}
```

7.3.4 Reduced Constant Frequency Statistics

The steady state data from all test runs was reduced and converted to engineering units using the appropriate RAW2MAT conversion program. The data were then processed using proprietary Matlab routines to produce the required statistics. Two sets of output files have been generated for each tested riser configuration: one for the barge motions and a second for the tension and bending information.

The barge motion files contain the following information for each period and amplitude:

1. Channel Name
2. Units (Physical Units)
3. Minimum
4. Maximum
5. Mean
6. Standard Deviation
7. Significant Amplitude
8. Period (Mean Zero Up-crossing Period)

The data presented is:

1. Barge Roll
2. Barge Pitch
3. Barge Surge Acceleration NOG
4. Barge Sway Acceleration NOG
5. Barge Heave Acceleration NOG

These data are not evaluated as part of this report.

The tension and bending moment files contain the following information for each period and amplitude:

1. Channel Name
2. Units (Physical Units)
3. Minimum
4. Maximum
5. Mean
6. Average Peak to Peak (Time Domain)
7. Ratio Peak to Peak (Time Domain)

displacement, the RAO calculated from the peak of the FFT closest to the excita frequency/ the peak of the actuator displacement FFT.

SMS decided not to filter the data beyond the filtering provided by the analog anti-aliasing filters(10 Hz cutoff). Consequently, even the tension and in-plane responses contain significant harmonic content different from the fundamental. As a result, the Average Peak to Peak listed in the statistics tables often does not reflect the peak to peak of the fundamental response. The zero crossing routine was confused by the higher harmonics. Consequently, the "Ratio p-p" is also of limited value. However, the RAO has been calculated from the response at the fundamental excitation frequency and is a valid number.

The peak to peak values listed in the statistical summaries should be used only for the cases where the "Ratio P-P" is in close agreement with "RAO".

Barge motion files are stored on the Processed Data CD-ROM and labeled by configuration (i.e. "CVAR Barge Motions.CSV")

7.3.5 Pup Motion Analysis

The X and Y accelerometer data from the pups was double integrated to determine the motion of each pup. To perform this analysis, a Matlab routine was prepared which corrected the accelerometers for the effects of gravity due to tilt and roll, transformi them to the mid-point of the pup and then into "X Acc NOG" and "Y Acc NO accelerations. These accelerations were then double integrated to produce "X Positions" "(In-Plane values) and "Y Positions" (Out-of-Plane values). Both corrected top and bottom accelerations and the processed channels are presented.

The following equations were taken from the Matlab program used to perform this analysis for each pup:

First: calculate dynamic angular accelerations

```
% top-bot difference in X acceleration /distance to give dynamic angular pitch acceleration
dXacc = ((data(3+(j-1)*4,:)-data(5+(j-1)*4,:))/dist)*degperrad; % pitch
avgXacc = (data(3+(j-1)*4,:)+data(5+(j-1)*4,:))/2;
avgYacc = (data(2+(j-1)*4,:)+data(4+(j-1)*4,:))/2;
addchan(dXacc,['Pup ' int2str(j) ' Angular Pitch Acc'], 'deg/s2');
addchan(avgXacc,['Pup ' int2str(j)  ' Avg X Acc'], 'ft/s2');
addchan(avgYacc,['Pup ' int2str(j)  ' Avg Y Acc'], 'ft/s2');
```

Second: double integrate to get dynamic angles using Matlab and SMS proprietary routines returning int2str(j).

Third: add static angles determined from 5 minute statistics files back in for pit only:

10. Pup 3 Top X Acc COR
11. Pup 3 Bot Y Acc COR
12. Pup 3 Bot X Acc COR
13. Pup 4 Top Y Acc COR
14. Pup 4 Top X Acc COR
15. Pup 4 Bot Y Acc COR
16. Pup 4 Bot X Acc COR
17. Pup 5 Top Y Acc COR
18. Pup 5 Top X Acc COR
19. Pup 5 Bot Y Acc COR
20. Pup 5 Bot X Acc COR
21. Pup 6 Top Y Acc COR
22. Pup 6 Top X Acc COR
23. Pup 6 Bot Y Acc COR
24. Pup 6 Bot X Acc COR
25. Pup 7 Top Y Acc COR
26. Pup 7 Top X Acc COR
27. Pup 7 Bot Y Acc COR
28. Pup 7 Bot X Acc COR
29. Pup 8 Top Y Acc COR
30. Pup 8 Top X Acc COR
31. Pup 8 Bot Y Acc COR
32. Pup 8 Bot X Acc COR
33. Displacement
34. Pup 1 X Acc NOG
35. Pup 1 Y Acc NOG
36. Pup 1 X Position
37. Pup 1 Y Position
38. Pup 1 X Acc NOG
39. Pup 1 Y Acc NOG
40. Pup 1 X Position
41. Pup 2 Y Position

integration of the pup accelerations has yielded. However, the smaller amplitude, hig frequency motion could be reviewed in the mid-depth region around pup 5.

The data for pup 5 at two cases, amplitude = 0.5', period = 10 seconds and amplitude = 3.0', period = 3 seconds were reduced. The pup accelerometer out puts, corrected for the static and instantaneous orientation in the gravity field and rotated to the in plane and out of plane orientation, were double integrated to estimate the time varying displacement of the pups. Statistics (Max, Min, Mean STDV and mean zero crossing period) were extracted from the time histories.

The results exhibited large excursions in the in plane motions at periods well in excess of the excitation period. We believe that these excursions are erroneous and due to an artifact in the double integration routine.

Nonetheless, we carried out a comparison with the ROV Video records for the case of a 3 foot amplitude and 3 second excitation period. using the power spectral density function for the Y displacement of Pup 5 where we had video coverage, we extracted an estimate of the out of plane motions, ignoring the large spike at 0.1 Hz. A substantial response is observed at 3 seconds, another at 1.5 seconds and another at 1 second. At three seconds the spectral peak is 0.19 ft^2-sec. This corresponds to a an rms displacement of 0.0844 feet. At 1.5 seconds, the displacement is .045 ft rms and at 1 second, an rms of 0.04 ft. The total displacement rms is 0.1 feet. The significant motion is 0.4 feet or approximately 3 diameters. This agrees with the visual observations made during these tests.

The time series, statistics sheet, and PSD plots for both these conditions are given in Appendix C. The complete statistics output for the pup motions for each riser configuration is given on the CD-ROM.

Visual observations at the surface and at the ROV indicate a low frequency sub-harmonic riser motion which bears careful analysis.

Additional review of the integrated data indicate that the frequency domain based integration routine used here has introduced some large amplitude, low frequency artifacts. This appears to affect the in-plane (X) motions more than the out of plane motions. The original cut off frequency for the integration routine was based on the double integrated actuator heave and selected to produce a clean displacement that was not significantly attenuated. The cut off frequency chosen was 0.08 Hz. This value was used to process several records and appeared to work well over the range of tested periods. Further examination of the pup displacement data indicates that many test records are too short to use such a low cut off frequency, which will result in larger than expected position values from the double integration routine. Examination of the PSDs provided in Appendix C as an example of the amount of low frequency content of the response which may affect the result.

The statistics and time series for the In-Plane (X) position responses are highly suspect, and should not be used without further analysis. Filtering to remove a response at f < 0.2 Hz should provide a satisfactory results. Time histories for the

Table 7-7: Data Cases Specified for Hard Copy Output

Case	Period (s)	Amplitude (ft)	Amplitude Orientation
CVAR 1	10	3.0	Vertical
CVAR 2	3	3.0	Vertical
SCR 1	10	3.0	Vertical
SCR 2	7	3.0	Vertical
SCR 3	5	3.0	Vertical
SCR 4	3	3.0	Vertical
SCR 5	3	3.5	Horizontal @45°
LW 1	10	4.0	Vertical
LW 2	3.5	4.0	Vertical

7.3.8 Description of File Formats

7.3.8.1 Calibration Files

The calibration files are in a text format which may be read by any text editor, such as Notepad. These files contain all the information necessary to convert the associated raw data file into engineering units. An example of a calibration file is given in Appendix E. Calibration files are recorded for each raw data record to ensure that the proper calibration values are available for later data reduction. All calibration files are provided with their matching raw data on the CD-ROMs.

7.3.8.2 Constants Files

The constants files are used to providing constant values for use in the data reduction equations that a user may wish to alter. These include information such as static rotation offset and tilt and pup depth. These files are also in a text format. An example of a constants file is given in Appendix F. All constants files are provided with their matching raw data on the CD-ROMs.

7.3.8.3 Data File

Data files are recorded in a binary format to minimize storage requirements. These binary files may be unpacked into either a Matlab format or into an ASCII CSV format file by using the appropriate routine. All raw data files are included on the Raw Data CD-ROM.

8 Commentary on System Performance

8.1 Riser Handling Equipment

In general, the riser handling equipment functioned very well. The slips, elevator, and trolley system all worked as designed.

8.2 Actuator

The actuator performed reasonably well, with total harmonic distortion based on power of 0.2%. Due to design changes made to increase the load capacity and stiffness of the subcarriage which were not reflected in the outer frame, the clearance for the 4 foot stroke is very small. The subcarriage and frame actually came in contact once during the LWSCR tests, resulting in some fractured welds and down time to repair the damage.

Additionally, the rigid shaft connections caused some alignment problems.

The control system appeared to have sufficient power and capability to meet the needs of this test program.

8.3 Data Acquisition System

The data acquisition system functioned well during these tests.

8.4 Instrumentation

The barge and actuator mounted instruments functioned quite well, with the exception of the sway axis accelerometer which failed during the SCR tests.

The electrical connection system in the riser was a source of significant problems. Bad cables, difficult to make connections, and delicate wire all combined to make this the primary source of delay and frustration during the tests. On the SCR (last configuration tested), it was necessary to replace most of the separate cables from the number 2 pup to the surface with a single piece of wire strung through all of the joints.

8.5 GPS

The GPS system was never able to provide centimeter level accuracies due to high horizon masking which resulted in less than optimum satellite acquisition. Sub-meter accuracy levels were achieved, as long as the barge moor was tensioned to at least 5 KIPS, which was sufficient for positioning the riser anchors and barge.

Appendix A

Riser Calibration Files

44	PUP 4 Acc Y Bot	ft/s^2	-0.05426500	111.930000	120.0	-120.0	2.000	DA	0	0.000
45	PUP 4 Acc X Bot	ft/s^2	0.05379700	-110.560000	120.0	-120.0	2.000	DA	0	0.000
46	PUP 4 Temperature	degC	-0.01679936	59.802548	59.4	-9.4	2.000	DA	0	0.000
47	PUP 5 Acc Y Top	ft/s^2	0.05278000	-108.480000	120.0	-120.0	2.000	DA	0	0.000
48	PUP 5 Acc X Top	ft/s^2	0.05532100	-112.600000	120.0	-120.0	2.000	DA	0	0.000
49	PUP 5 Bending X	ft-lbs	-0.19956840	409.124700	600.0	-600.0	2.000	DA	0	0.000
50	PUP 5 Bending Y	ft-lbs	-0.19634320	399.371500	600.0	-600.0	2.000	DA	0	0.000
51	PUP 5 Tension	lbs	-1.15675825	2406.773000	2500.0	-2500.0	2.000	DA	0	0.000
52	PUP 5 Acc Y Bot	ft/s^2	-0.05350500	109.510000	120.0	-120.0	2.000	DA	0	0.000
53	PUP 5 Acc X Bot	ft/s^2	0.05260600	-107.100000	120.0	-120.0	2.000	DA	0	0.000
54	PUP 5 Temperature	degC	-0.01697506	59.609010	59.4	-9.4	2.000	DA	0	0.000
55	PUP 6 Acc Y Top	ft/s^2	0.05349100	-109.660000	120.0	-120.0	2.000	DA	0	0.000
56	PUP 6 Acc X Top	ft/s^2	0.05488100	-112.700000	120.0	-120.0	2.000	DA	0	0.000
57	PUP 6 Bending X	ft-lbs	-0.19660670	401.967100	600.0	-600.0	2.000	DA	0	0.000
58	PUP 6 Bending Y	ft-lbs	-0.19710000	402.816100	600.0	-600.0	2.000	DA	0	0.000
59	PUP 6 Tension	lbs	-1.18540905	2497.567000	2500.0	-2500.0	2.000	DA	0	0.000
60	PUP 6 Acc Y Bot	ft/s^2	-0.05346800	109.450000	120.0	-120.0	2.000	DA	0	0.000
61	PUP 6 Acc X Bot	ft/s^2	0.05261200	-105.020000	120.0	-120.0	2.000	DA	0	0.000
62	PUP 6 Temperature	degC	-0.01674603	59.881905	59.4	-9.4	2.000	DA	0	0.000
63	PUP 7 Acc Y Top	ft/s^2	0.05230500	-106.240000	120.0	-120.0	2.000	DA	0	0.000
64	PUP 7 Acc X Top	ft/s^2	0.05338800	-110.060000	120.0	-120.0	2.000	DA	0	0.000
65	PUP 7 Bending X	ft-lbs	-0.19728750	403.913200	600.0	-600.0	2.000	DA	0	0.000
66	PUP 7 Bending Y	ft-lbs	-0.19604970	403.143600	600.0	-600.0	2.000	DA	0	0.000
67	PUP 7 Tension	lbs	-1.17045370	2418.480000	2500.0	-2500.0	2.000	DA	0	0.000
68	PUP 7 Acc Y Bot	ft/s^2	-0.05397300	112.420000	120.0	-120.0	2.000	DA	0	0.000
69	PUP 7 Acc X Bot	ft/s^2	0.05376100	-110.570000	120.0	-120.0	2.000	DA	0	0.000
70	PUP 7 Temperature	degC	-0.01671949	60.523296	59.4	-9.4	2.000	DA	0	0.000
71	PUP 8 Acc Y Top	ft/s^2	0.05434300	-112.160000	120.0	-120.0	2.000	DA	0	0.000
72	PUP 8 Acc X Top	ft/s^2	0.05211100	-107.320000	120.0	-120.0	2.000	DA	0	0.000
73	PUP 8 Bending X	ft-lbs	-0.19479080	399.144930	600.0	-600.0	2.000	DA	0	0.000
74	PUP 8 Bending Y	ft-lbs	-0.20505080	418.713740	600.0	-600.0	2.000	DA	0	0.000
75	PUP 8 Tension	lbs	-1.14837950	2338.157500	2500.0	-2500.0	2.000	DA	0	0.000
76	PUP 8 Acc Y Bot	ft/s^2	-0.05536300	112.920000	120.0	-1200.0	2.000	DA	0	0.000
77	PUP 8 Acc X Bot	ft/s^2	0.05510000	-113.510000	120.0	-1200.0	2.000	DA	0	0.000
78	PUP 8 Temperature	degC	-0.01674603	59.881905	59.4	-9.4	2.000	DA	0	0.000
-1	Actuator Heave Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-2	Barge Surge Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-3	Barge Sway Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-4	Barge Heave Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-5	PUP 1 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-6	PUP 1 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-7	PUP 1 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-8	PUP 1 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-9	PUP 1 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-10	PUP 1 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-11	PUP 1 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-12	PUP 1 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-13	PUP 1 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-14	PUP 1 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-15	PUP 2 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-16	PUP 2 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-17	PUP 2 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-18	PUP 2 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-19	PUP 2 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-20	PUP 2 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-21	PUP 2 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-22	PUP 2 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-23	PUP 2 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-24	PUP 2 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-25	PUP 3 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-26	PUP 3 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-27	PUP 3 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-28	PUP 3 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-29	PUP 3 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-30	PUP 3 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-31	PUP 3 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-32	PUP 3 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-33	PUP 3 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-34	PUP 3 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000

```
that should be compared against the THRESHOLD needs to be followed by a
letter corresponding to the desired statistic (A,R,X,M,D and S). When
more than one channel in selected, any one channel above the THRESHOLD
will cause all channels to be saved.
```

LWSCR Calibration File

```
HCR JIP Monitoring System
CIO-DAS08 14 300 IRQ7 8.319735 330 Y
1                      <-- Number of Secondary Devices Following
SER-STIM 64 COM2 57600 nodeid.txt chancdw.txt
84                     <-- Number of Derived Channels
40.000000                  <-- SampleRate (Hz)
S                      <--  Storage  Mode:  (C)ontinuous;  (T)hreshold;  (O)p  Control;  (I)nterval;
(S)tart/Stop
0                      <-- Storage Length (minutes): Threshold & Operator Control Storage Mode only
0                      <-- Interval Modulus (every Nth Process Interval) - Interval Storage mode only
Y                      <-- Statistical Calculations - (Y)es or (N)o
N                      <-- Statistical Threshold Checking - (Y)es or (N)o - Continue & Interval mode only
0                      <-- Number of sample to skip when plotting (0 for no skips)
5                      <-- Process Interval (1,2,3,4,5,6,10,12,15,20,30,60)
N                      <-- Transmit Data COM2 - (Y)es or (N)o
0                      <-- Number of samples to skip when transmitting (0 for no skips)
Y                      <-- Store SYSTEM log entries - (Y)es or (N)o
c:\hcrdata     <-- Data Storage Path
---------------------------------------------------------------------------------------------------------
---------
 CH# <-CHANNEL NAME-----------> <UNITS--> <-SLOPE    INTERCEPT MAXSCALE MINSCALE DELTA STAT TX THRESHOLD
TRIGGER
---------------------------------------------------------------------------------------------------------
---------
```

CH#	CHANNEL NAME	UNITS	SLOPE	INTERCEPT	MAXSCALE	MINSCALE	DELTA	STAT	TX	THRESHOLD
1	Actuator Load	lbs	-2.65350000	5450.800000	5500.0	-5500.0	10.000	DA	0	0.000
2	Pipe Pitch	deg	-0.01488969	30.145012	30.0	-30.0	2.000	DA	0	0.000
3	Pipe Pitch Rate	deg/s	-0.01488969	30.145012	30.0	-30.0	2.000	DA	0	0.000
4	Pipe Roll	deg	0.01495879	-29.774636	30.0	-30.0	2.000	DA	0	0.000
5	Pipe Roll Rate	deg/s	0.01495879	-29.774636	30.0	-30.0	2.000	DA	0	0.000
6	Accuator Heave Acc	ft/s^2	-0.03322709	100.065923	64.3	-64.3	10.000	DA	0	0.000
7	Barge Roll	deg	-0.01471440	30.198833	30.0	-30.0	5.000	DA	0	0.000
8	Barge Roll Rate	deg/s	-0.01471440	30.198833	100.0	-100.0	2.000	DA	0	0.000
9	Barge Pitch	deg	0.01476448	-29.852142	30.0	-30.0	5.000	DA	0	0.000
10	Barge Pitch Rate	deg/s	0.01476448	-29.852142	30.0	-30.0	2.000	DA	0	0.000
11	Barge Surge Acc	ft/s^2	-0.03368494	69.222543	64.3	-64.3	10.000	DA	0	0.000
12	Barge Sway Acc	ft/s^2	-0.03390770	69.111356	64.3	-64.3	10.000	DA	0	0.000
13	Barge Heave Acc	ft/s^2	-0.03402365	101.797669	64.3	-64.3	10.000	DA	0	0.000
14	Empty Channel	lbs	1.00000000	0.000000	4096.0	0.0	2.000	DA	0	0.000
15	PUP 1 Acc Y Top	ft/s^2	-0.05453500	112.390000	120.0	-120.0	2.000	DA	0	0.000
16	PUP 1 Acc X Top	ft/s^2	0.05331600	-111.920000	120.0	-120.0	2.000	DA	0	0.000
17	PUP 1 Bending X	ft-lbs	-0.19290430	394.480030	600.0	-600.0	2.000	DA	0	0.000
18	PUP 1 Bending Y	ft-lbs	-0.19452980	398.832440	600.0	-600.0	2.000	DA	0	0.000
19	PUP 1 Tension	lbs	-1.14062175	2389.581300	2500.0	-2500.0	2.000	DA	0	0.000
20	PUP 1 Acc Y Bot	ft/s^2	0.05552800	-113.450000	120.0	-120.0	2.000	DA	0	0.000
21	PUP 1 Acc X Bot	ft/s^2	0.05370400	-109.810000	120.0	-120.0	2.000	DA	0	0.000
22	PUP 1 Temperature	degC	-0.01679936	60.138535	59.4	-9.4	2.000	DA	0	0.000
23	PUP 2 Acc Y Top	ft/s^2	-0.05443600	110.940000	120.0	-120.0	2.000	DA	0	0.000
24	PUP 2 Acc X Top	ft/s^2	0.05254200	-110.940000	120.0	-120.0	2.000	DA	0	0.000
25	PUP 2 Bending X	ft-lbs	-0.19612230	402.003900	600.0	-600.0	2.000	DA	0	0.000
26	PUP 2 Bending Y	ft-lbs	-0.19929140	408.936500	600.0	-600.0	2.000	DA	0	0.000
27	PUP 2 Tension	lbs	-1.44097200	2362.570200	2500.0	-2500.0	2.000	DA	0	0.000
28	PUP 2 Acc Y Bot	ft/s^2	0.05340300	-108.840000	120.0	-120.0	2.000	DA	0	0.000
29	PUP 2 Acc X Bot	ft/s^2	0.05355900	-108.270000	120.0	-120.0	2.000	DA	0	0.000
30	PUP 2 Temperature	degC	-0.01685304	60.733866	59.4	-9.4	2.000	DA	0	0.000
31	PUP 3 Acc Y Top	ft/s^2	0.05483300	-112.050000	120.0	-120.0	2.000	DA	0	0.000
32	PUP 3 Acc X Top	ft/s^2	0.05557200	-114.520000	120.0	-120.0	2.000	DA	0	0.000
33	PUP 3 Bending X	ft-lbs	-0.19100180	389.925700	600.0	-600.0	2.000	DA	0	0.000
34	PUP 3 Bending Y	ft-lbs	-0.19487710	401.057000	600.0	-600.0	2.000	DA	0	0.000
35	PUP 3 Tension	lbs	-1.10624035	2264.616750	2500.0	-2500.0	2.000	DA	0	0.000
36	PUP 3 Acc Y Bot	ft/s^2	-0.05426500	111.930000	120.0	-120.0	2.000	DA	0	0.000
37	PUP 3 Acc X Bot	ft/s^2	0.05379700	-110.560000	120.0	-120.0	2.000	DA	0	0.000
38	PUP 3 Temperature	degC	-0.01679936	59.802548	59.4	-9.4	2.000	DA	0	0.000

-31	PUP 3 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-32	PUP 3 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-33	PUP 3 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-34	PUP 3 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-35	PUP 4 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-36	PUP 4 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-37	PUP 4 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-38	PUP 4 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-39	PUP 4 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-40	PUP 4 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-41	PUP 4 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-42	PUP 4 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-43	PUP 4 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-44	PUP 4 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-45	PUP 5 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-46	PUP 5 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-47	PUP 5 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-48	PUP 5 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-49	PUP 5 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-50	PUP 5 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-51	PUP 5 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-52	PUP 5 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-53	PUP 5 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-54	PUP 5 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-55	PUP 6 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-56	PUP 6 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-57	PUP 6 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-58	PUP 6 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-59	PUP 6 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-60	PUP 6 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-61	PUP 6 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-62	PUP 6 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-63	PUP 6 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-64	PUP 6 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-65	PUP 7 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-66	PUP 7 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-67	PUP 7 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-68	PUP 7 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-69	PUP 7 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-70	PUP 7 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-71	PUP 7 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-72	PUP 7 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-73	PUP 7 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-74	PUP 7 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-75	PUP 8 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-76	PUP 8 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-77	PUP 8 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-78	PUP 8 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-79	PUP 8 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-80	PUP 8 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-81	PUP 8 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-82	PUP 8 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-83	PUP 8 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-84	PUP 8 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000

```
Notes:
    STAT has the following format: xy where
        x is the processing interval to use
            D - Display Stats
            P - PROCINT Stats
            T - Test Stats
        y is the statistic
            A - Average (mean)
            R - Standard deviation
            X - maXimum
            M - Minimum
            D - Double Amplitude Significant (4 X Stdev)
            S - Single Amplitude Significant (2 X Stdev)
      i.e. PA is the Average over the PROCINT processing interval
```

34	PUP 3 Bending Y	ft-lbs	-0.19487710	401.057000	600.0	-600.0	2.000	DA	0	0.000
35	PUP 3 Tension	lbs	-2.21248070	4529.233500	1000.0	-1000.0	2.000	DA	0	0.000
36	PUP 3 Acc Y Bot	ft/s^2	-0.05426500	111.930000	120.0	-120.0	2.000	DA	0	0.000
37	PUP 3 Acc X Bot	ft/s^2	0.05379700	-110.560000	120.0	-120.0	2.000	DA	0	0.000
38	PUP 3 Temperature	degC	-0.01679936	59.802548	59.4	-9.4	2.000	DA	0	0.000
39	PUP 4 Acc Y Top	ft/s^2	0.05278000	-108.480000	120.0	-120.0	2.000	DA	0	0.000
40	PUP 4 Acc X Top	ft/s^2	0.05532100	-112.600000	120.0	-120.0	2.000	DA	0	0.000
41	PUP 4 Bending X	ft-lbs	-0.19956840	409.124700	600.0	-600.0	2.000	DA	0	0.000
42	PUP 4 Bending Y	ft-lbs	-0.19634320	399.371500	600.0	-600.0	2.000	DA	0	0.000
43	PUP 4 Tension	lbs	-2.31351650	4813.546000	1000.0	-1000.0	2.000	DA	0	0.000
44	PUP 4 Acc Y Bot	ft/s^2	-0.05350500	109.510000	120.0	-120.0	2.000	DA	0	0.000
45	PUP 4 Acc X Bot	ft/s^2	0.05260600	-107.100000	120.0	-120.0	2.000	DA	0	0.000
46	PUP 4 Temperature	degC	-0.01697506	59.609010	59.4	-9.4	2.000	DA	0	0.000
47	PUP 5 Acc Y Top	ft/s^2	0.05349100	-109.660000	120.0	-120.0	2.000	DA	0	0.000
48	PUP 5 Acc X Top	ft/s^2	0.05488100	-112.700000	120.0	-120.0	2.000	DA	0	0.000
49	PUP 5 Bending X	ft-lbs	-0.19660670	401.967100	600.0	-600.0	2.000	DA	0	0.000
50	PUP 5 Bending Y	ft-lbs	-0.19710000	402.816100	600.0	-600.0	2.000	DA	0	0.000
51	PUP 5 Tension	lbs	-2.37081810	4995.134000	1000.0	-1000.0	2.000	DA	0	0.000
52	PUP 5 Acc Y Bot	ft/s^2	-0.05346800	109.450000	120.0	-120.0	2.000	DA	0	0.000
53	PUP 5 Acc X Bot	ft/s^2	0.05261200	-105.020000	120.0	-120.0	2.000	DA	0	0.000
54	PUP 5 Temperature	degC	-0.01674603	59.881905	59.4	-9.4	2.000	DA	0	0.000
55	PUP 6 Acc Y Top	ft/s^2	0.05230500	-106.240000	120.0	-120.0	2.000	DA	0	0.000
56	PUP 6 Acc X Top	ft/s^2	0.05338800	-110.060000	120.0	-120.0	2.000	DA	0	0.000
57	PUP 6 Bending X	ft-lbs	-0.19728750	403.913200	600.0	-600.0	2.000	DA	0	0.000
58	PUP 6 Bending Y	ft-lbs	-0.19604970	403.143600	600.0	-600.0	2.000	DA	0	0.000
59	PUP 6 Tension	lbs	-2.34090740	4836.960000	1000.0	-1000.0	2.000	DA	0	0.000
60	PUP 6 Acc Y Bot	ft/s^2	-0.05397300	112.420000	120.0	-120.0	2.000	DA	0	0.000
61	PUP 6 Acc X Bot	ft/s^2	0.05376100	-110.570000	120.0	-120.0	2.000	DA	0	0.000
62	PUP 6 Temperature	degC	-0.01671949	60.523296	59.4	-9.4	2.000	DA	0	0.000
63	PUP 7 Acc Y Top	ft/s^2	0.05403000	-112.390000	120.0	-120.0	2.000	DA	0	0.000
64	PUP 7 Failed X Top	ft/s^2	0.55259000	-113.210000	120.0	-120.0	2.000	DA	0	0.000
65	PUP 7 Bending X	ft-lbs	-0.21199280	435.251413	600.0	-600.0	2.000	DA	0	0.000
66	PUP 7 Bending Y	ft-lbs	-0.19400710	398.407404	600.0	-600.0	2.000	DA	0	0.000
67	PUP 7 Tension	lbs	-2.28819440	4725.140470	1000.0	-1000.0	2.000	DA	0	0.000
68	PUP 7 Acc Y Bot	ft/s^2	-0.05340300	108.840000	120.0	-120.0	2.000	DA	0	0.000
69	PUP 7 Acc X Bot	ft/s^2	0.05355900	-108.270000	120.0	-120.0	2.000	DA	0	0.000
70	PUP 7 Temperature	degC	-0.01679936	59.466561	59.4	-9.4	2.000	DA	0	0.000
71	PUP 8 Acc Y Top	ft/s^2	0.05434300	-112.160000	120.0	-120.0	2.000	DA	0	0.000
72	PUP 8 Acc X Top	ft/s^2	0.05211100	-107.320000	120.0	-120.0	2.000	DA	0	0.000
73	PUP 8 Bending X	ft-lbs	-0.19479080	399.144930	600.0	-600.0	2.000	DA	0	0.000
74	PUP 8 Bending Y	ft-lbs	-0.20505080	418.713740	600.0	-600.0	2.000	DA	0	0.000
75	PUP 8 Tension	lbs	-2.29675900	4676.315000	1000.0	-1000.0	2.000	DA	0	0.000
76	PUP 8 Acc Y Bot	ft/s^2	-0.05536300	112.920000	120.0	-1200.0	2.000	DA	0	0.000
77	PUP 8 Acc X Bot	ft/s^2	0.05510000	-113.510000	120.0	-1200.0	2.000	DA	0	0.000
78	PUP 8 Temperature	degC	-0.01674603	59.881905	59.4	-9.4	2.000	DA	0	0.000
-1	Actuator Heave Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-2	Barge Surge Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-3	Barge Sway Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-4	Barge Heave Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-5	PUP 1 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-6	PUP 1 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-7	PUP 1 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-8	PUP 1 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-9	PUP 1 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-10	PUP 1 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-11	PUP 1 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-12	PUP 1 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-13	PUP 1 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-14	PUP 1 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-15	PUP 2 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-16	PUP 2 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-17	PUP 2 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-18	PUP 2 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-19	PUP 2 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-20	PUP 2 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-21	PUP 2 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-22	PUP 2 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-23	PUP 2 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-24	PUP 2 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-25	PUP 3 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000

```
      M - Minimum
      D - Double Amplitude Significant (4 X Stdev)
      S - Single Amplitude Significant (2 X Stdev)
   i.e. PA is the Average over the PROCINT processing interval

THRESHOLD is used for Threshold Storage Mode and Statistical Threshold
   Checking. When using Threshold Storage Mode, any channel that should
   be compared against the THRESHOLD needs to be followed by the letter
   'T'. When using Statistical Threshold Checking, any channel's statistics
   that should be compared against the THRESHOLD needs to be followed by a
   letter corresponding to the desired statistic (A,R,X,M,D and S). When
   more than one channel in selected, any one channel above the THRESHOLD
   will cause all channels to be saved.
```

Appendix B

Load Cell Calibration Certification Sheet

CERTIFICATE OF CALIBRATION

This certifies that the following **LOAD CELL** was calibrated in accordance with applicable FUTEK procedures.

CALIBRATION DATA

Model Number......... L2900
Capacity.................... 5000 lbs.
Input Resistance....... 755 Ω
EXCITATION .... 10 VDC
Test Temp................. 70°F (21°C)

I.D. Number....................... 10786
Recommended Range................ 0 to ± 5000 lbs.
Output Resistance................ 703 Ω
ZERO (mV/V) 0.0094
Relative Humidity............... 46%

Units of Applied Load: LB.	LOAD CELL READING (mV/V) Tension	Compression
0	0.0000	0.0000
1000	0.3677	-0.3672
2000	0.7354	-0.7352
3000	1.1046	-1.1043
4000	1.4720	-1.4725
5000	1.8400	-1.8404
0	0.0001	0.0000

CALIBRATION EQUIPMENT

Reference Load Cell and Digital Indicator:

Load Cell FUTEK Model L2355 ..... S/N: 12608 (LO Range)
BLH Model LCc Indicator No. 7260870
System Error does not exceed: .01% for transfer standard
Reference NIST Number: SJT.01/106931
System Cal. Date: Jan 12, 1998 *Next Cal. Date by:* Jan, 1999

digital indicator:

HP Model Number 34401A..........S/N: US36014993
Cal. Date: November 8, 1996 *Next Cal. Date:* November 1998

Supporting documentation relative to traceability is on file and is available for examination upon request.

Calibrated by: B. HANZE

Date of Calibration: ***May 22, 1997*** **Recommended Re-Calibration Date: Apr. 1998**

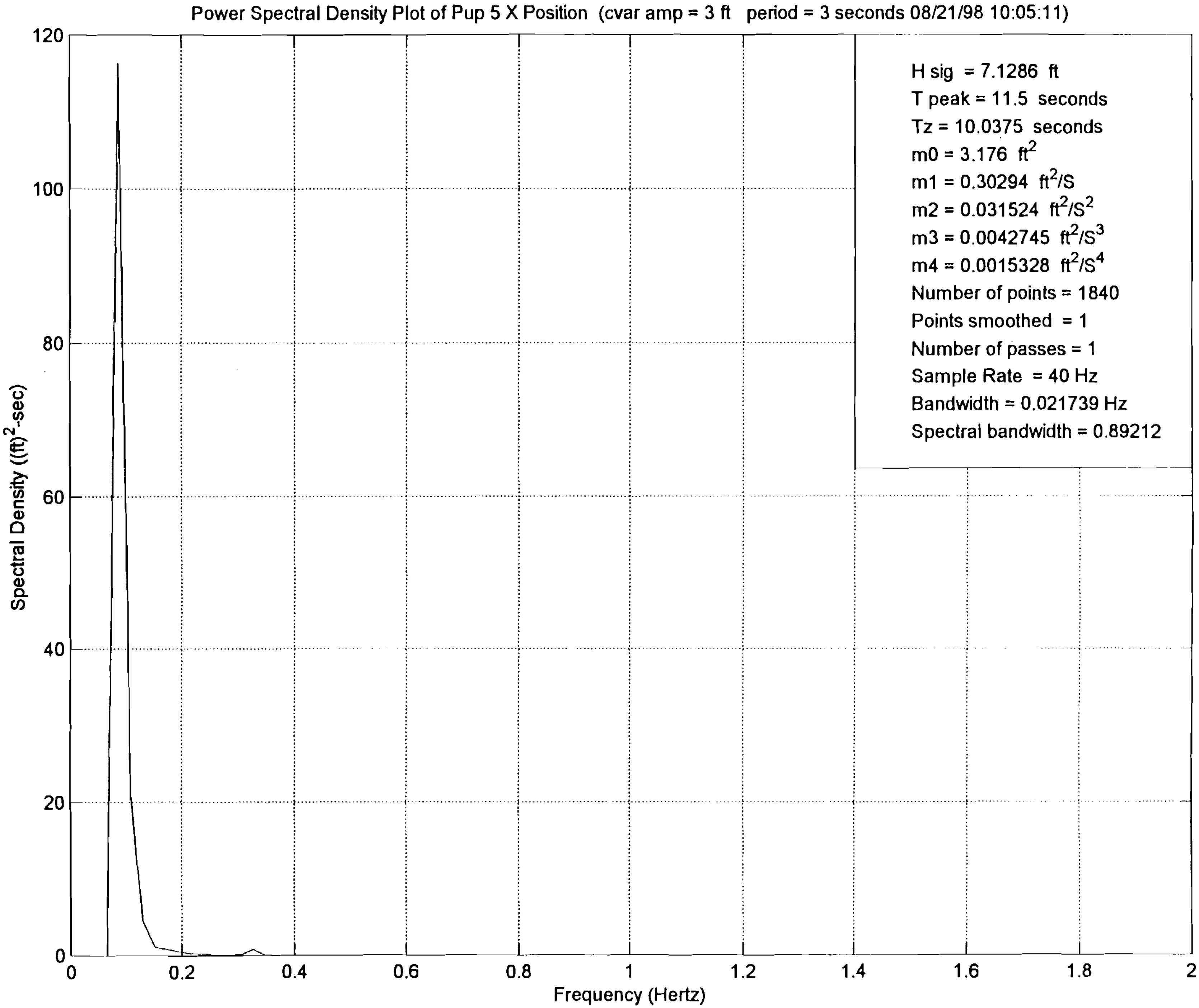
FUTEK ADVANCED SENSOR TECHNOLOGY INC 26052 Merit Circle, Suite 103 Laguna Hills, CA 92653 **TEL: (714) 367-1274**

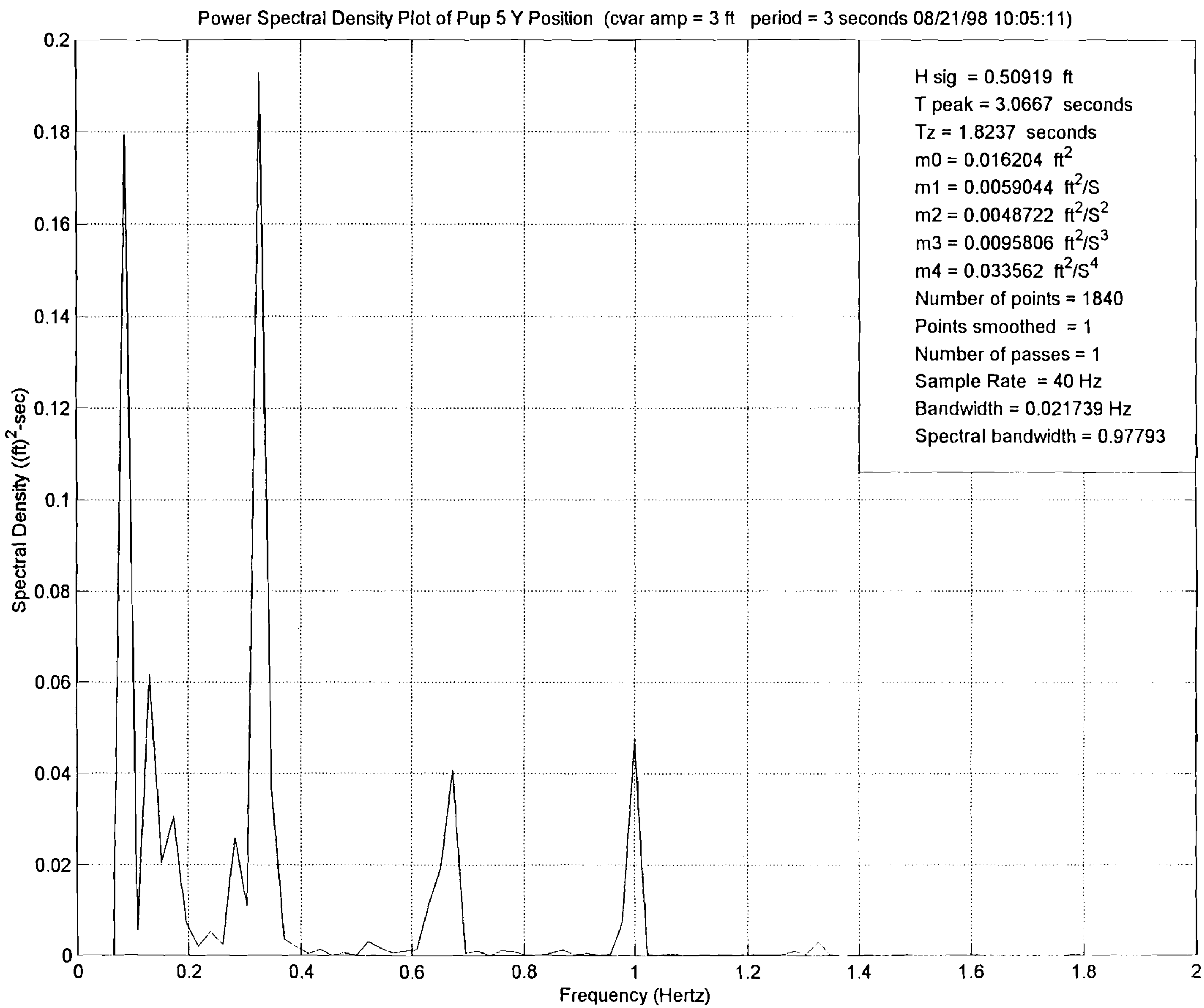
Appendix C

Time Series, PSD Plots, and Statistics Sheets for Select CVAR Motions

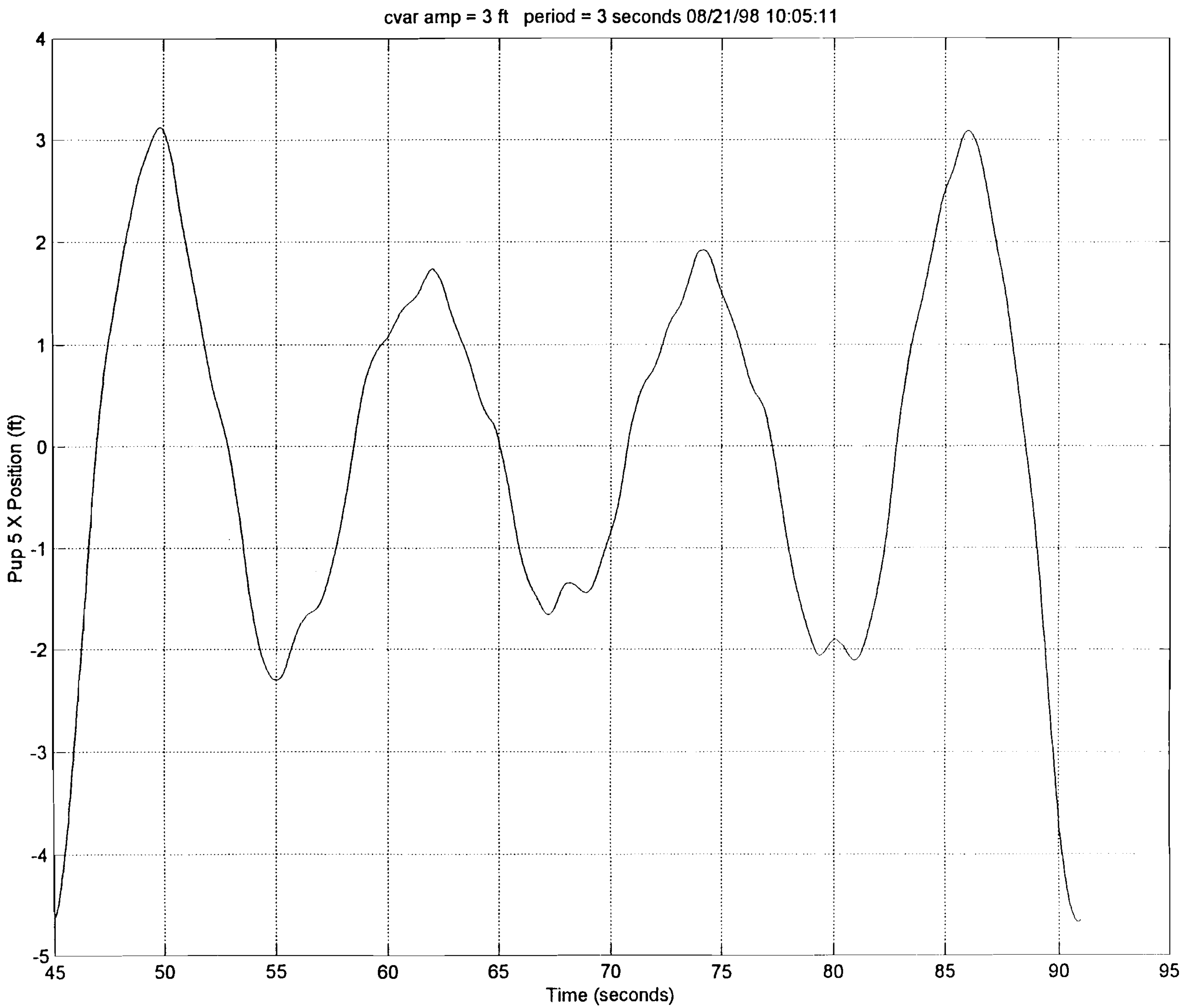
cvar amp = 3 ft   period = 3 seconds 08/21/98 10:05:11

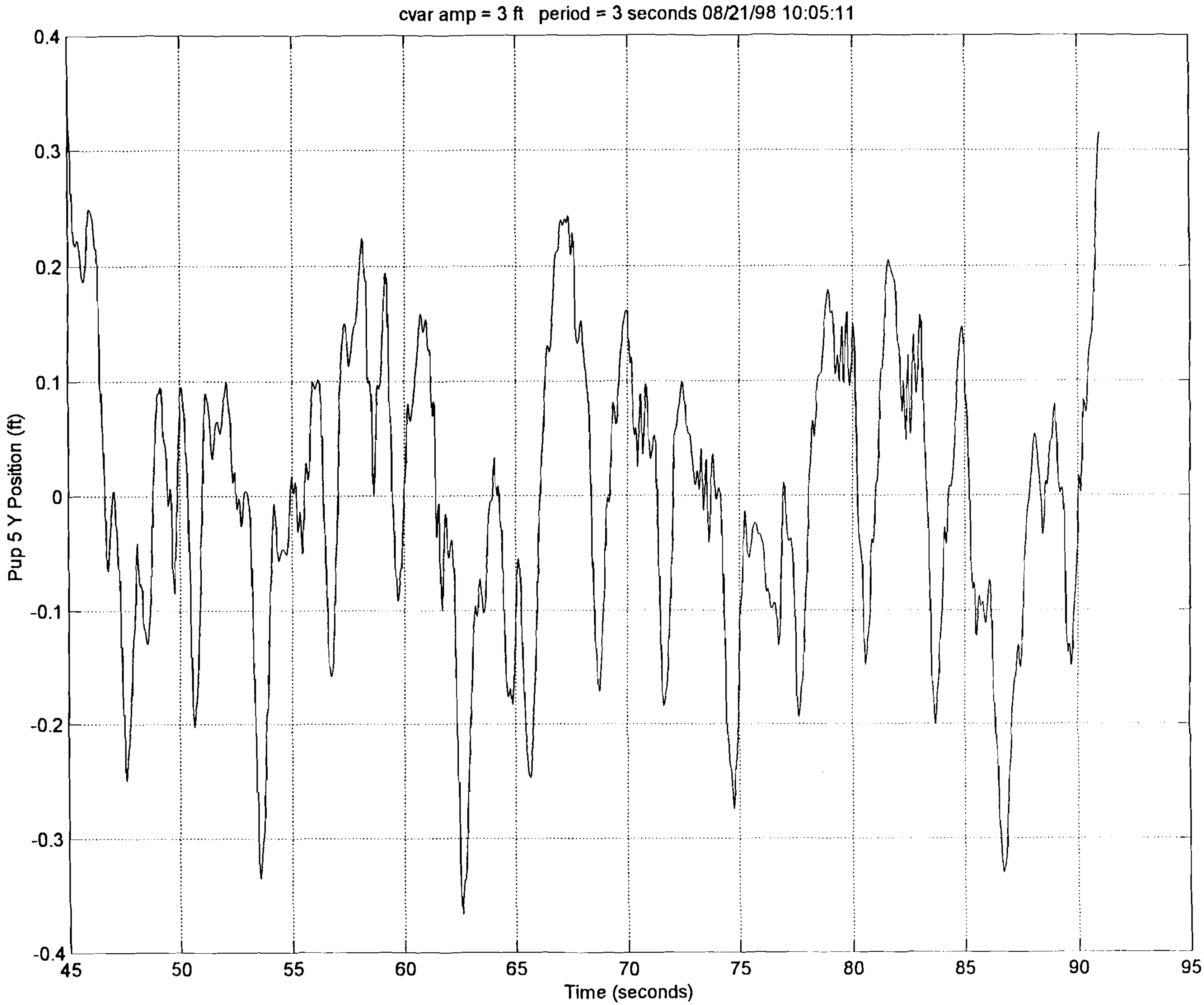
Channel Name	Units	Minimum	Maximum	Mean	Std Dev	Sig Amp	Period
Displacement	ft	-2.7464	2.7464	0.0015	1.9431	2.7464	3.0661
Pup 1 X Acc NOG	ft/s2	18.5837	44.1865	32.1225	5.7883	10.4859	2.0762
Pup 1 Y Acc NOG	ft/s2	-30.8258	43.6655	4.4567	8.3508	20.9845	0.4714
Pup 1 X Position	ft	-11.2622	12.0660	0.0064	6.0667	10.4001	11.7500
Pup 1 Y Position	ft	-1.0958	1.2723	-0.0003	0.6837	1.1174	11.3583
Pup 2 X Acc NOG	ft/s2	15.7106	51.5980	31.6890	7.2620	15.3240	1.6960
Pup 2 Y Acc NOG	ft/s2	-33.8146	27.0374	-2.4012	8.3609	20.1556	0.4634
Pup 2 X Position	ft	-6.8127	10.1330	0.0054	3.7409	6.2796	8.9375
Pup 2 Y Position	ft	-0.4267	0.4232	0.0002	0.1839	0.2593	3.3396
Pup 3 X Acc NOG	ft/s2	15.7851	47.2964	31.6760	7.0225	13.3837	1.9966
Pup 3 Y Acc NOG	ft/s2	-39.5396	37.5952	-2.1834	8.5307	20.9303	0.4624
Pup 3 X Position	ft	-3.7771	3.8288	0.0013	1.7933	2.7113	3.0196
Pup 3 Y Position	ft	-0.2938	0.2844	0.0001	0.1177	0.1505	2.0726
Pup 4 X Acc NOG	ft/s2	20.6425	45.4916	32.1406	5.2842	10.3938	1.9207
Pup 4 Y Acc NOG	ft/s2	-44.5391	43.4034	-0.7843	10.1145	25.5387	0.5000
Pup 4 X Position	ft	-2.1844	3.0469	0.0017	1.2460	1.7458	2.9875
Pup 4 Y Position	ft	-0.2746	0.3890	0.0002	0.1079	0.1545	1.7917
Pup 5 X Acc NOG	ft/s2	27.8267	37.3979	32.3125	1.5509	2.8403	0.7161
Pup 5 Y Acc NOG	ft/s2	-35.8902	30.2074	-2.7766	7.2339	17.7260	0.4727
Pup 5 X Position	ft	-4.6729	3.1243	-0.0025	1.7854	2.7123	11.9500
Pup 5 Y Position	ft	-0.3671	0.3221	0.0002	0.1275	0.2054	2.3736
Pup 6 X Acc NOG	ft/s2	24.4725	40.0220	32.0255	4.3792	6.7837	2.9964
Pup 6 Y Acc NOG	ft/s2	-19.5024	23.7247	1.3899	5.0021	12.2002	0.5279
Pup 6 X Position	ft	-6.4060	5.2542	-0.0033	2.7617	3.8131	7.1350
Pup 6 Y Position	ft	-0.3784	0.5017	0.0001	0.1701	0.2728	2.9714
Pup 7 X Acc NOG	ft/s2	16.5620	97.0067	57.2203	22.7834	33.7681	0.5546
Pup 7 Y Acc NOG	ft/s2	-30.8753	8.9435	-13.8376	5.3361	11.7599	0.6000
Pup 7 X Position	ft	-23.4521	21.1269	-0.0125	13.7436	21.6320	11.5417
Pup 7 Y Position	ft	-0.7416	0.8935	0.0001	0.3693	0.5982	3.0196
Pup 8 X Acc NOG	ft/s2	23.4516	37.4271	32.1866	2.4010	4.2467	1.4062
Pup 8 Y Acc NOG	ft/s2	-17.0120	15.8447	-0.5064	4.1412	9.3596	0.4986
Pup 8 X Position	ft	-4.5134	4.2874	0.0004	2.2709	3.8321	11.6333
Pup 8 [illegible]sition	ft	-0.3707	0[illegible]	0.0000	0.1876	0.2888	[illegible]


Power Spectral Density Plot of Pup 5 X Position (cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11)
H sig = 7.1286 ft
T peak = 11.5 seconds
Tz = 10.0375 seconds
m0 = 3.176 ft^2
m1 = 0.30294 ft^2/S
m2 = 0.031524 ft^2/S^2
m3 = 0.0042745 ft^2/S^3
m4 = 0.0015328 ft^2/S^4
Number of points = 1840
Points smoothed = 1
Number of passes = 1
Sample Rate = 40 Hz
Bandwidth = 0.021739 Hz
Spectral bandwidth = 0.89212
Spectral Density ((ft)^2-sec)
Frequency (Hertz)
0
20
40
60
80
100
120
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2



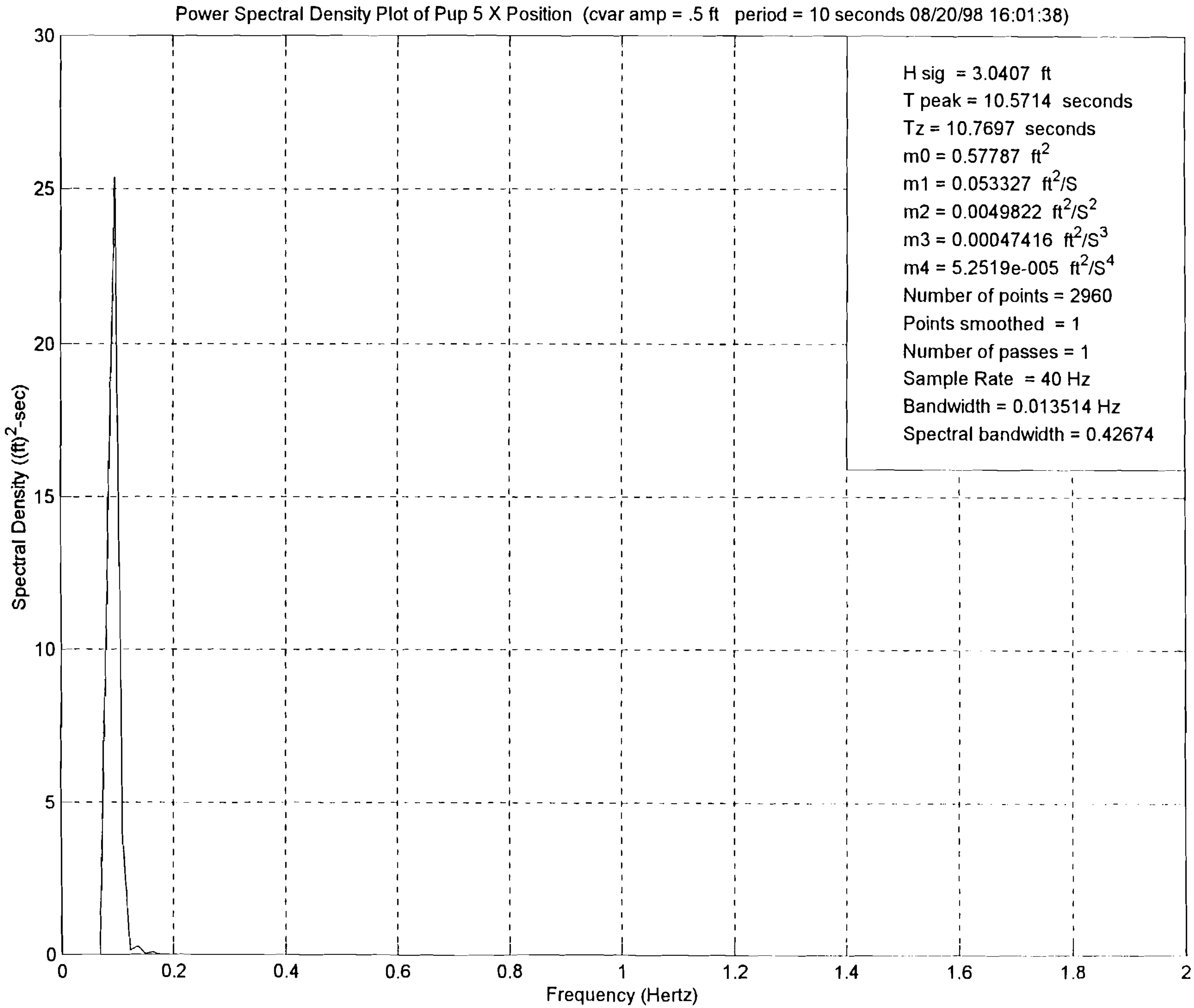
Power Spectral Density Plot of Pup 5 Y Position (cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11)
H sig = 0.50919 ft
T peak = 3.0667 seconds
Tz = 1.8237 seconds
m0 = 0.016204 ft^2
m1 = 0.0059044 ft^2/S
m2 = 0.0048722 ft^2/S^2
m3 = 0.0095806 ft^2/S^3
m4 = 0.033562 ft^2/S^4
Number of points = 1840
Points smoothed = 1
Number of passes = 1
Sample Rate = 40 Hz
Bandwidth = 0.021739 Hz
Spectral bandwidth = 0.97793
Spectral Density ((ft)^2-sec)
Frequency (Hertz)
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2
0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2

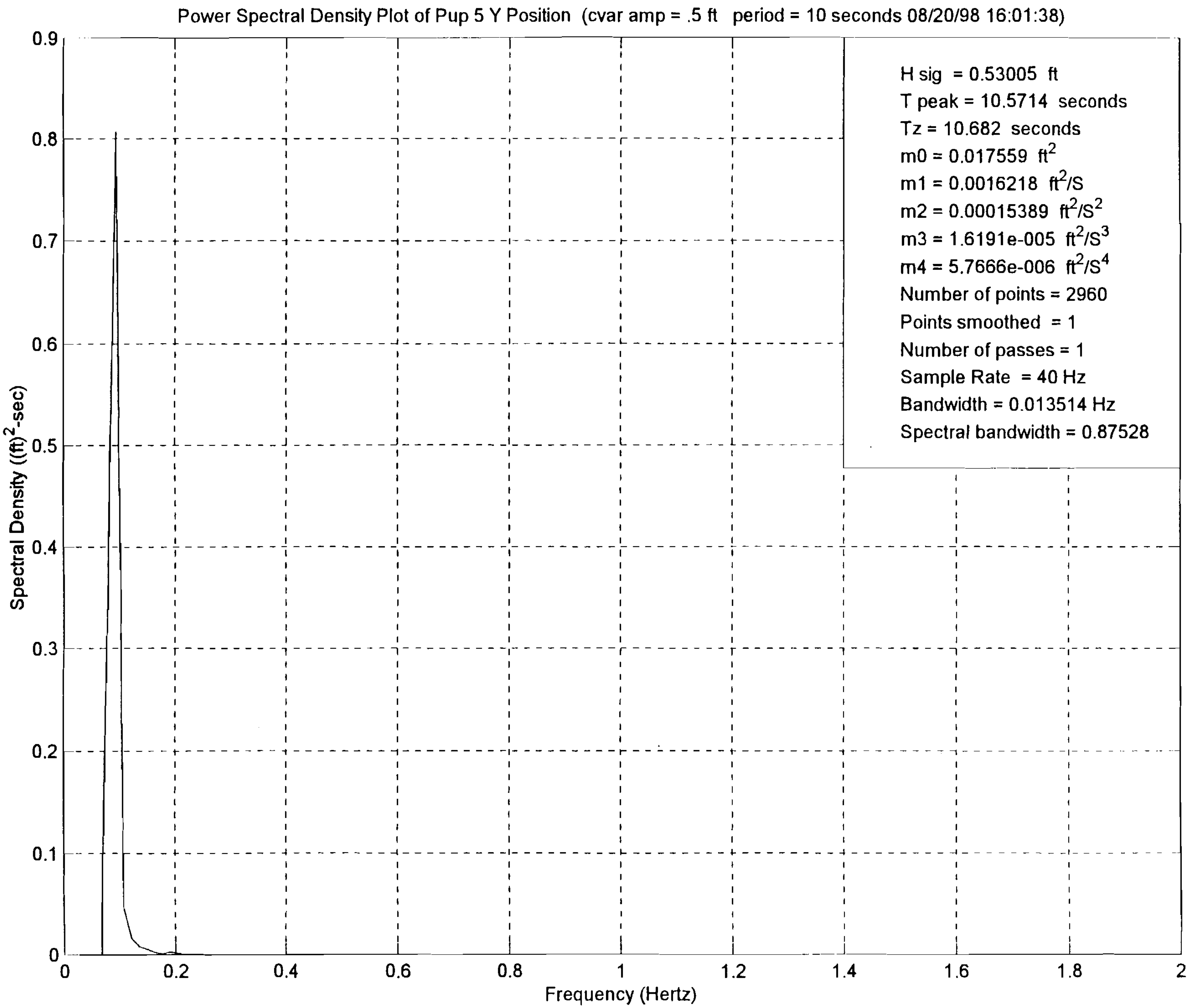

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 5 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
-5
45
50
55
60
65
70
75
80
85
90
95


cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 5 Y Position (ft)
Time (seconds)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
45
50
55
60
65
70
75
80
85
90
95

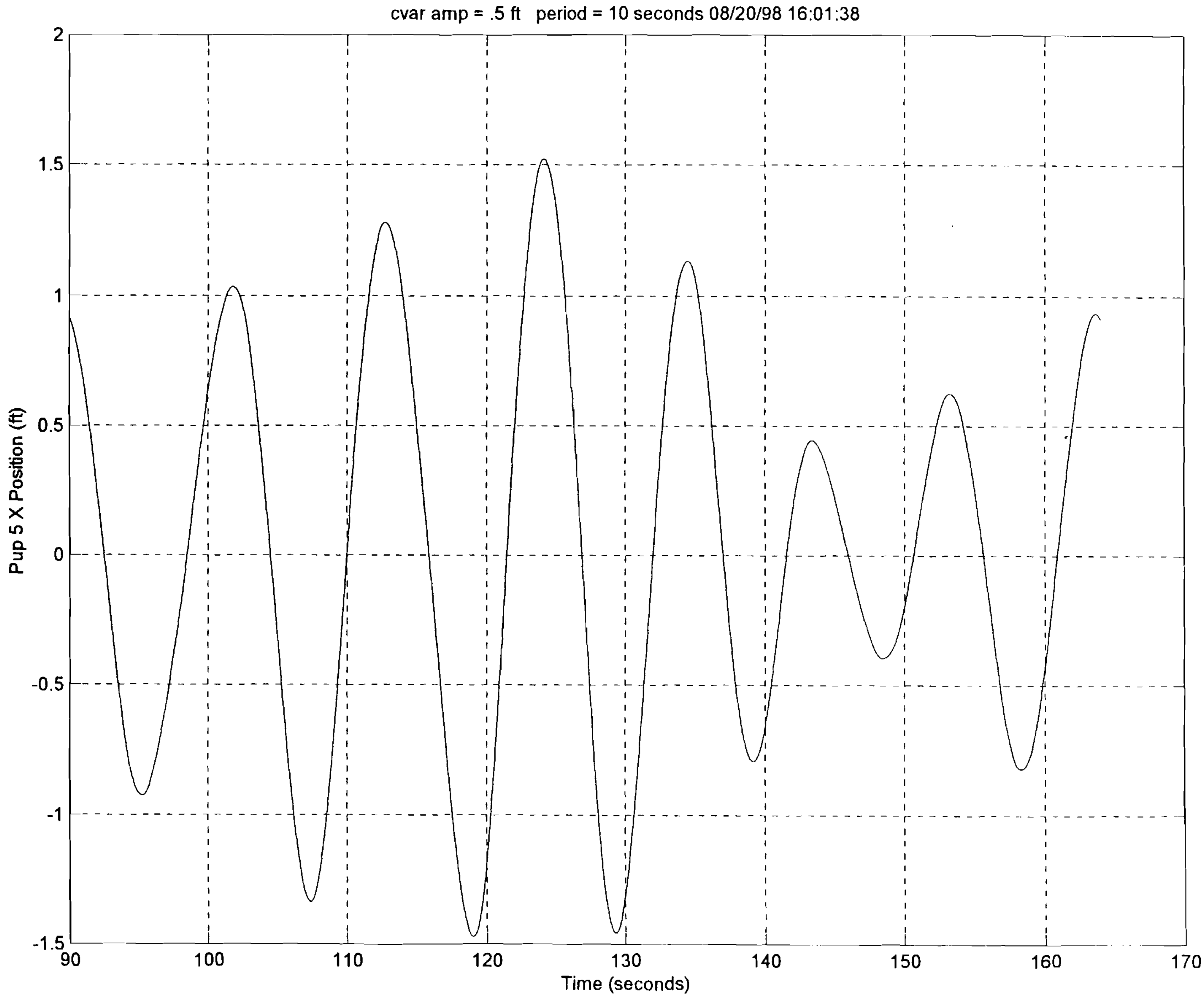
cvar amp = .5 ft   period = 10 seconds 08/20/98 16:01:38

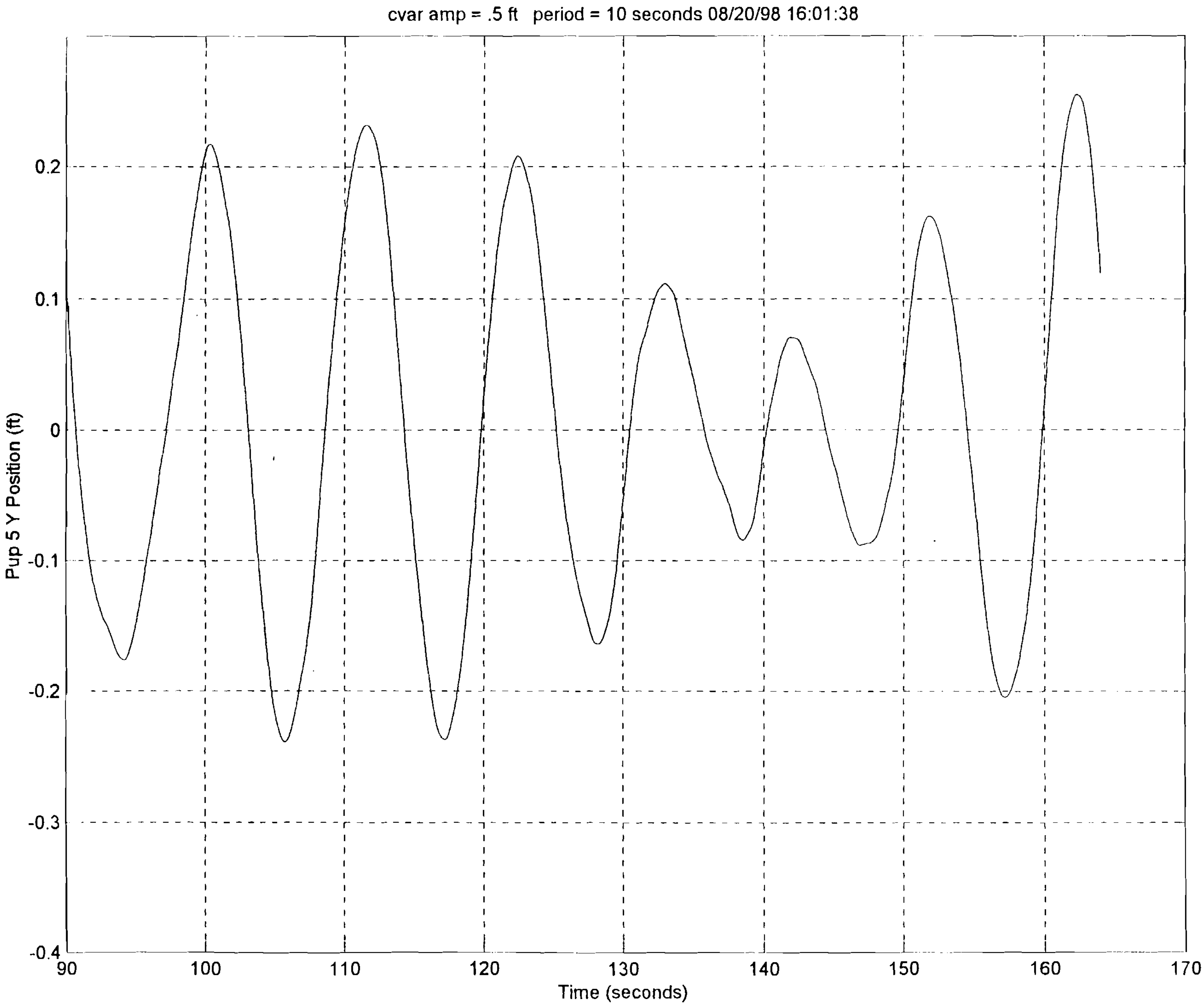
Channel Name	Units	Minimum	Maximum	Mean	Std Dev	Sig Amp	Period
Displacement	ft	-0.4553	0.4553	0.0001	0.3221	0.4553	10.5708
Pup 1 X Acc NOG	ft/s2	30.8039	33.6680	32.1388	0.4694	0.5102	1.0057
Pup 1 Y Acc NOG	ft/s2	3.6658	4.3375	3.9874	0.1058	0.1908	0.6888
Pup 1 X Position	ft	-2.5398	2.5608	0.0004	1.1124	2.2816	10.8250
Pup 1 Y Position	ft	-0.3308	0.2956	0.0000	0.1450	0.2744	10.6125
Pup 2 X Acc NOG	ft/s2	30.6665	33.6155	32.0683	0.5608	0.6629	0.9635
Pup 2 Y Acc NOG	ft/s2	-3.5655	-2.8349	-3.2054	0.1205	0.1841	0.5284
Pup 2 X Position	ft	-3.0011	2.9290	0.0009	1.8156	2.9490	12.3050
Pup 2 Y Position	ft	-0.3536	0.3571	0.0000	0.1598	0.3363	10.7375
Pup 3 X Acc NOG	ft/s2	31.2064	33.2351	32.1265	0.3618	0.5515	0.5492
Pup 3 Y Acc NOG	ft/s2	-1.3573	-0.6037	-0.9807	0.1152	0.1769	0.6404
Pup 3 X Position	ft	-1.7272	1.7689	0.0003	0.9095	1.5355	12.2350
Pup 3 Y Position	ft	-0.1823	0.1960	0.0000	0.0968	0.1779	10.6458
Pup 4 X Acc NOG	ft/s2	31.5817	32.7206	32.1396	0.1976	0.3546	0.3907
Pup 4 Y Acc NOG	ft/s2	0.2569	1.0247	0.6157	0.1280	0.1877	0.6277
Pup 4 X Position	ft	-0.7120	0.7019	0.0001	0.3744	0.6469	12.3800
Pup 4 Y Position	ft	-0.2449	0.2648	0.0000	0.1344	0.2462	10.6333
Pup 5 X Acc NOG	ft/s2	31.4859	33.0351	32.1760	0.2869	0.3117	1.1111
Pup 5 Y Acc NOG	ft/s2	-1.6471	-0.8789	-1.2251	0.1207	0.1766	0.5423
Pup 5 X Position	ft	-1.4710	1.5222	0.0003	0.7604	1.4022	10.5208
Pup 5 Y Position	ft	-0.2386	0.2551	0.0000	0.1325	0.2289	10.6458
Pup 6 X Acc NOG	ft/s2	31.3635	32.9532	32.1351	0.3023	0.3046	1.4886
Pup 6 Y Acc NOG	ft/s2	2.9497	3.5141	3.2248	0.1108	0.1389	0.8444
Pup 6 X Position	ft	-1.8749	1.7954	0.0002	0.9430	1.7251	12.3850
Pup 6 Y Position	ft	-0.3059	0.3173	0.0000	0.1606	0.2884	10.5542
Pup 7 X Acc NOG	ft/s2	24.8204	85.0133	44.8477	18.8240	29.3369	7.6056
Pup 7 Y Acc NOG	ft/s2	-14.0552	-11.9941	-13.2782	0.5073	0.7800	3.9542
Pup 7 X Position	ft	-22.7114	25.4704	0.0056	11.6368	22.9195	5.6833
Pup 7 Y Position	ft	-0.8331	0.7908	0.0002	0.3341	0.6000	6.2250
Pup 8 X Acc NOG	ft/s2	31.1737	33.4103	32.1411	0.4769	0.5672	2.3467
Pup 8 Y Acc NOG	ft/s2	0.4878	0.9644	0.7501	0.0823	0.1307	0.5942
Pup 8 X Position	ft	-2.8166	2.7262	0.0006	1.3861	2.6000	12.4750
Pup 8 Y Position	ft	-0.1535	0.1618	0.0000	0.0712	0.1388	10.2625


Power Spectral Density Plot of Pup 5 X Position (cvar amp = .5 ft period = 10 seconds 08/20/98 16:01:38)
H sig = 3.0407 ft
T peak = 10.5714 seconds
Tz = 10.7697 seconds
m0 = 0.57787 ft2
m1 = 0.053327 ft2/S
m2 = 0.0049822 ft2/S2
m3 = 0.00047416 ft2/S3
m4 = 5.2519e-005 ft2/S4
Number of points = 2960
Points smoothed = 1
Number of passes = 1
Sample Rate = 40 Hz
Bandwidth = 0.013514 Hz
Spectral bandwidth = 0.42674
Spectral Density ((ft)2-sec)
Frequency (Hertz)
0
5
10
15
20
25
30
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2



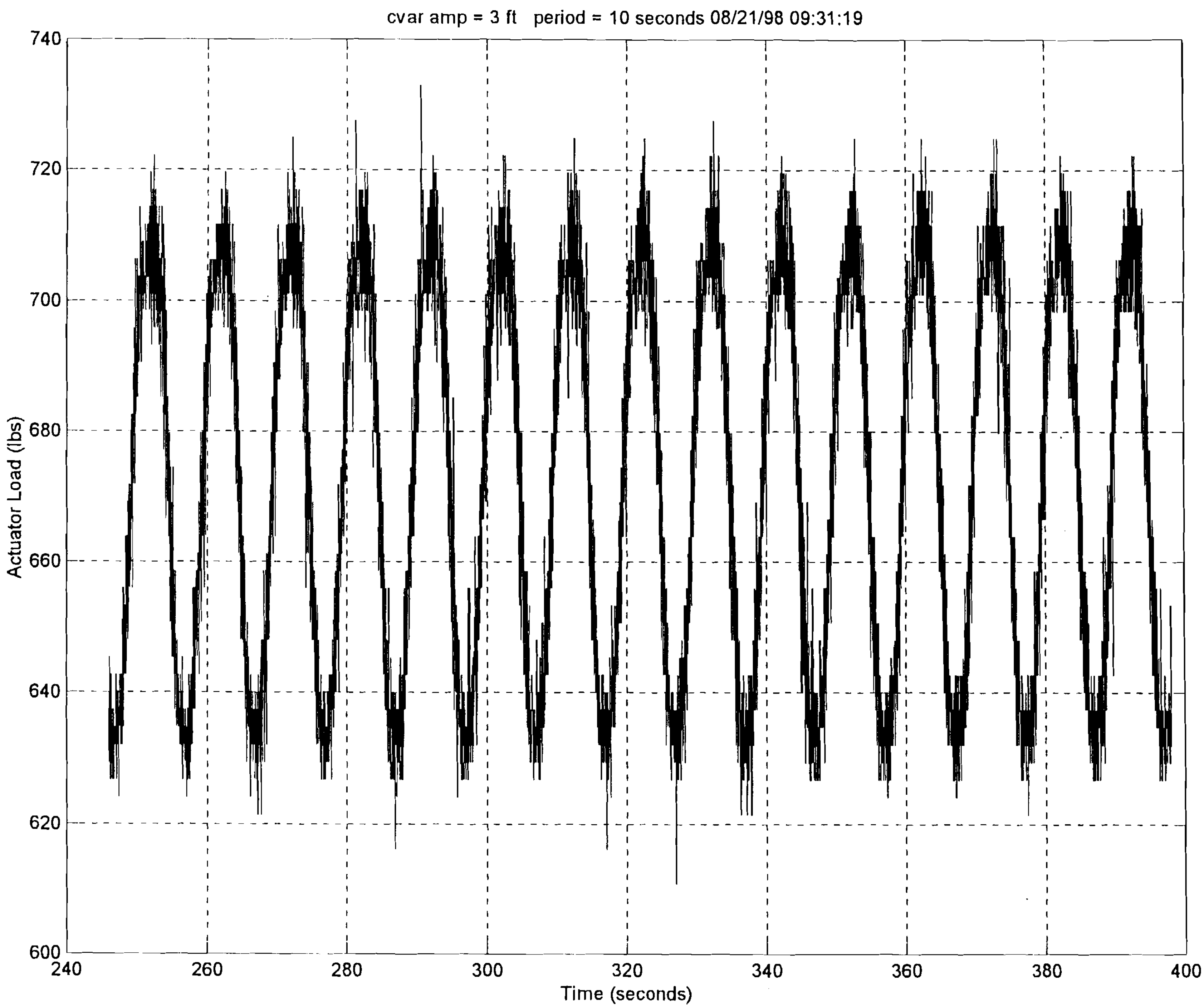
Power Spectral Density Plot of Pup 5 Y Position (cvar amp = .5 ft period = 10 seconds 08/20/98 16:01:38)
H sig = 0.53005 ft
T peak = 10.5714 seconds
Tz = 10.682 seconds
m0 = 0.017559 ft^2
m1 = 0.0016218 ft^2/S
m2 = 0.00015389 ft^2/S^2
m3 = 1.6191e-005 ft^2/S^3
m4 = 5.7666e-006 ft^2/S^4
Number of points = 2960
Points smoothed = 1
Number of passes = 1
Sample Rate = 40 Hz
Bandwidth = 0.013514 Hz
Spectral bandwidth = 0.87528
Spectral Density ((ft)^2-sec)
Frequency (Hertz)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

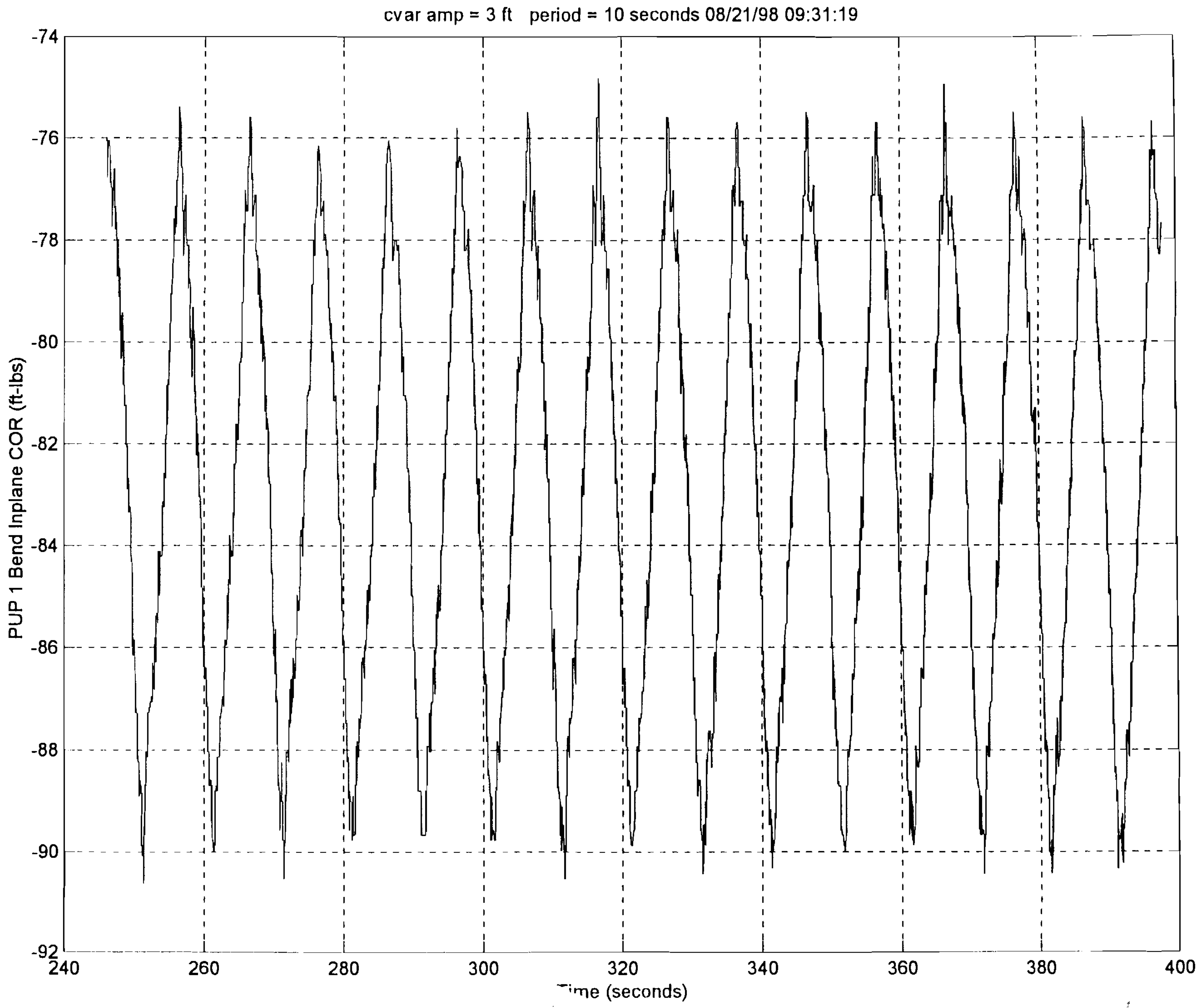

cvar amp = .5 ft period = 10 seconds 08/20/98 16:01:38
Pup 5 X Position (ft)
2
1.5
1
0.5
0
-0.5
-1
-1.5
90
100
110
120
130
140
150
160
170
Time (seconds)

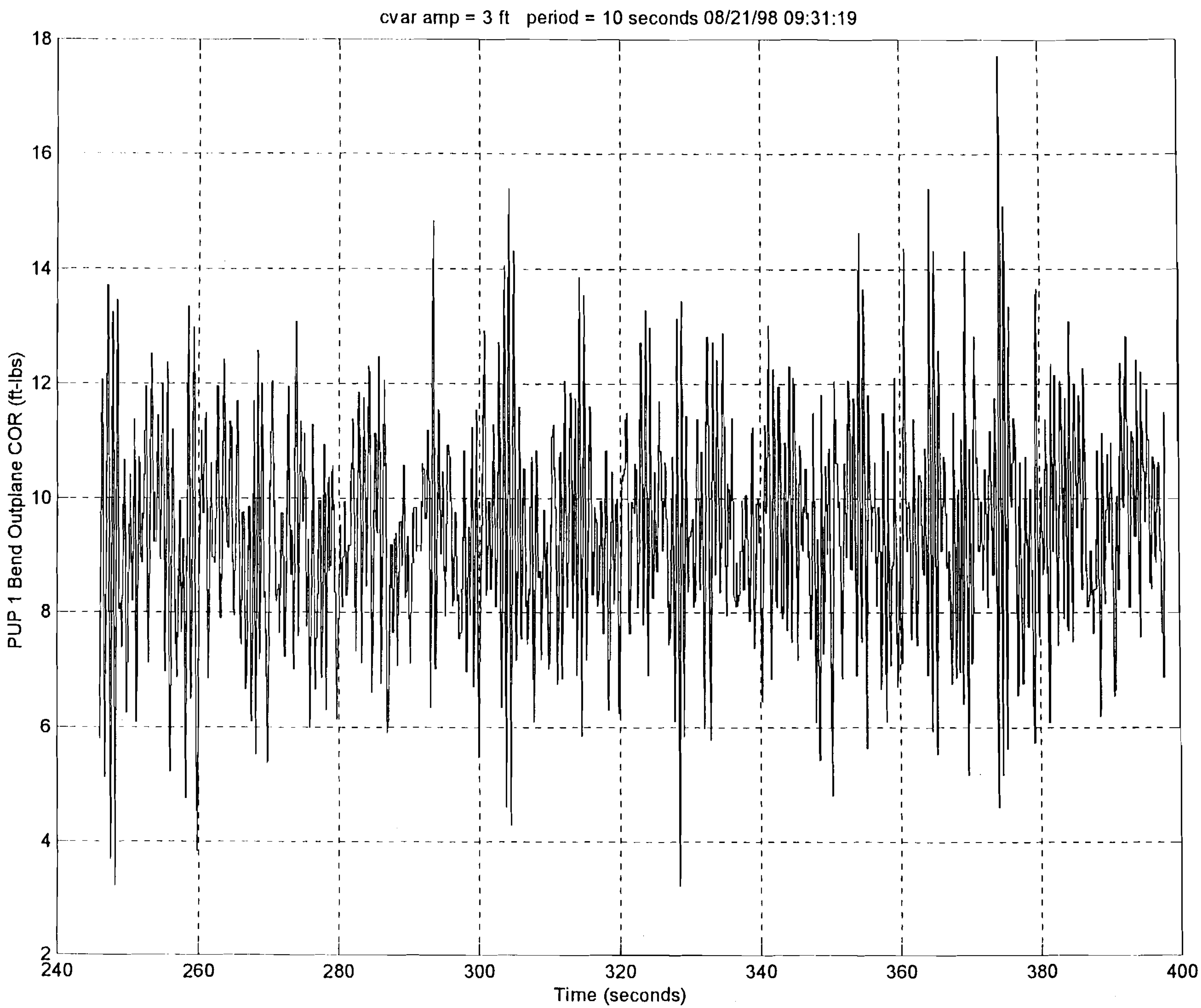

cvar amp = .5 ft period = 10 seconds 08/20/98 16:01:38
Pup 5 Y Position (ft)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
90
100
110
120
130
140
150
160
170
Time (seconds)

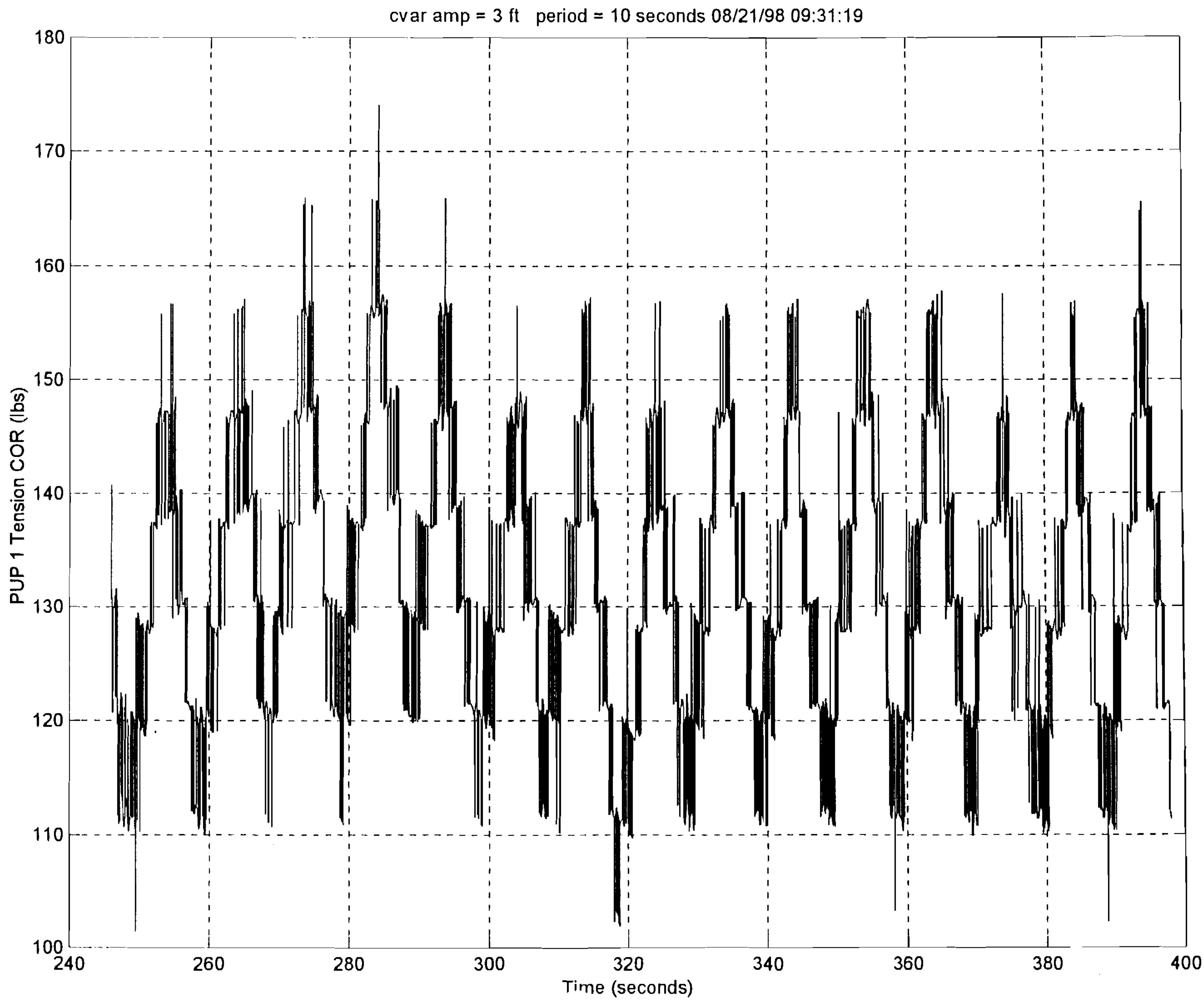
Appendix D

Plots From Specified Select Data Runs

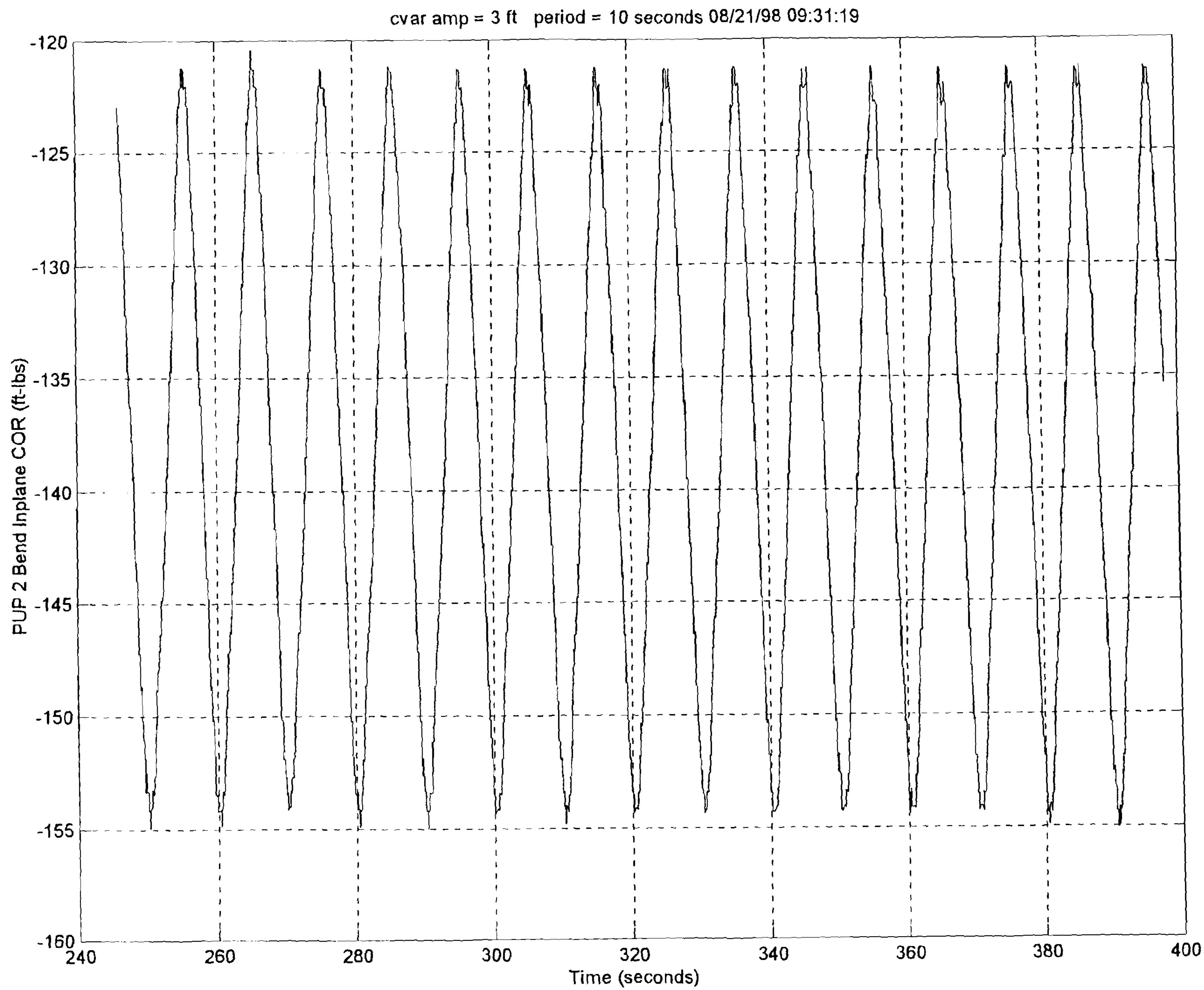

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Actuator Load (lbs)
740
720
700
680
660
640
620
600
240
260
280
300
320
340
360
380
400
Time (seconds)

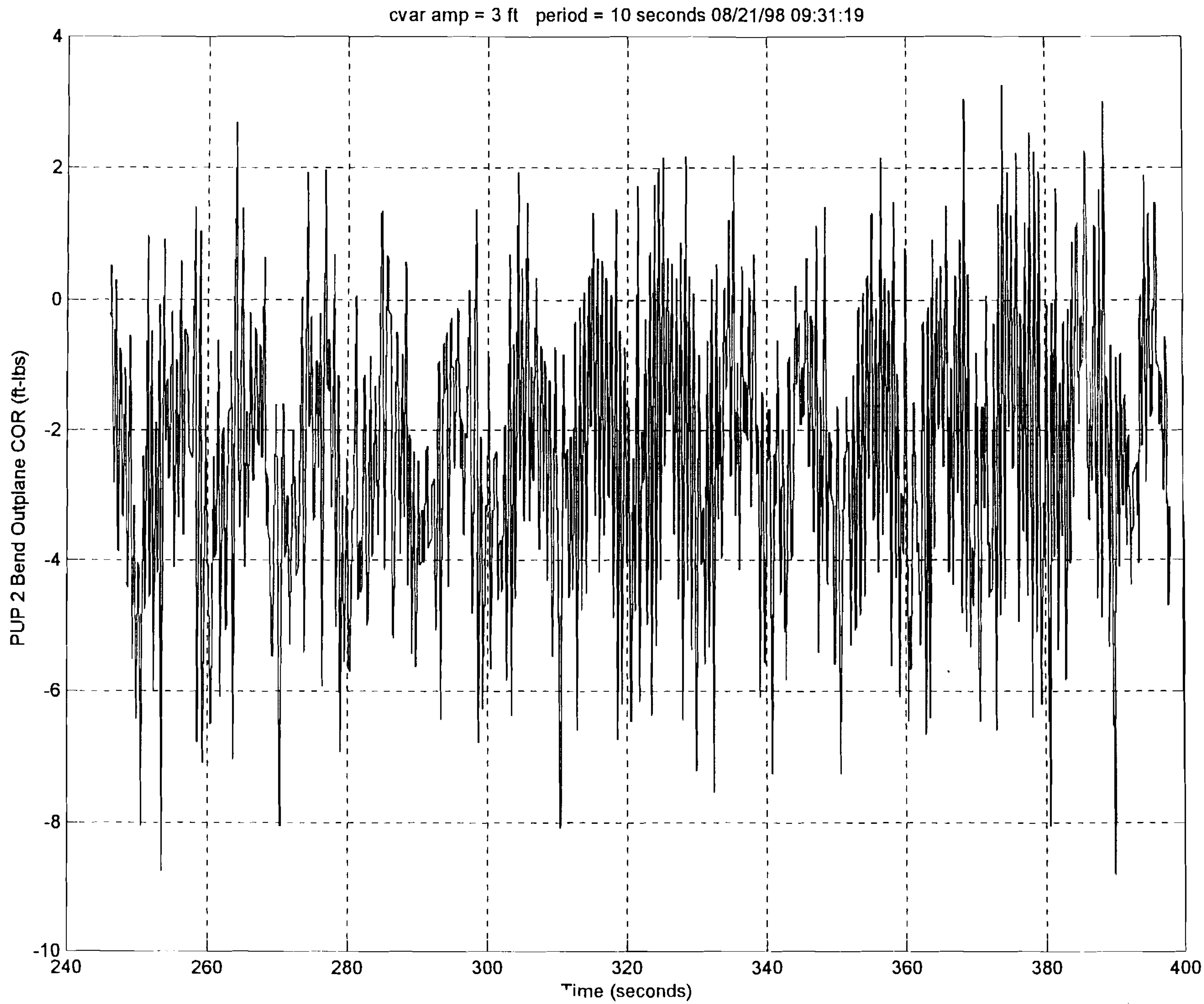

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 1 Bend Inplane COR (ft-lbs)
-74
-76
-78
-80
-82
-84
-86
-88
-90
-92
240
260
280
300
320
340
360
380
400
Time (seconds)

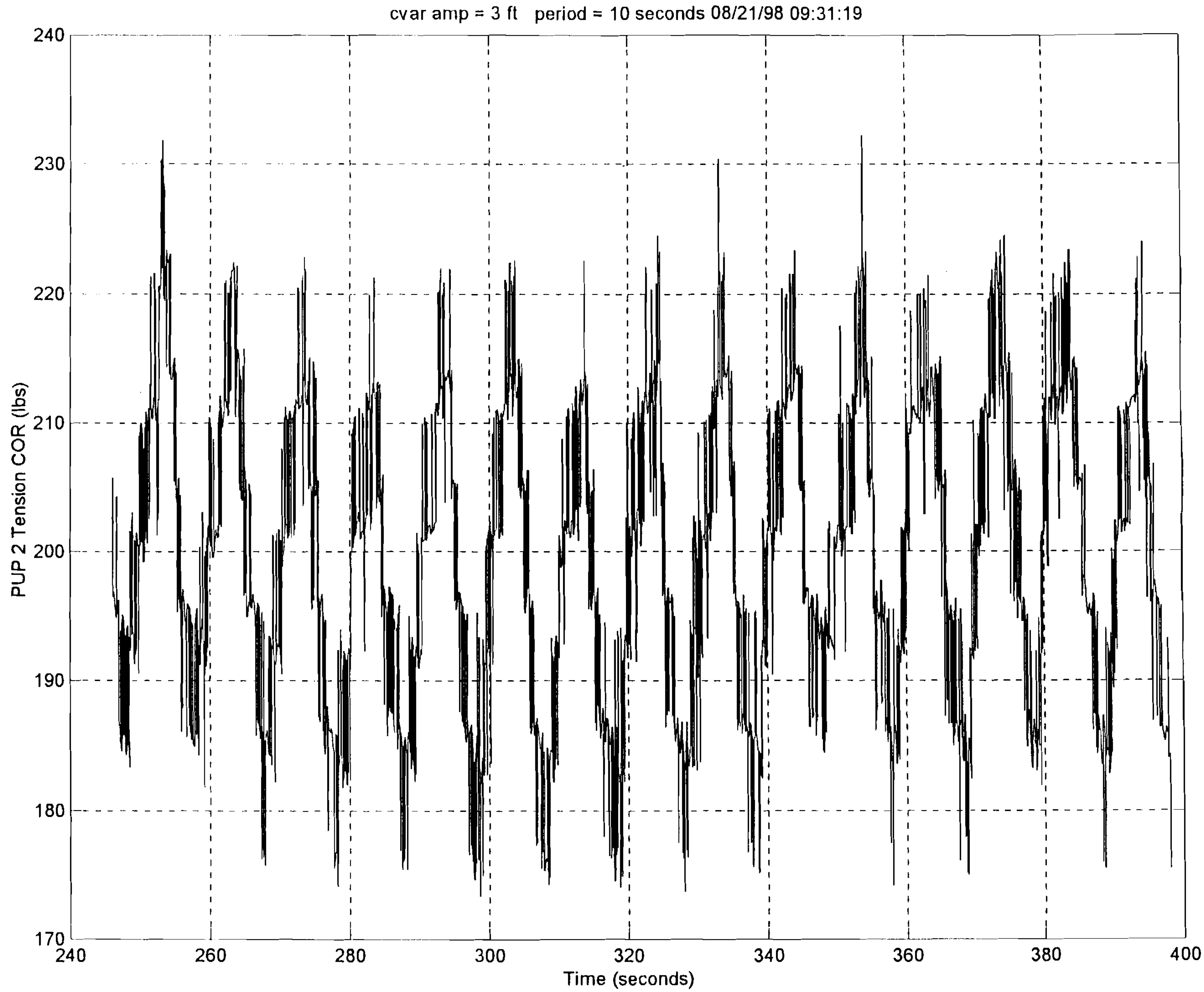

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 1 Bend Outplane COR (ft-lbs)
Time (seconds)

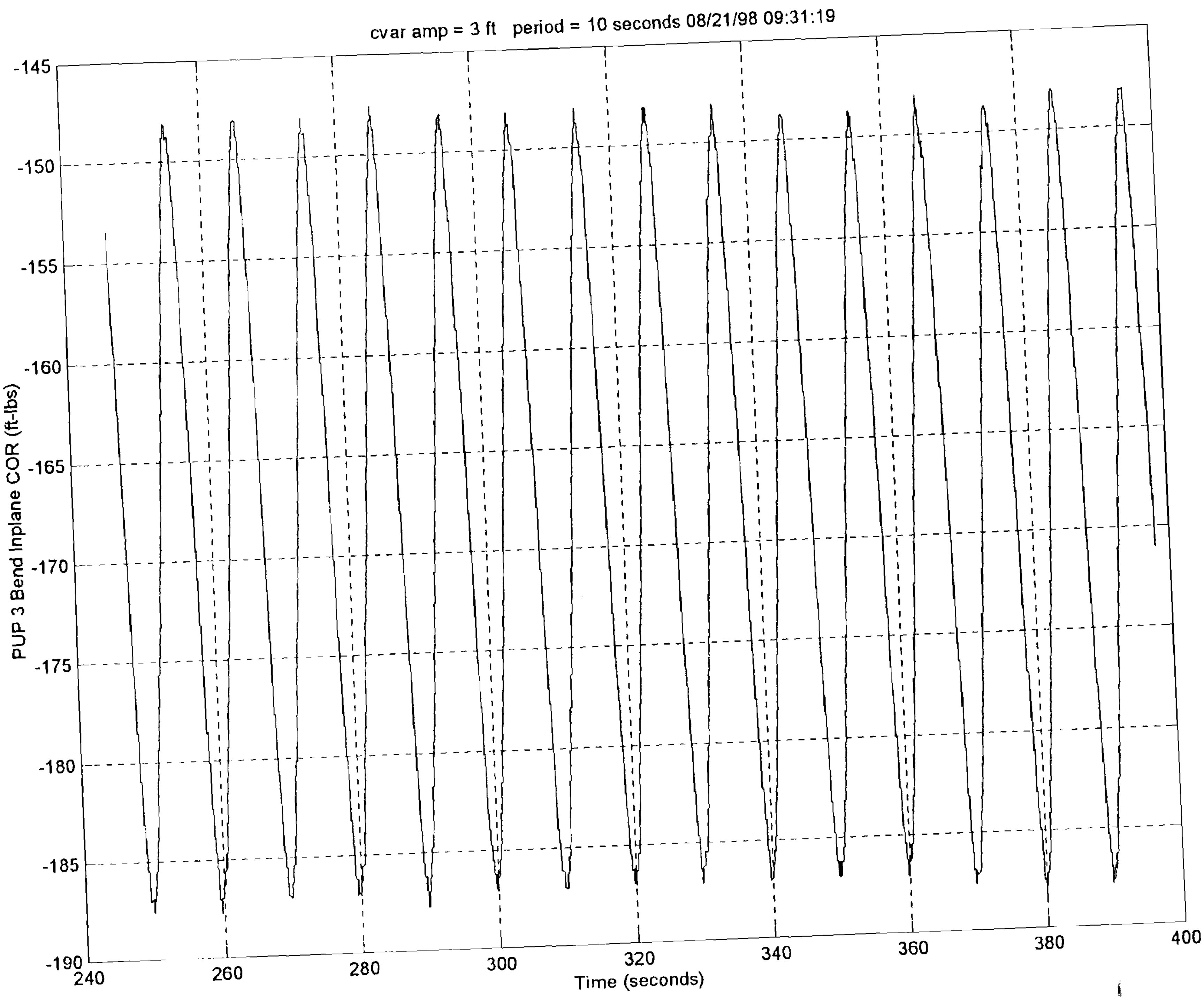


cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 1 Tension COR (lbs)
180
170
160
150
140
130
120
110
100
240
260
280
300
320
340
360
380
400
Time (seconds)

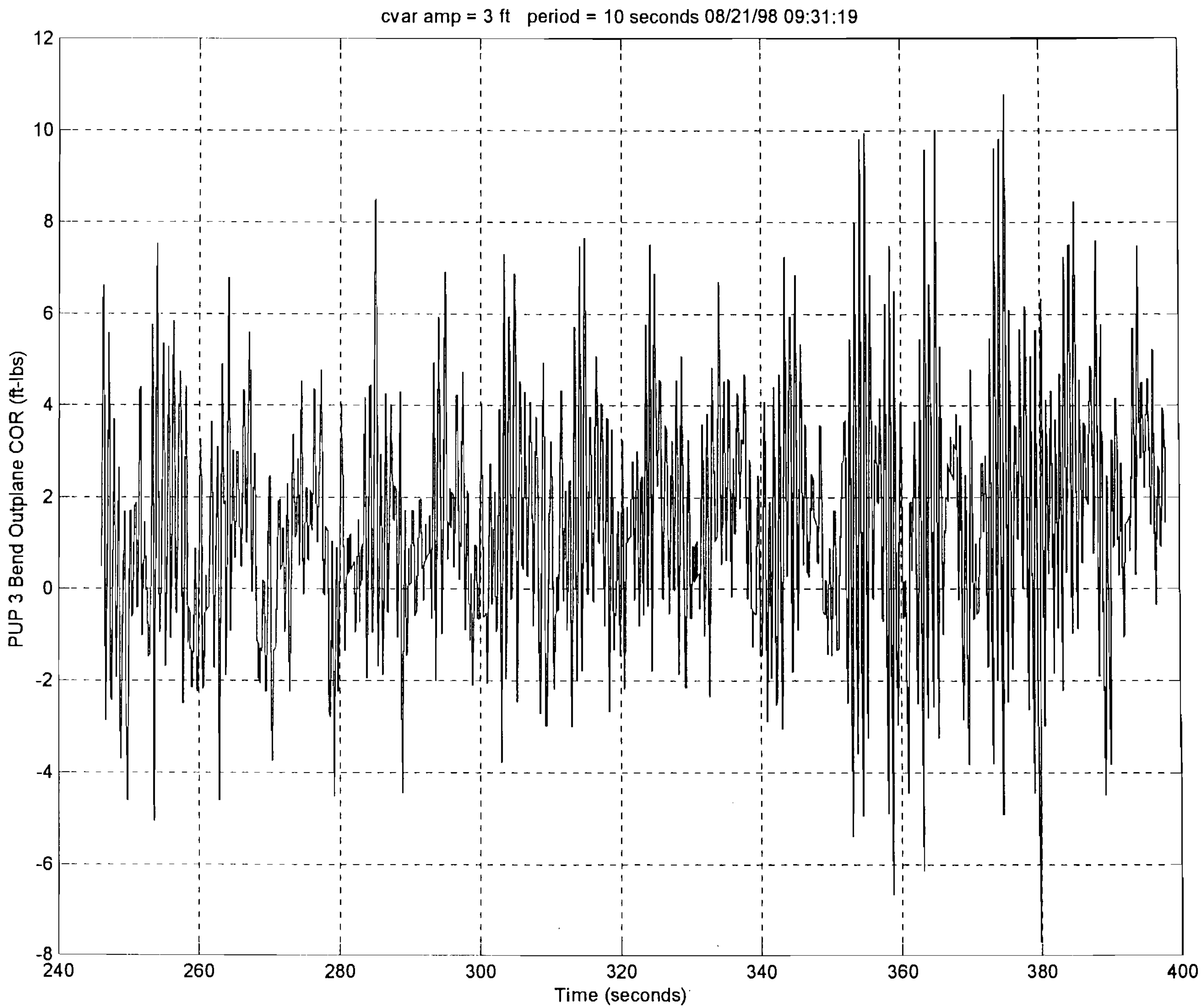

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 2 Bend Inplane COR (ft-lbs)
-120
-125
-130
-135
-140
-145
-150
-155
-160
240
260
280
300
320
340
360
380
400
Time (seconds)


cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 2 Bend Outplane COR (ft-lbs)
4
2
0
-2
-4
-6
-8
-10
240
260
280
300
320
340
360
380
400
Time (seconds)

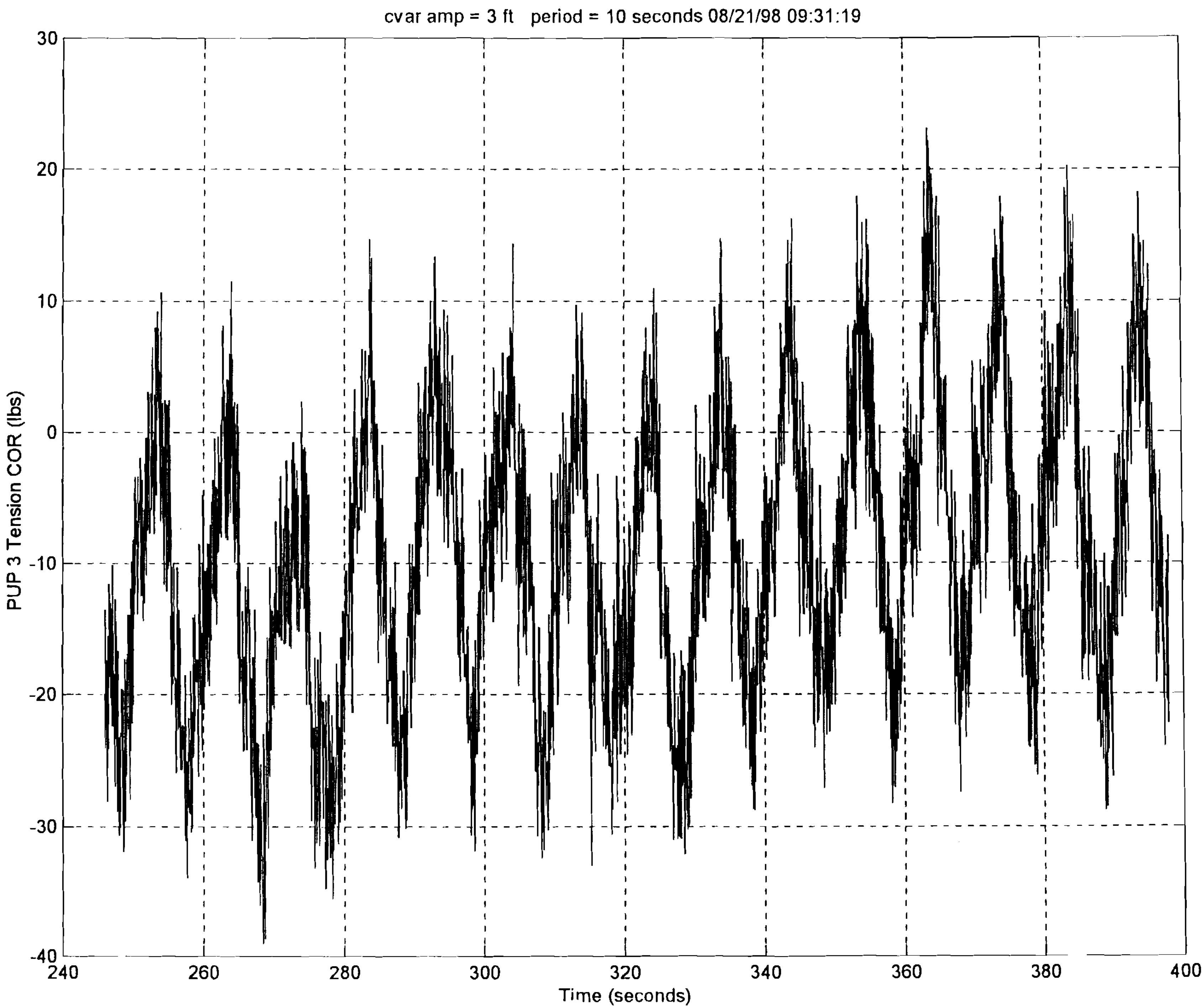

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 2 Tension COR (lbs)
Time (seconds)
240
230
220
210
200
190
180
170
240
260
280
300
320
340
360
380
400

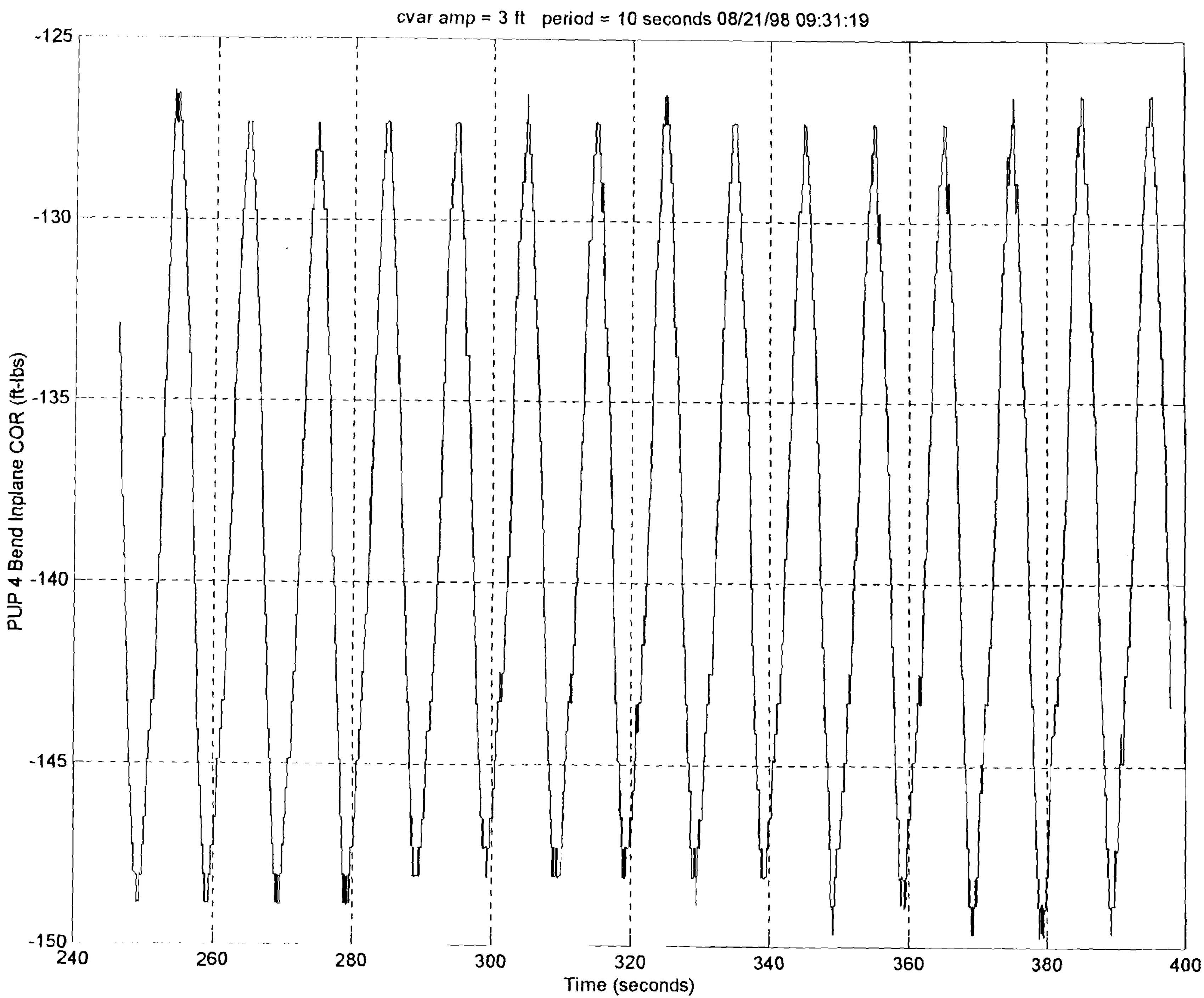


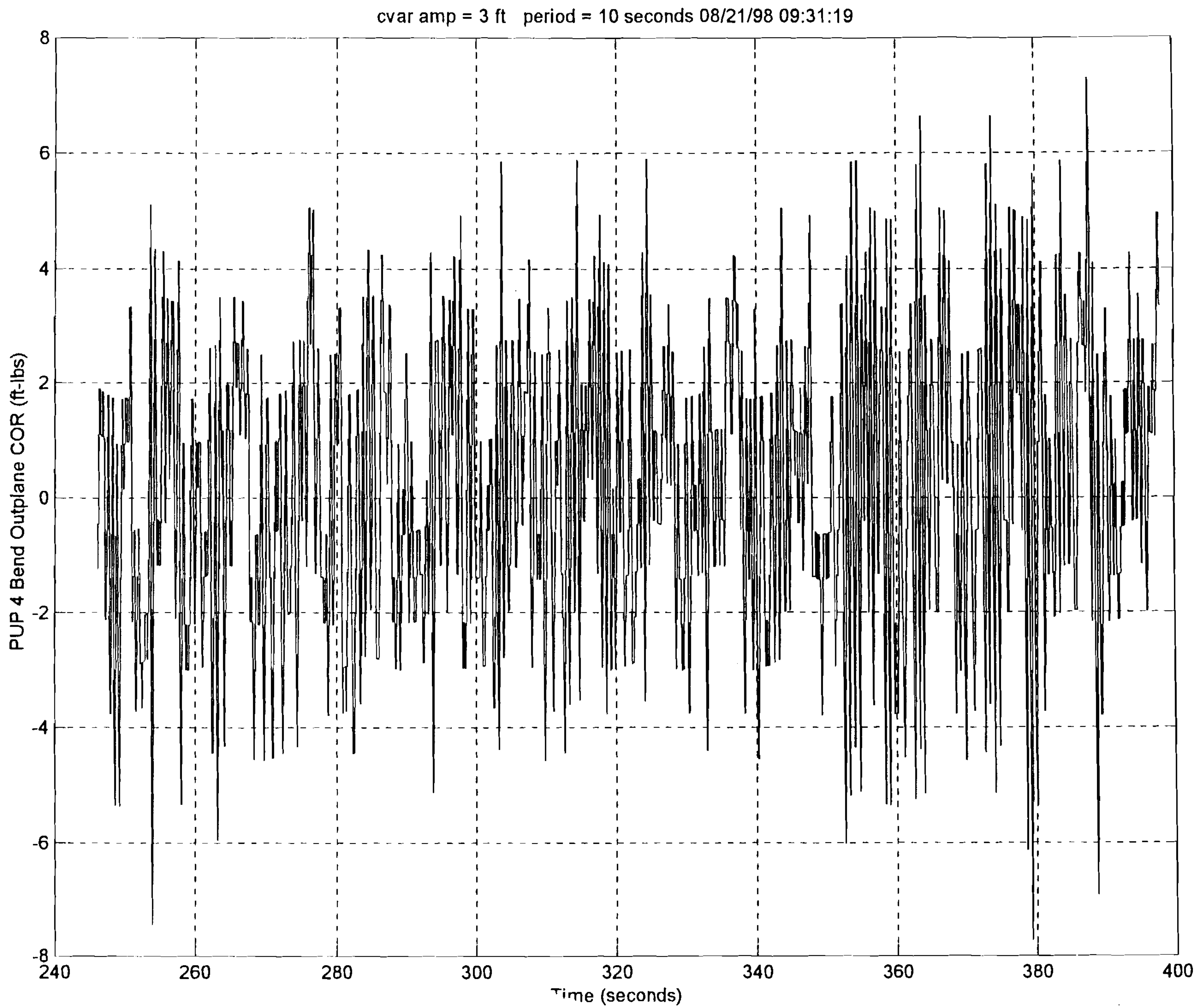
cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 3 Bend Inplane COR (ft-lbs)
-145
-150
-155
-160
-165
-170
-175
-180
-185
-190
240
260
280
300
320
340
360
380
400
Time (seconds)

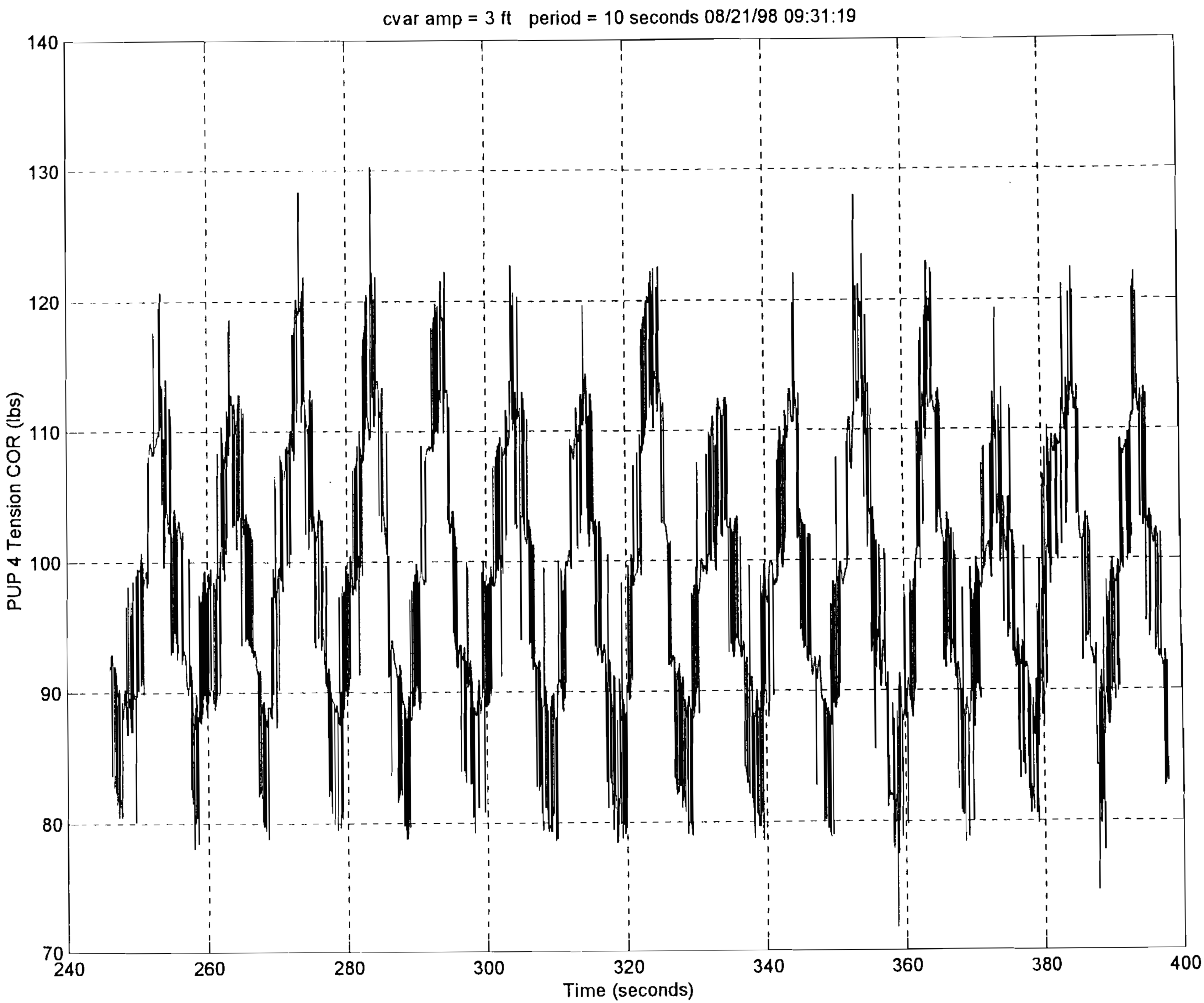


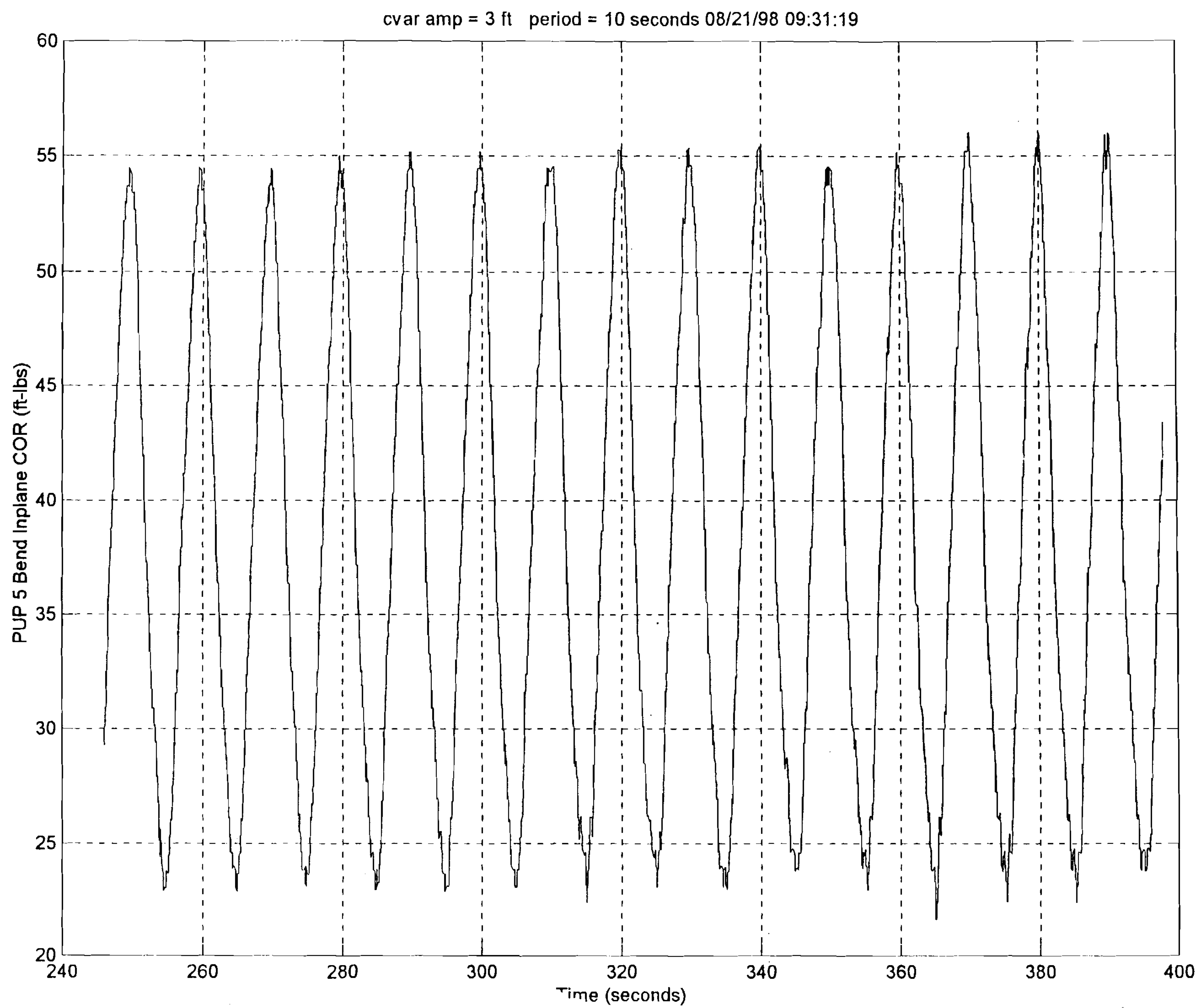
cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 3 Bend Outplane COR (ft-lbs)
12
10
8
6
4
2
0
-2
-4
-6
-8
240
260
280
300
320
340
360
380
400
Time (seconds)

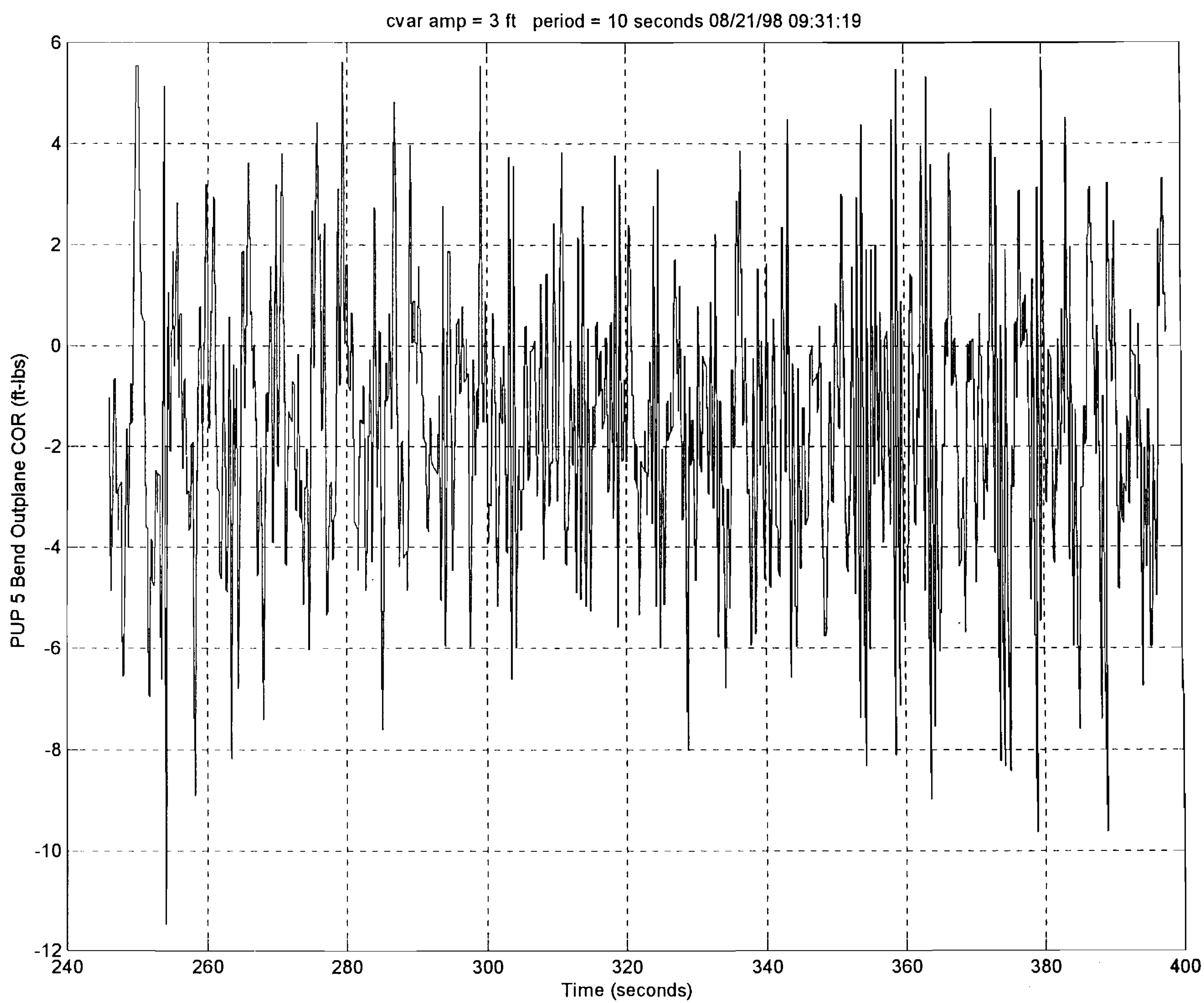

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 3 Tension COR (lbs)
Time (seconds)
30
20
10
0
-10
-20
-30
-40
240
260
280
300
320
340
360
380
400

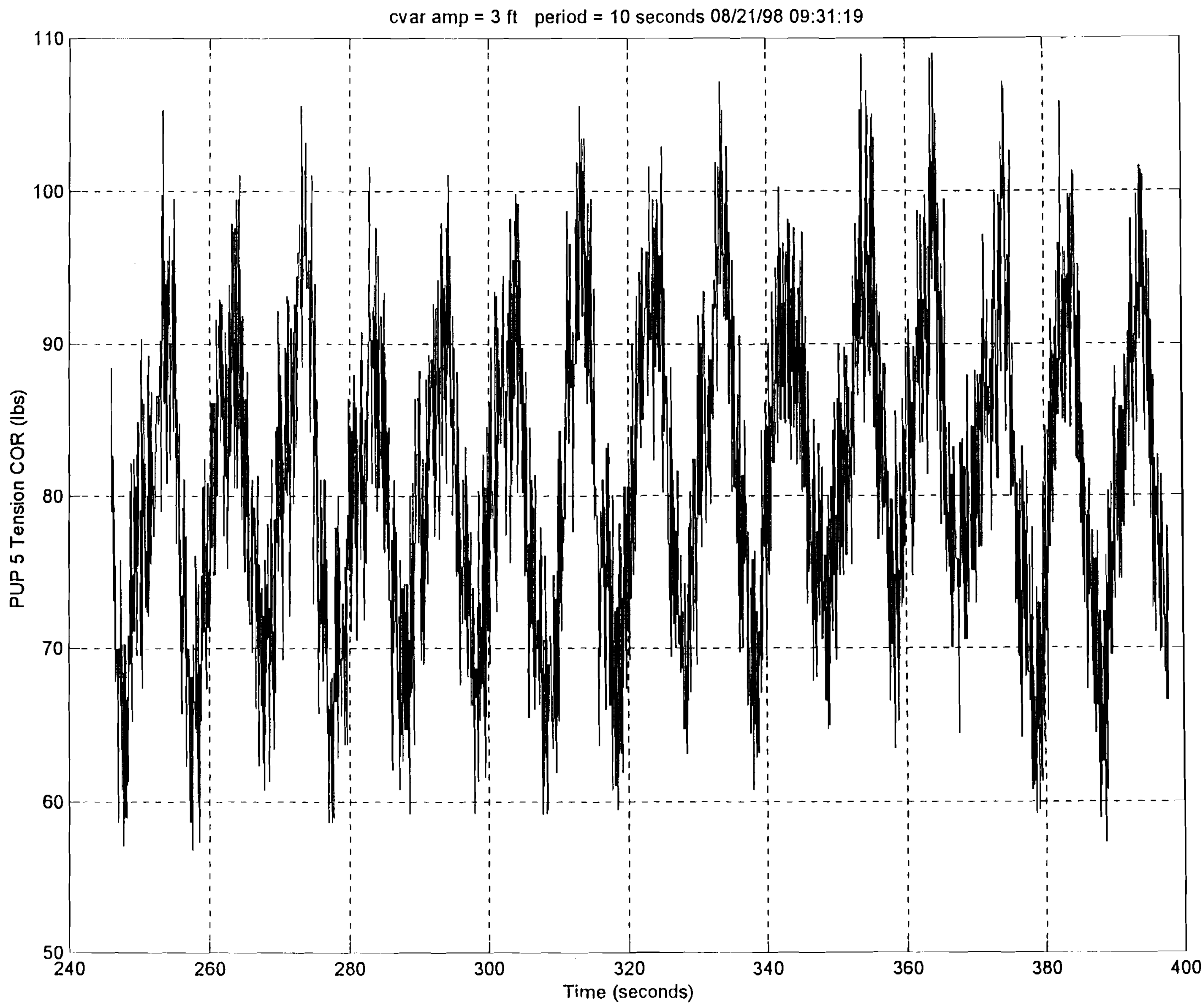

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 4 Bend Inplane COR (ft-lbs)
-125
-130
-135
-140
-145
-150
240
260
280
300
320
340
360
380
400
Time (seconds)


cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 4 Bend Outplane COR (ft-lbs)
8
6
4
2
0
-2
-4
-6
-8
240
260
280
300
320
340
360
380
400
Time (seconds)

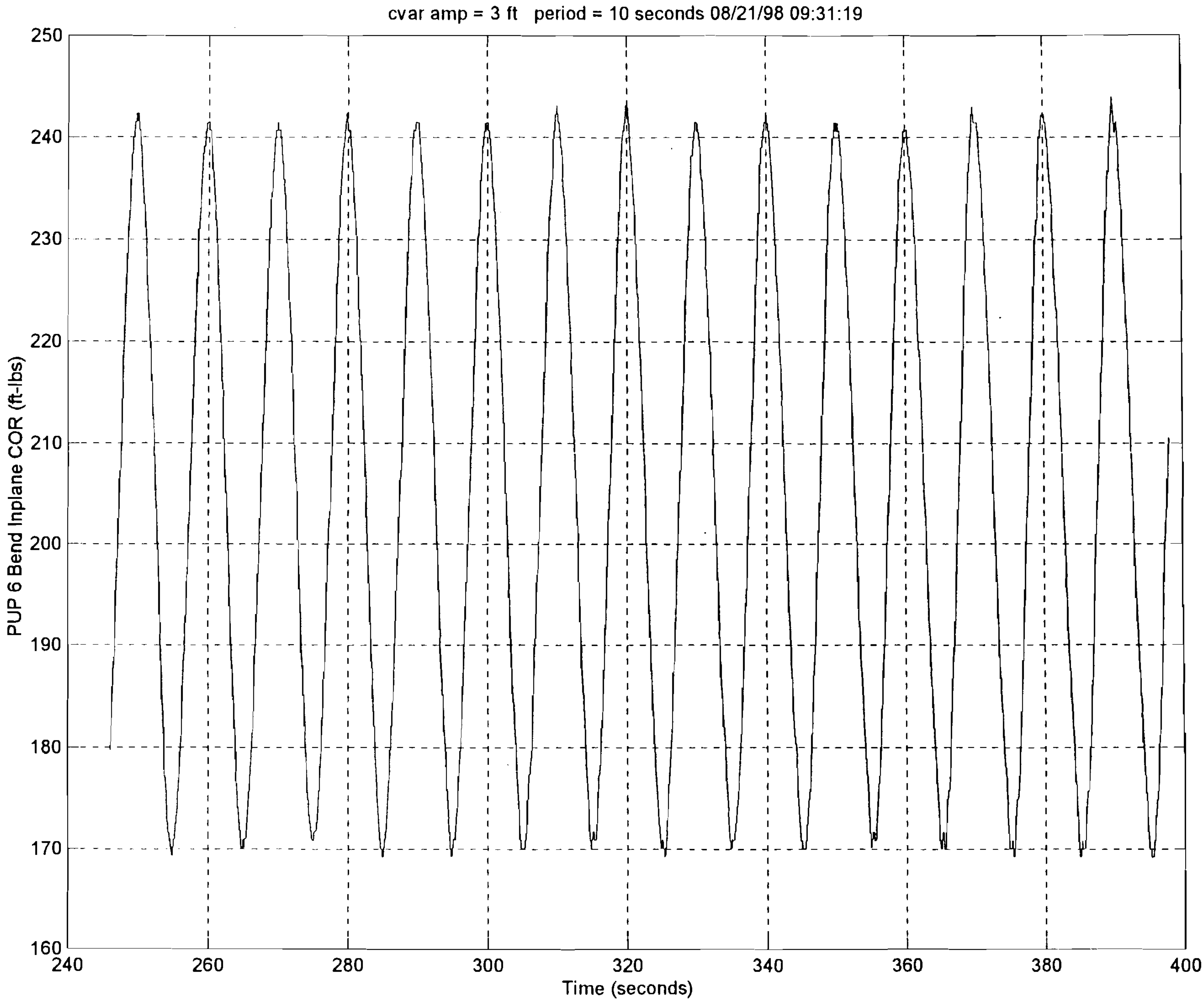

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 4 Tension COR (lbs)
140
130
120
110
100
90
80
70
240
260
280
300
320
340
360
380
400
Time (seconds)


cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 5 Bend Inplane COR (ft-lbs)
60
55
50
45
40
35
30
25
20
240
260
280
300
320
340
360
380
400
Time (seconds)

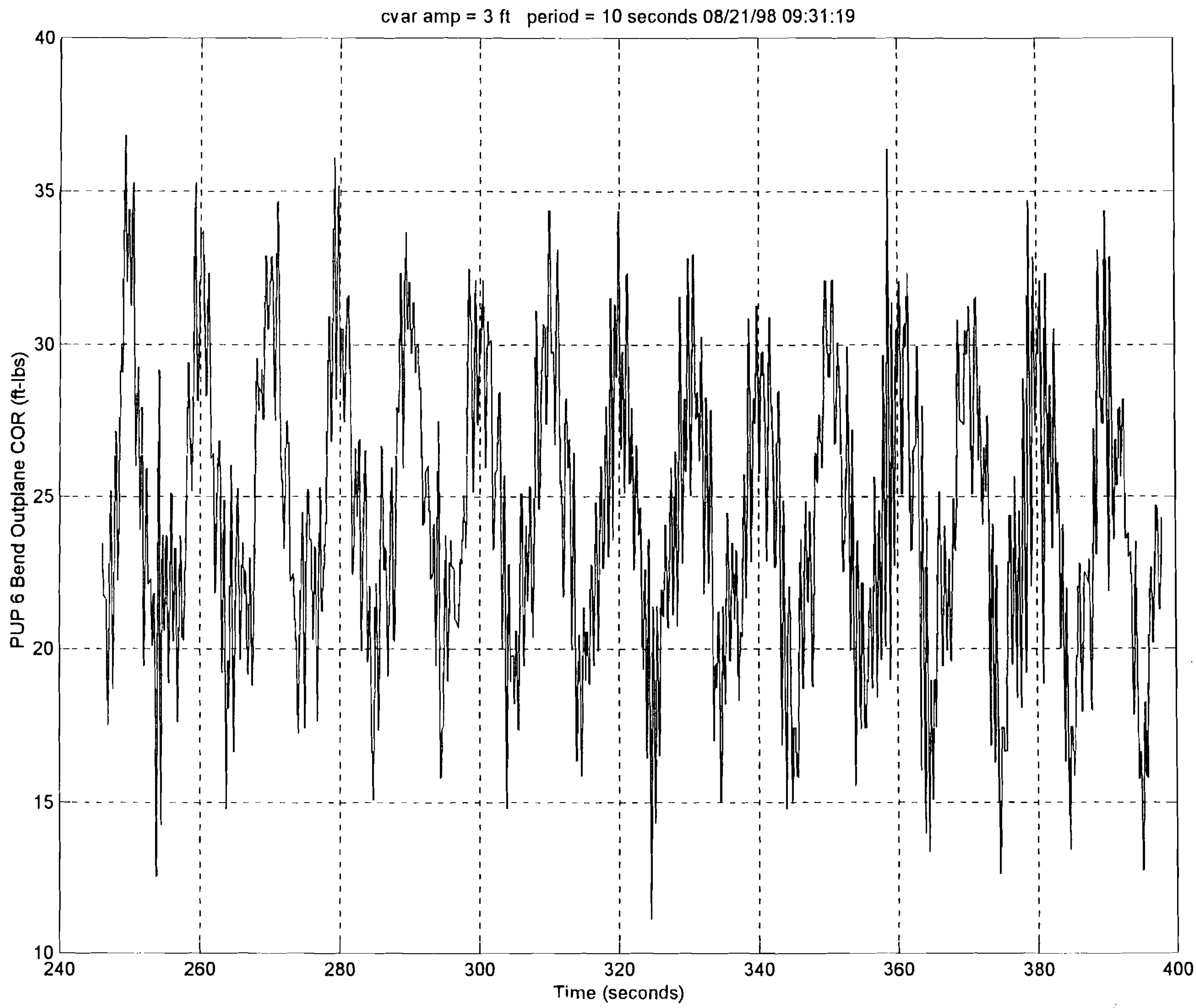

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 5 Bend Outplane COR (ft-lbs)
Time (seconds)
6
4
2
0
-2
-4
-6
-8
-10
-12
240
260
280
300
320
340
360
380
400

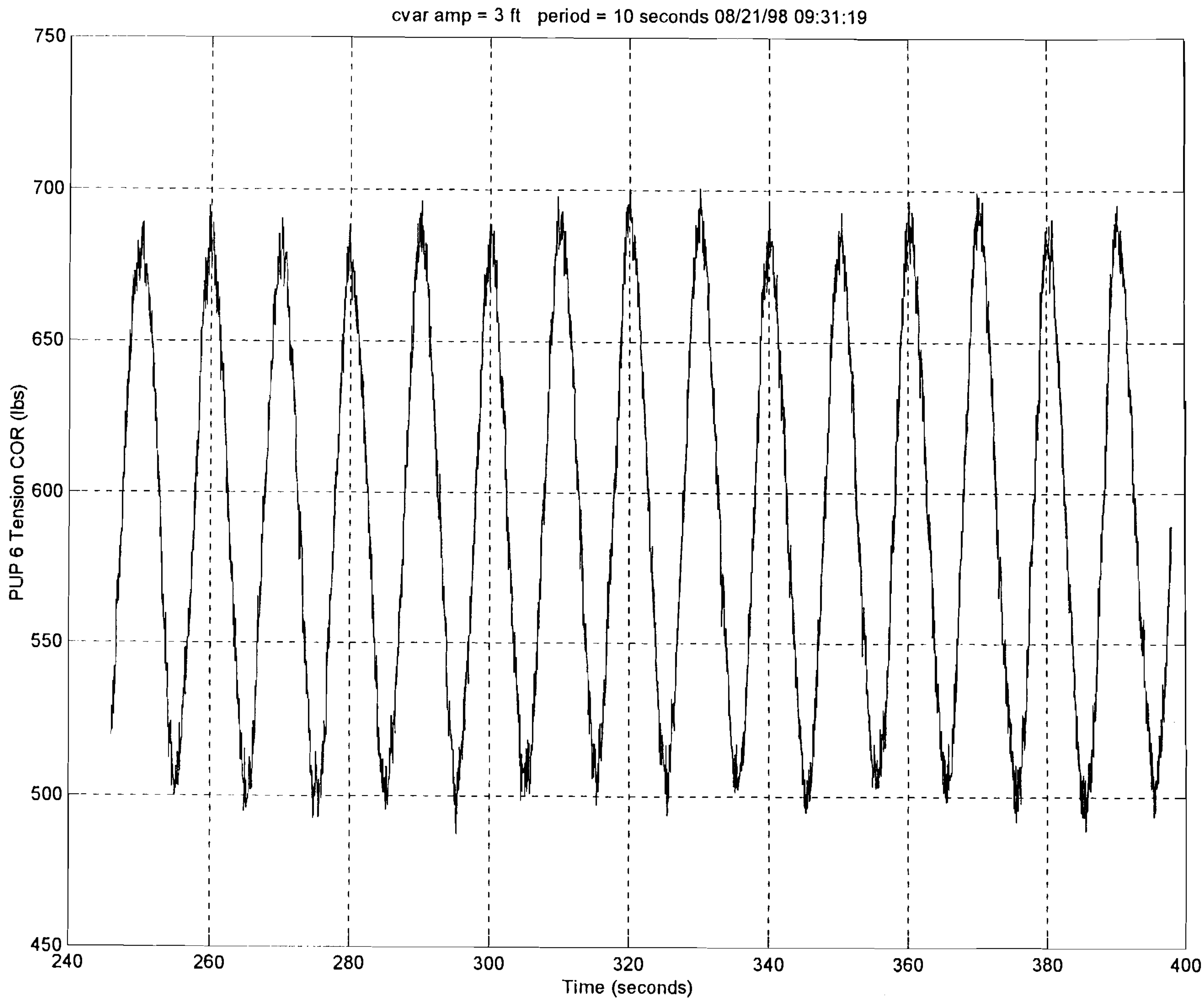


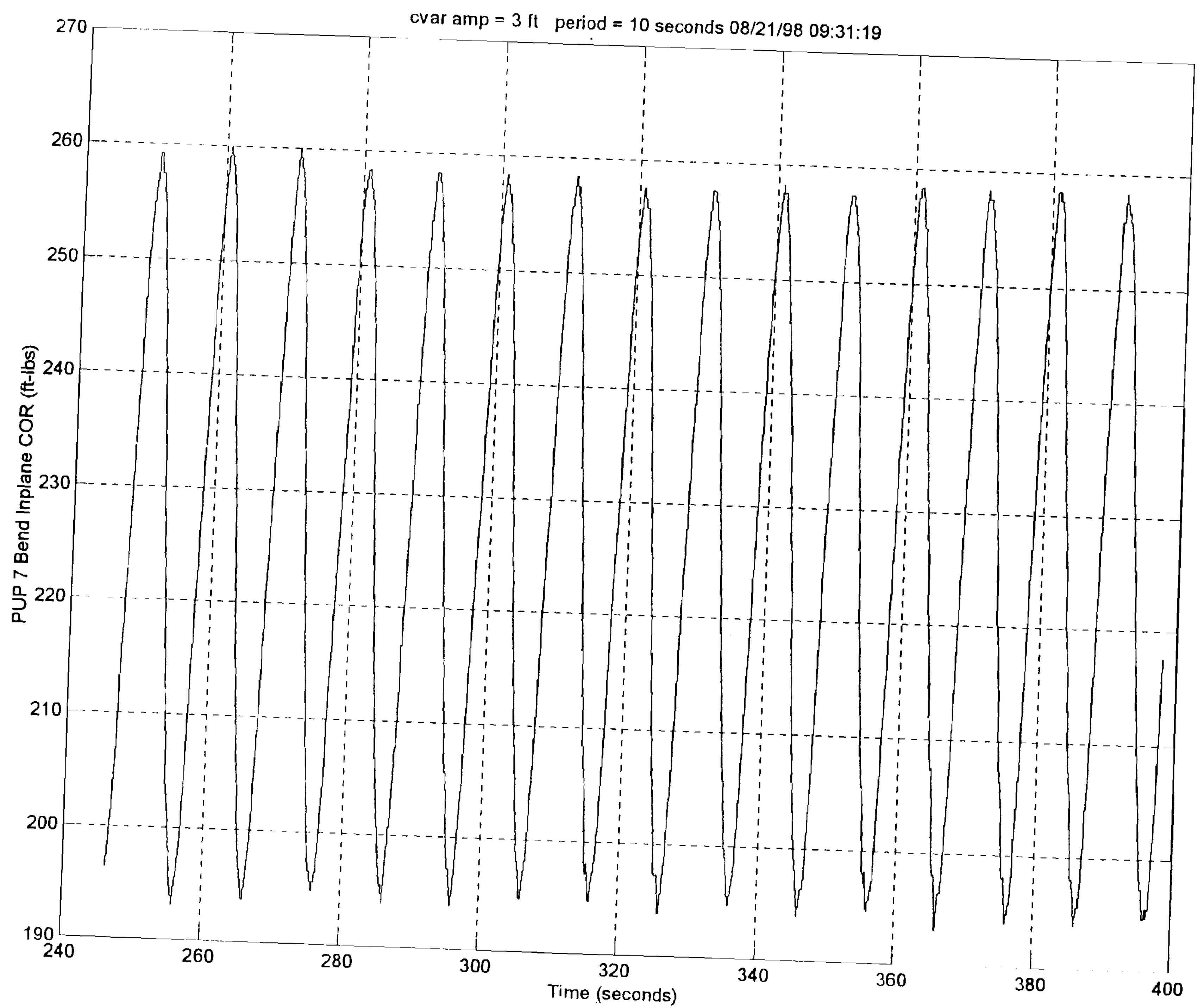
cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 5 Tension COR (lbs)
Time (seconds)
110
100
90
80
70
60
50
240
260
280
300
320
340
360
380
400

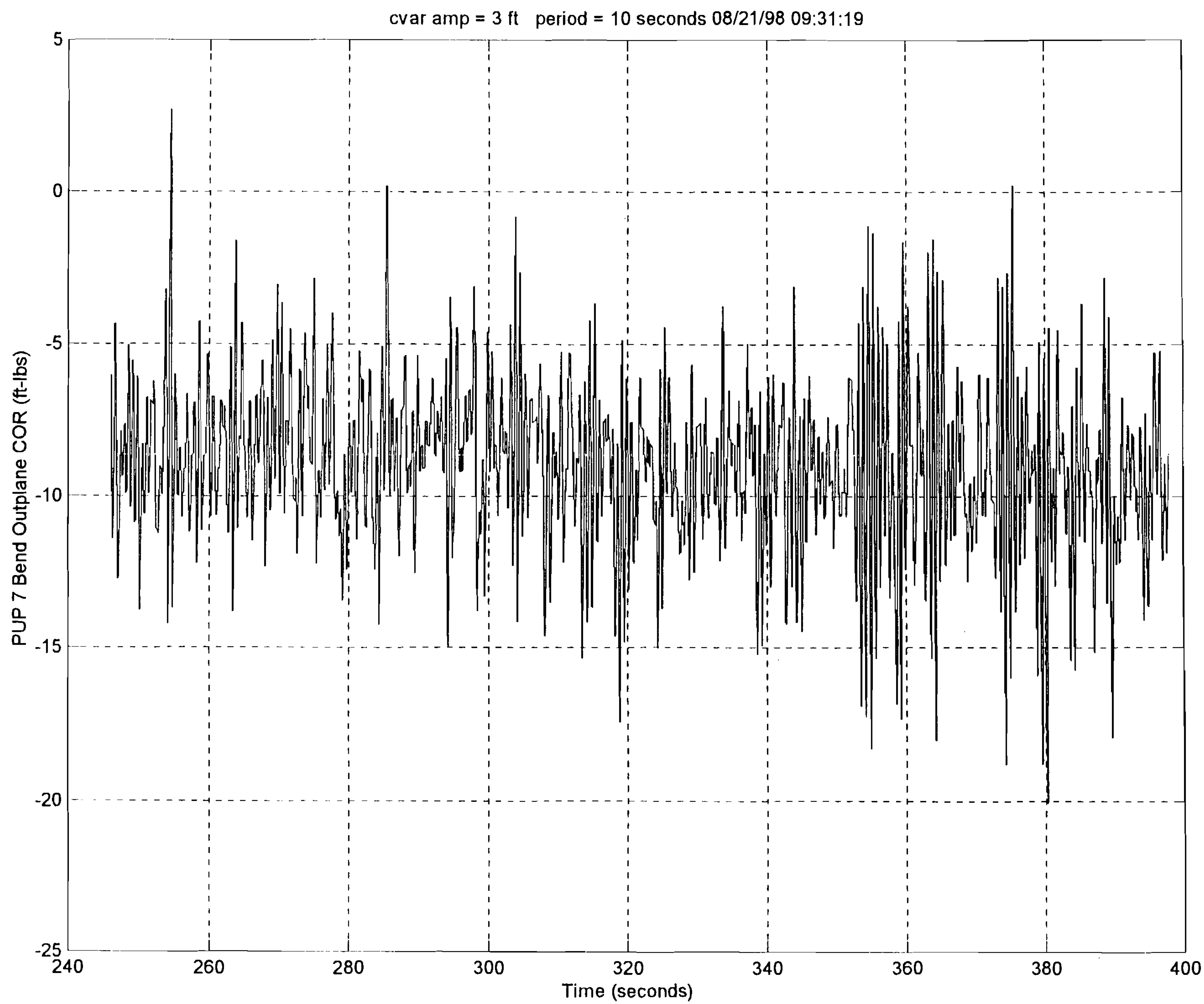


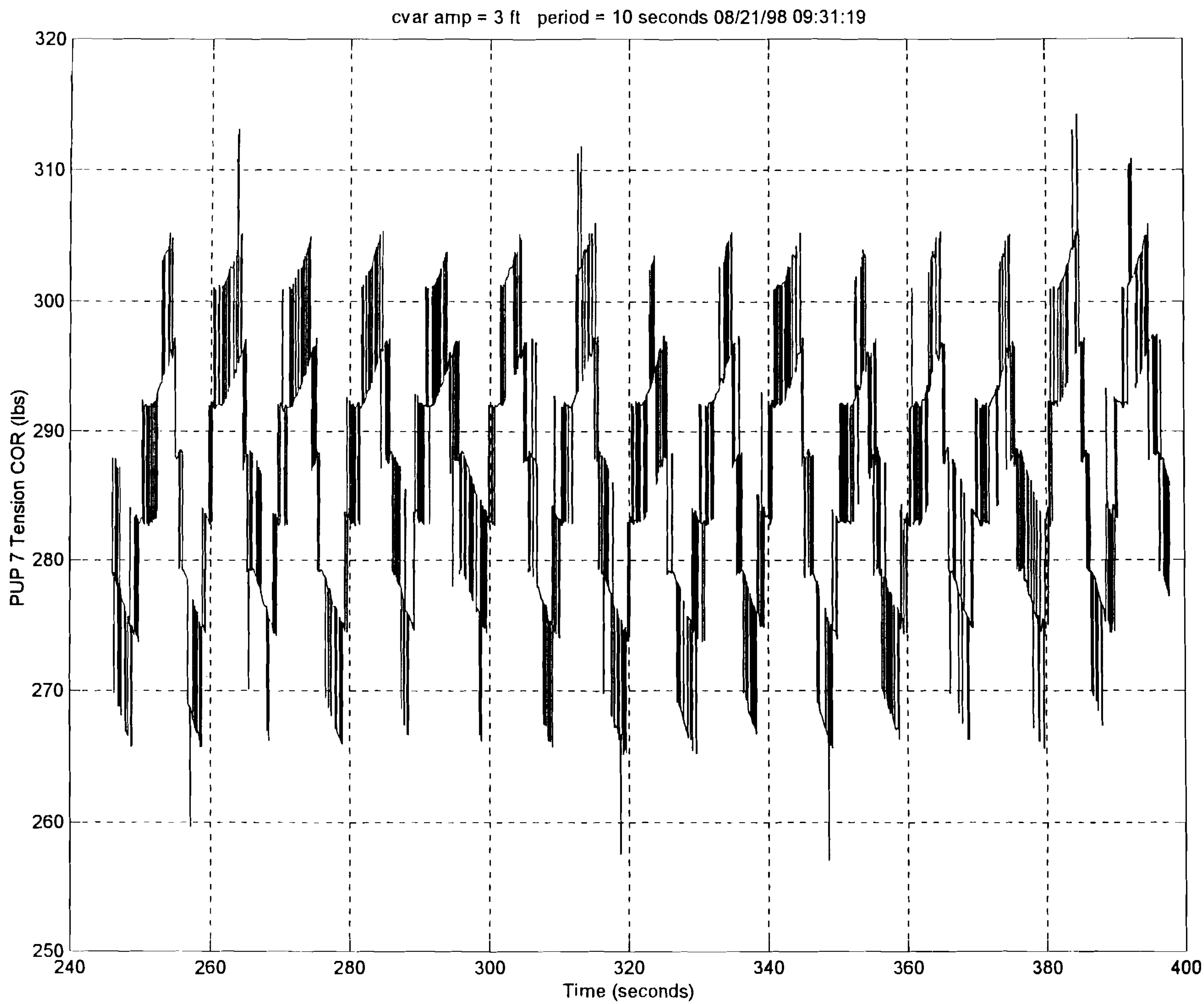
cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 6 Bend Inplane COR (ft-lbs)
250
240
230
220
210
200
190
180
170
160
240
260
280
300
320
340
360
380
400
Time (seconds)


cvar amp = 3 ft   period = 10 seconds 08/21/98 09:31:19
PUP 6 Bend Outplane COR (ft-lbs)
Time (seconds)
40
35
30
25
20
15
10
240
260
280
300
320
340
360
380
400

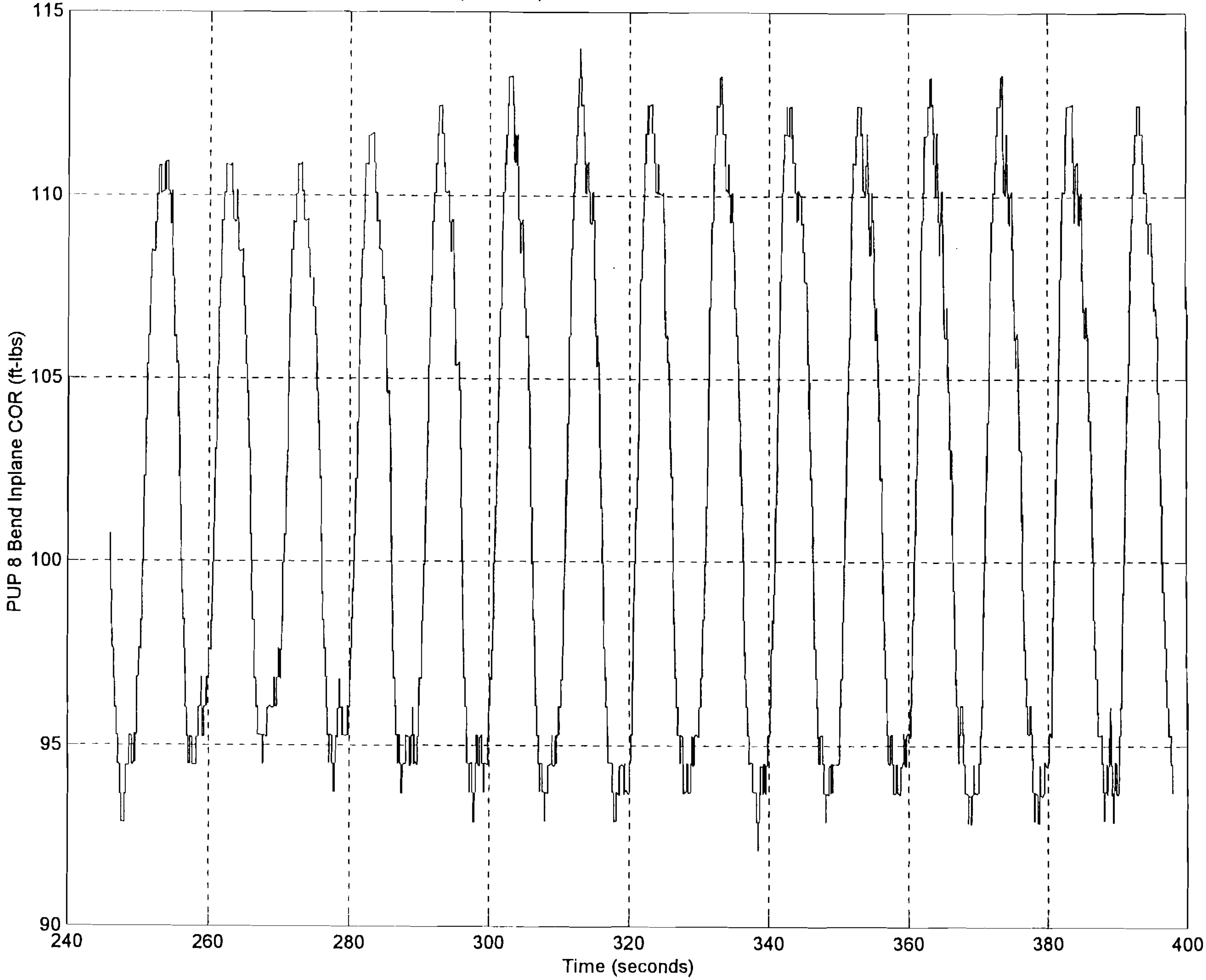

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 6 Tension COR (lbs)
750
700
650
600
550
500
450
240
260
280
300
320
340
360
380
400
Time (seconds)

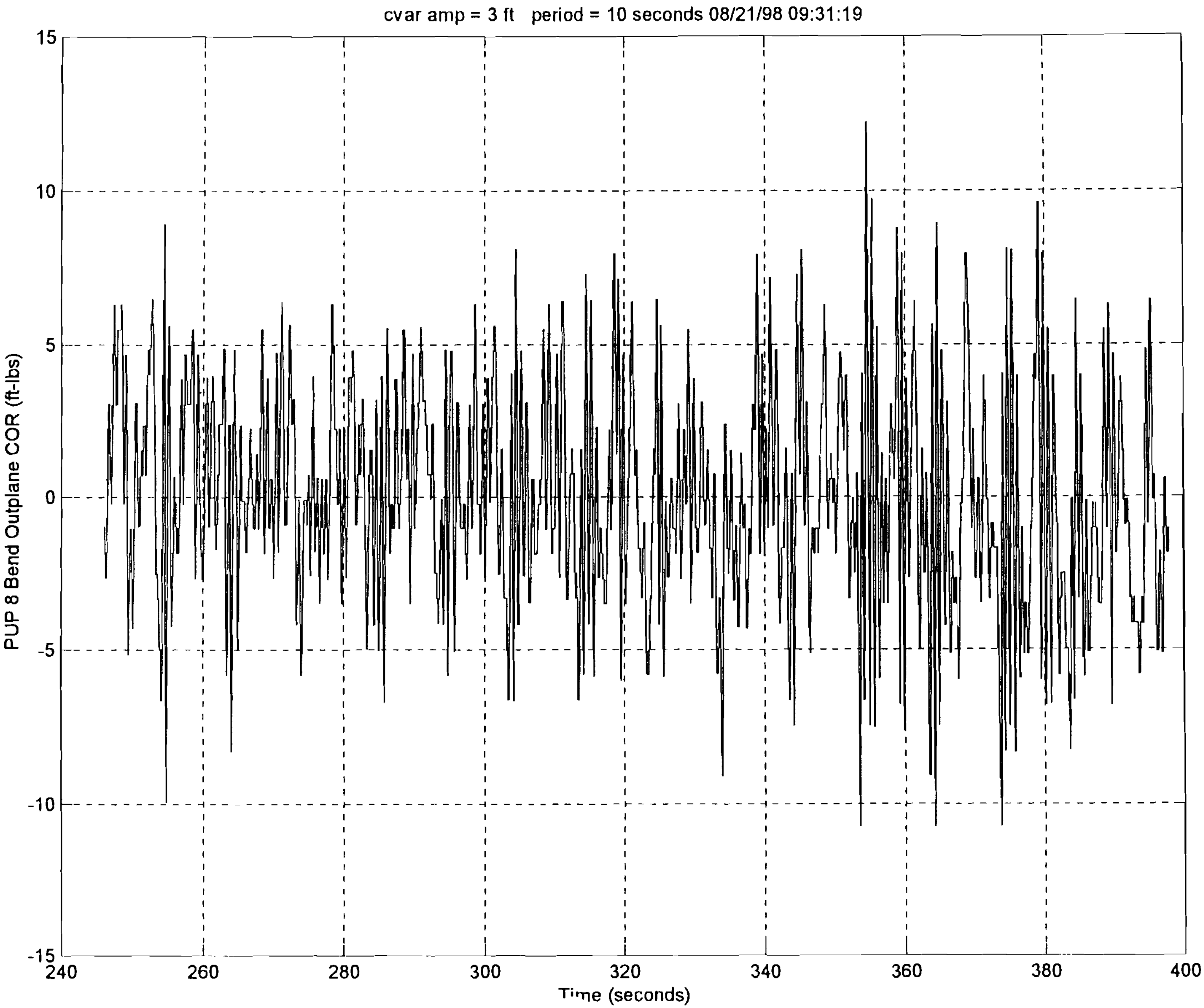

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 7 Bend Inplane COR (ft-lbs)
270
260
250
240
230
220
210
200
190
240
260
280
300
320
340
360
380
400
Time (seconds)

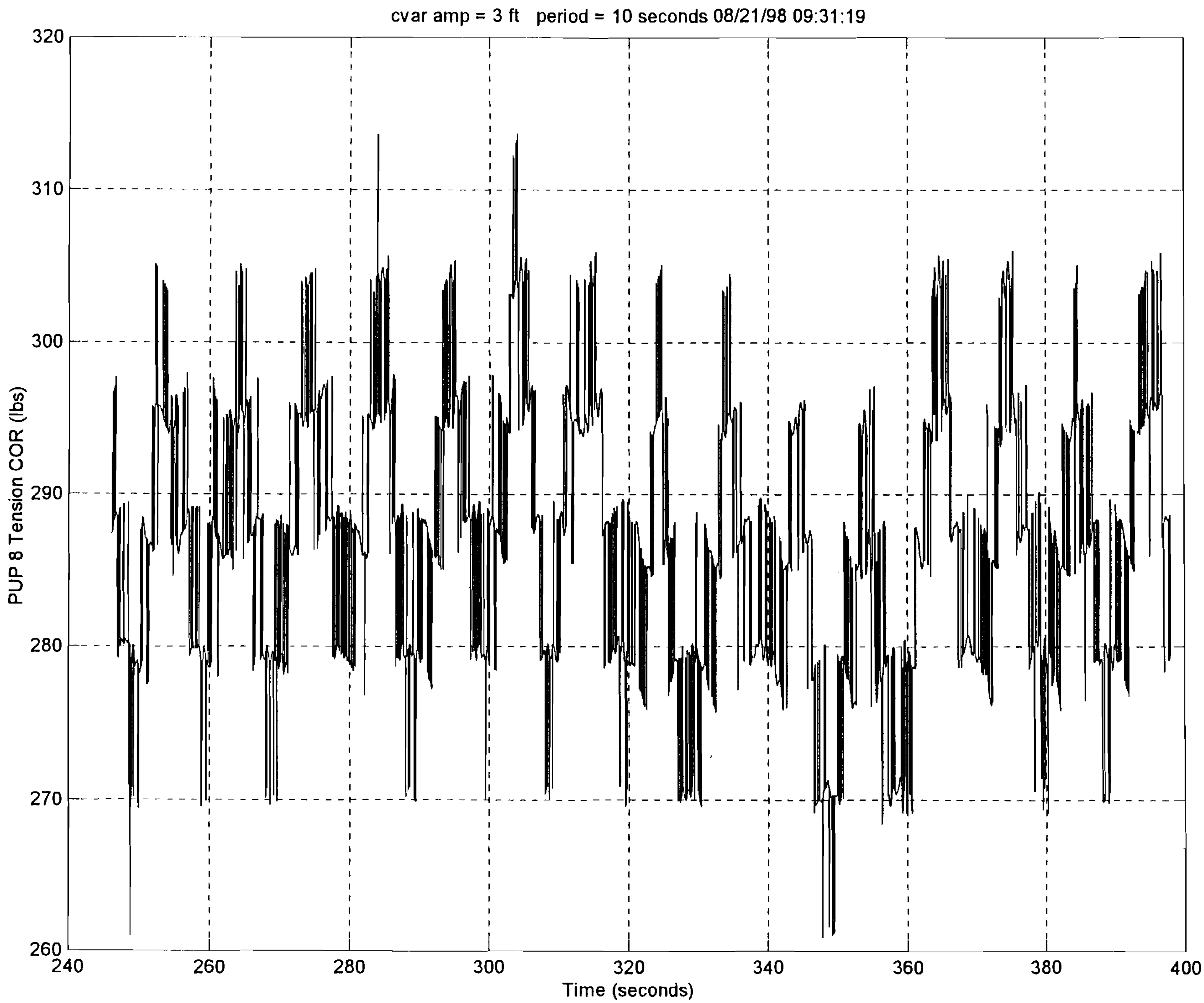

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 7 Bend Outplane COR (ft-lbs)
5
0
-5
-10
-15
-20
-25
240
260
280
300
320
340
360
380
400
Time (seconds)

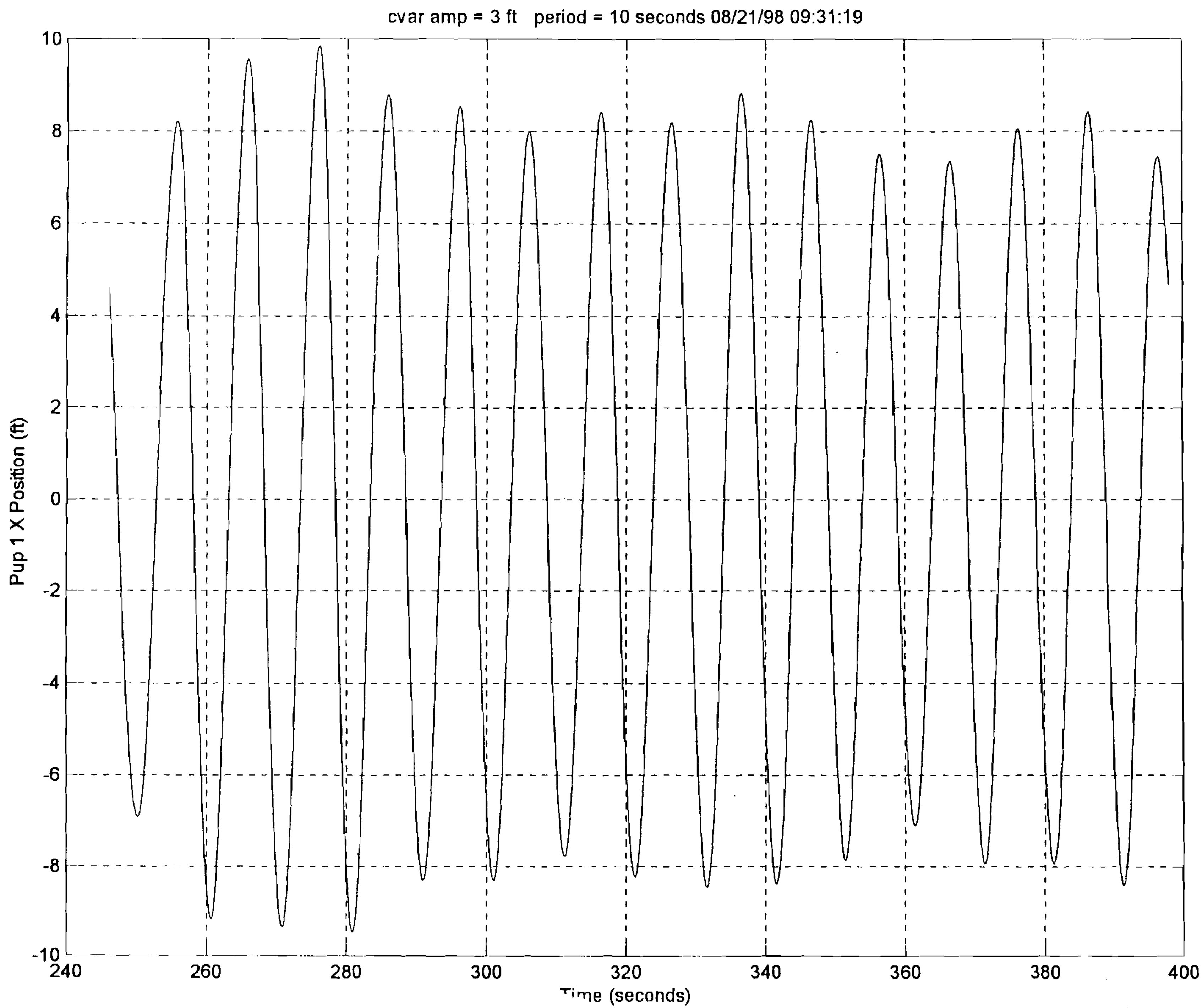

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 7 Tension COR (lbs)
320
310
300
290
280
270
260
250
240
260
280
300
320
340
360
380
400
Time (seconds)

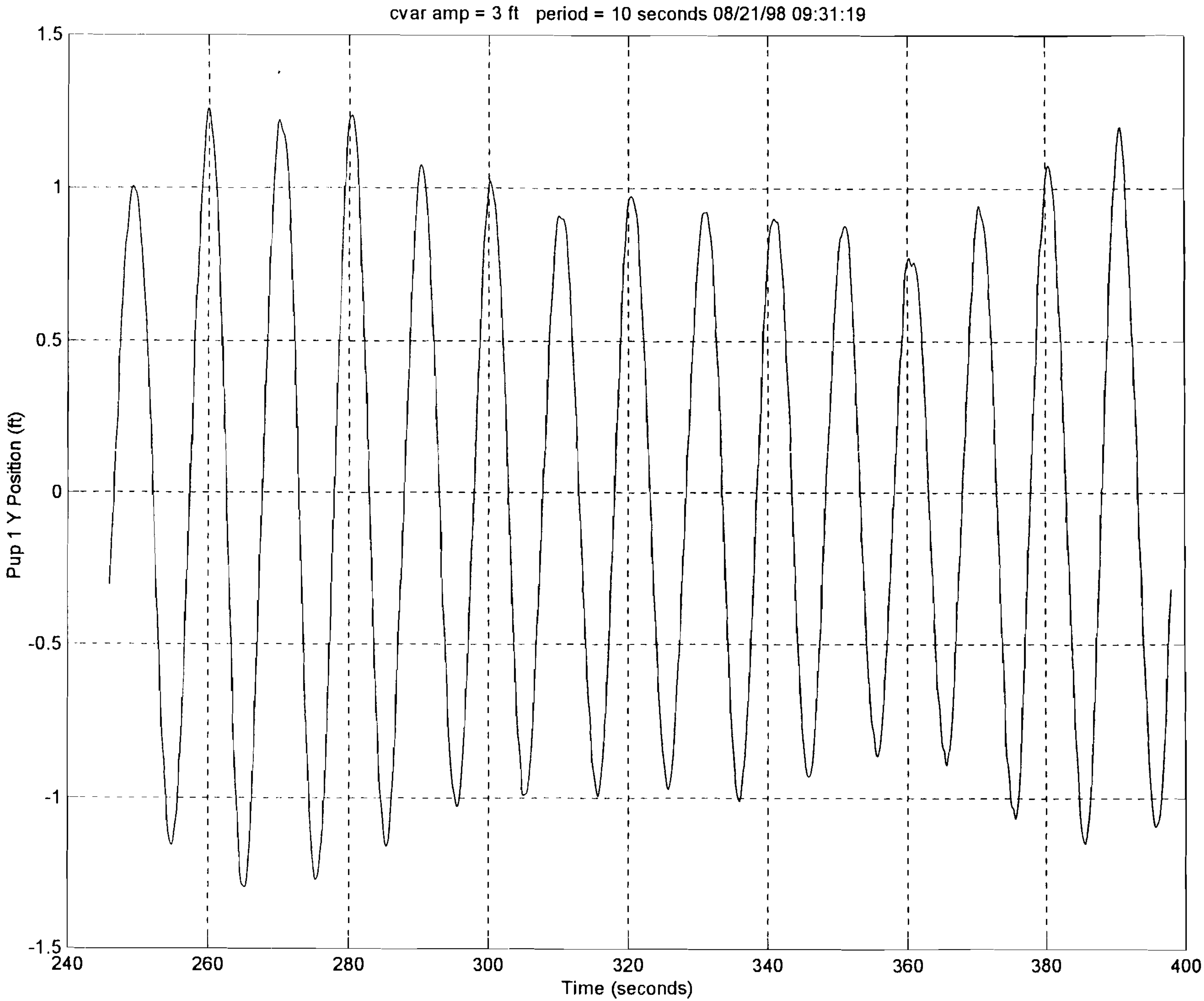
cvar amp = 3 ft   period = 10 seconds 08/21/98 09:31:19

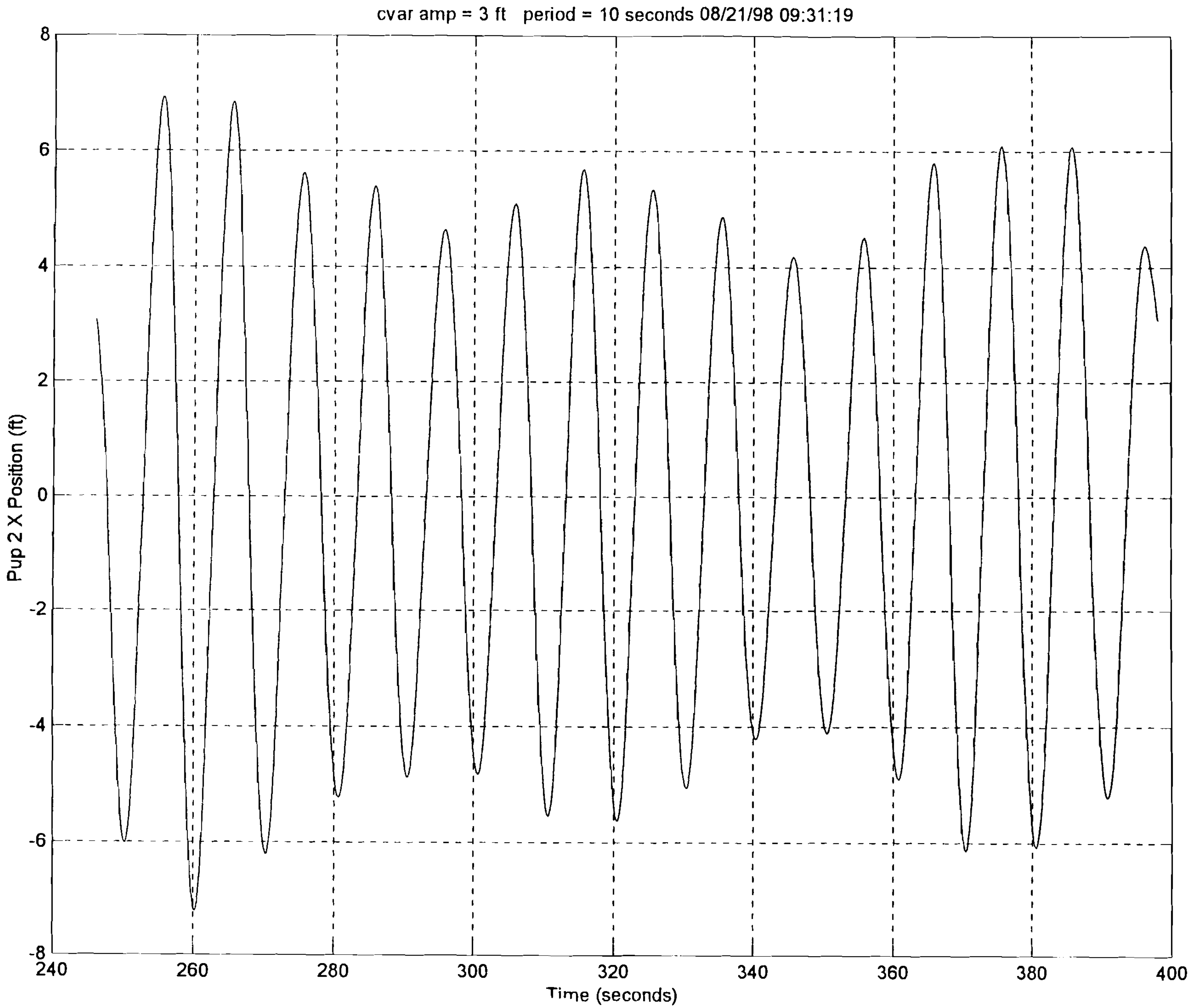


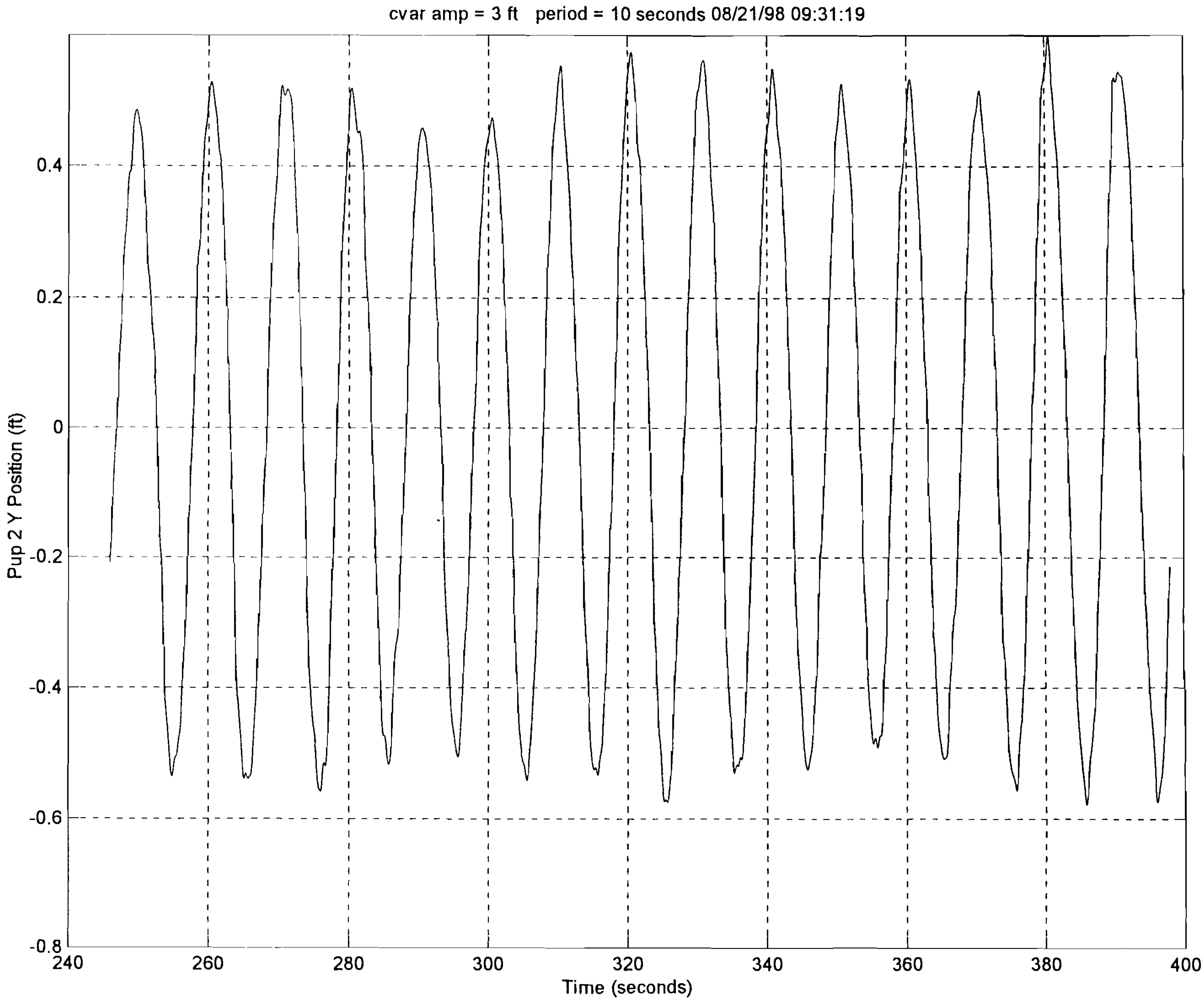

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 8 Bend Outplane COR (ft-lbs)
Time (seconds)
15
10
5
0
-5
-10
-15
240
260
280
300
320
340
360
380
400

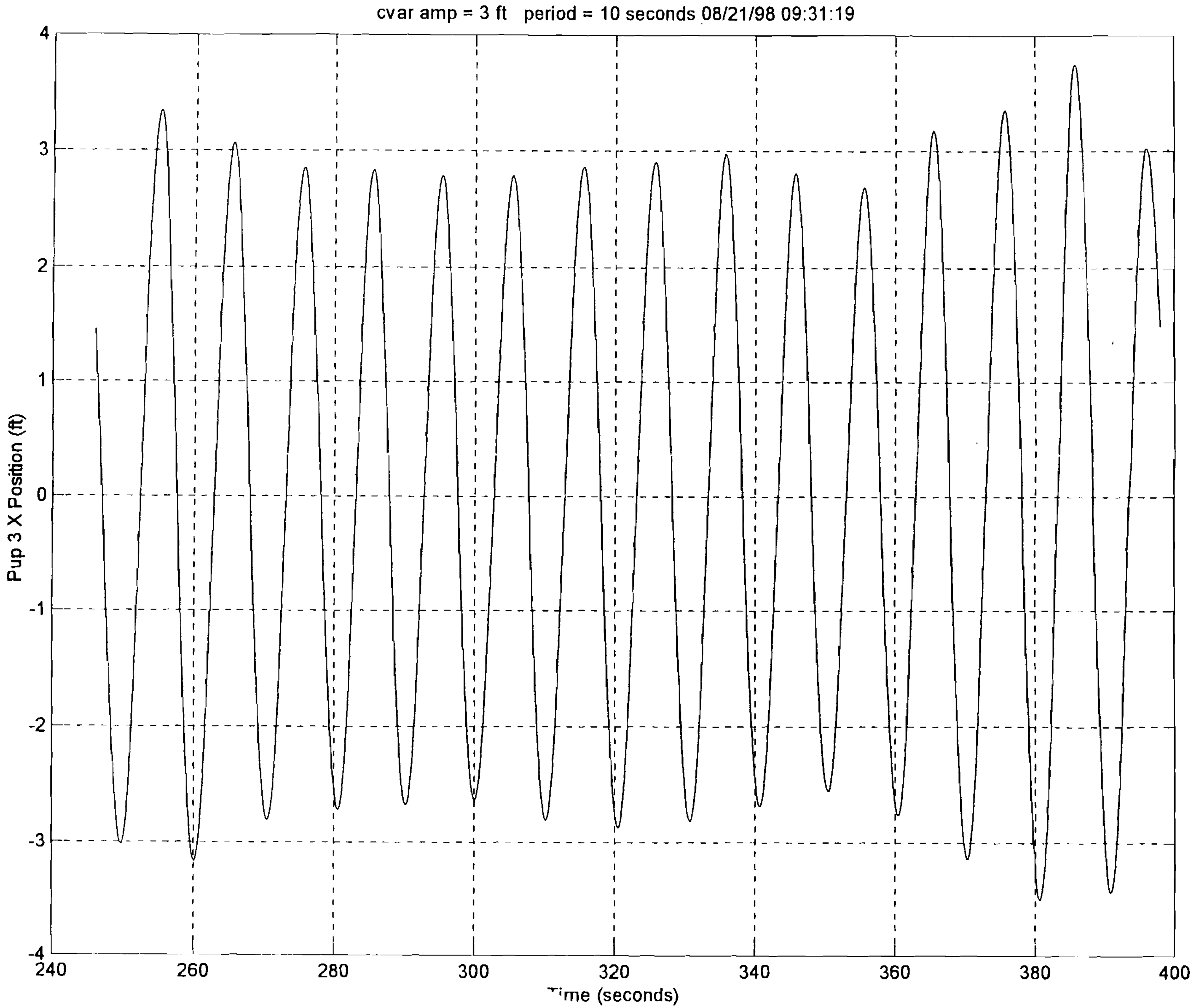

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
PUP 8 Tension COR (lbs)
320
310
300
290
280
270
260
240
260
280
300
320
340
360
380
400
Time (seconds)

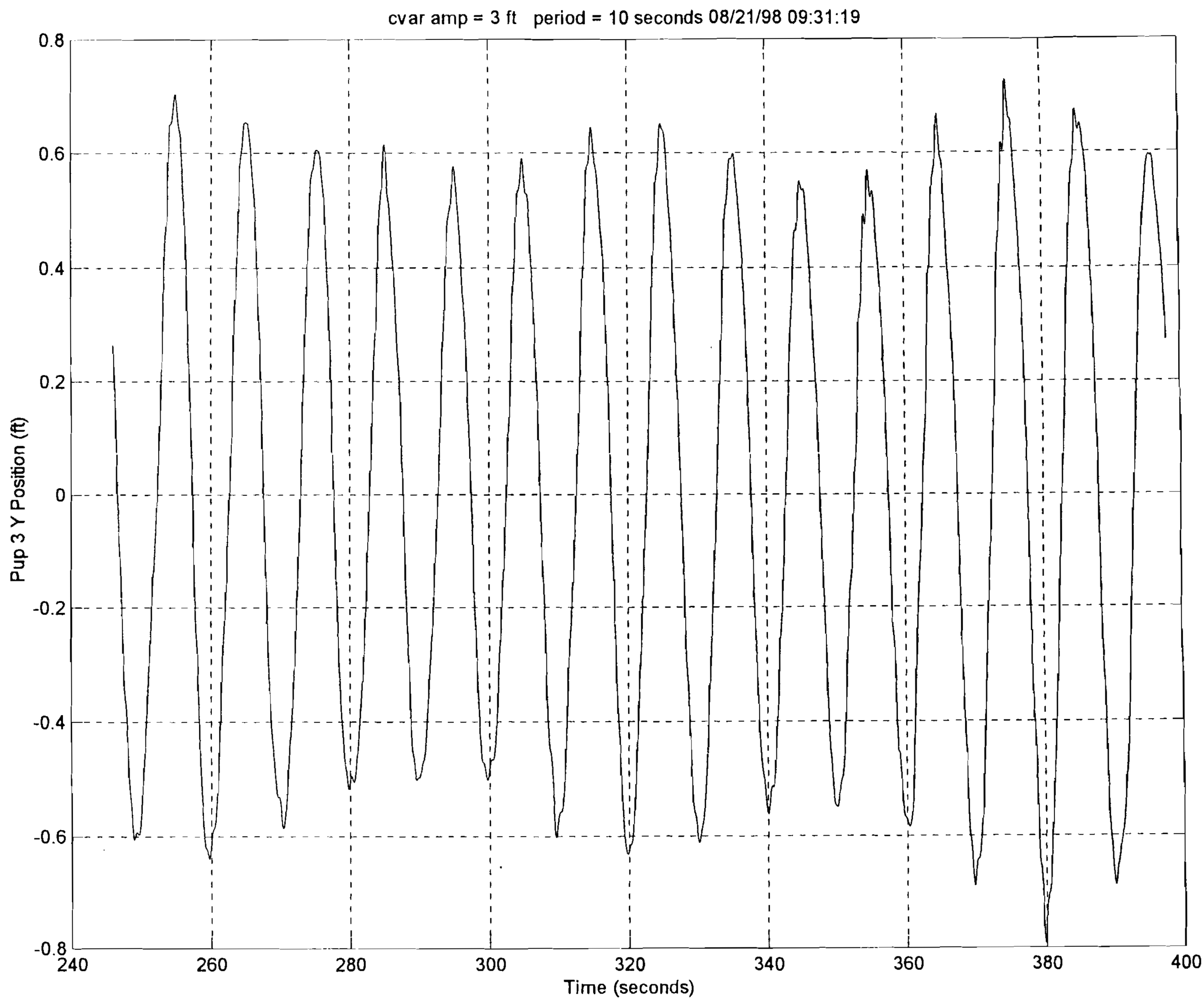

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 1 X Position (ft)
Time (seconds)
10
8
6
4
2
0
-2
-4
-6
-8
-10
240
260
280
300
320
340
360
380
400

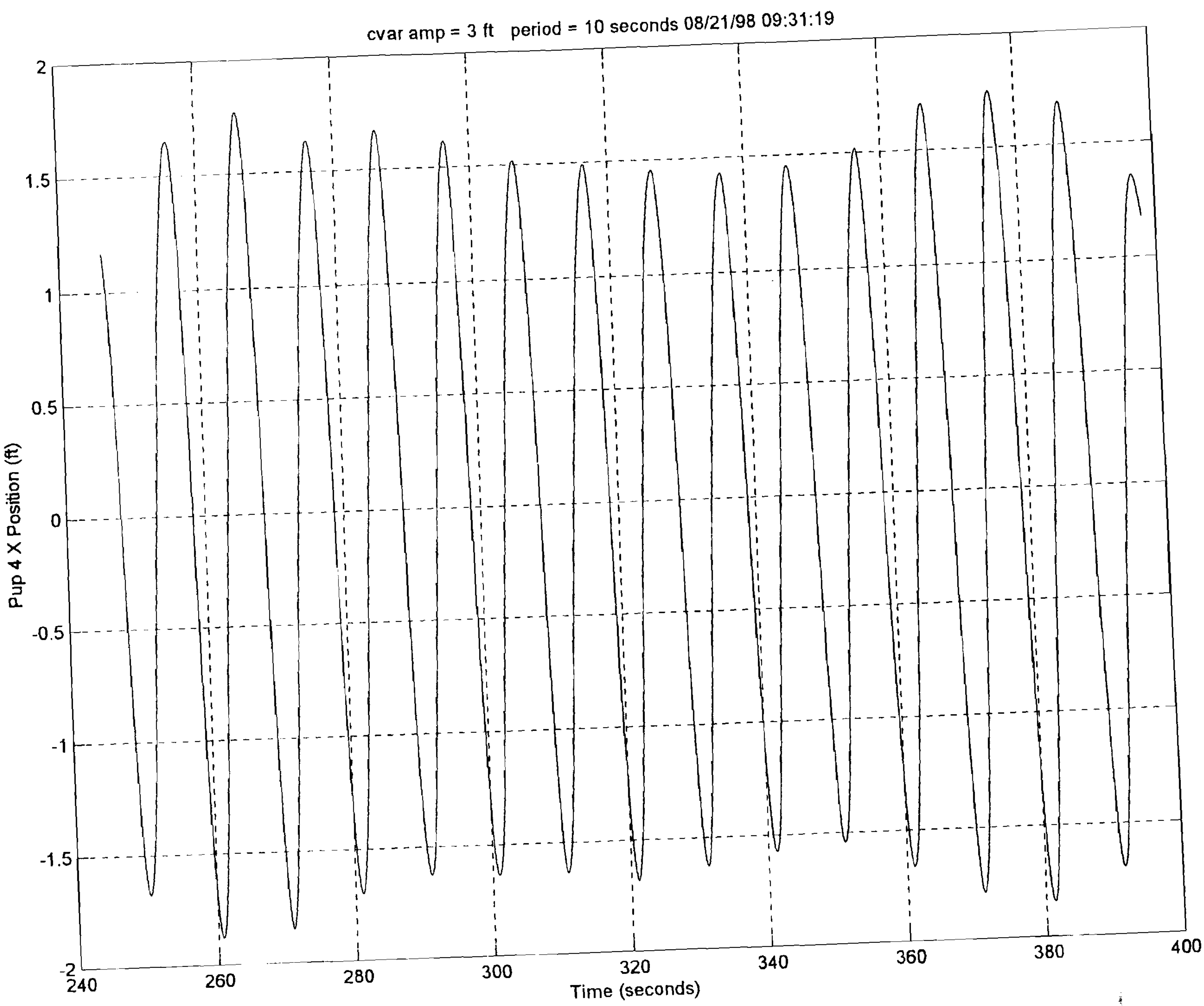

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 1 Y Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
-1.5
240
260
280
300
320
340
360
380
400

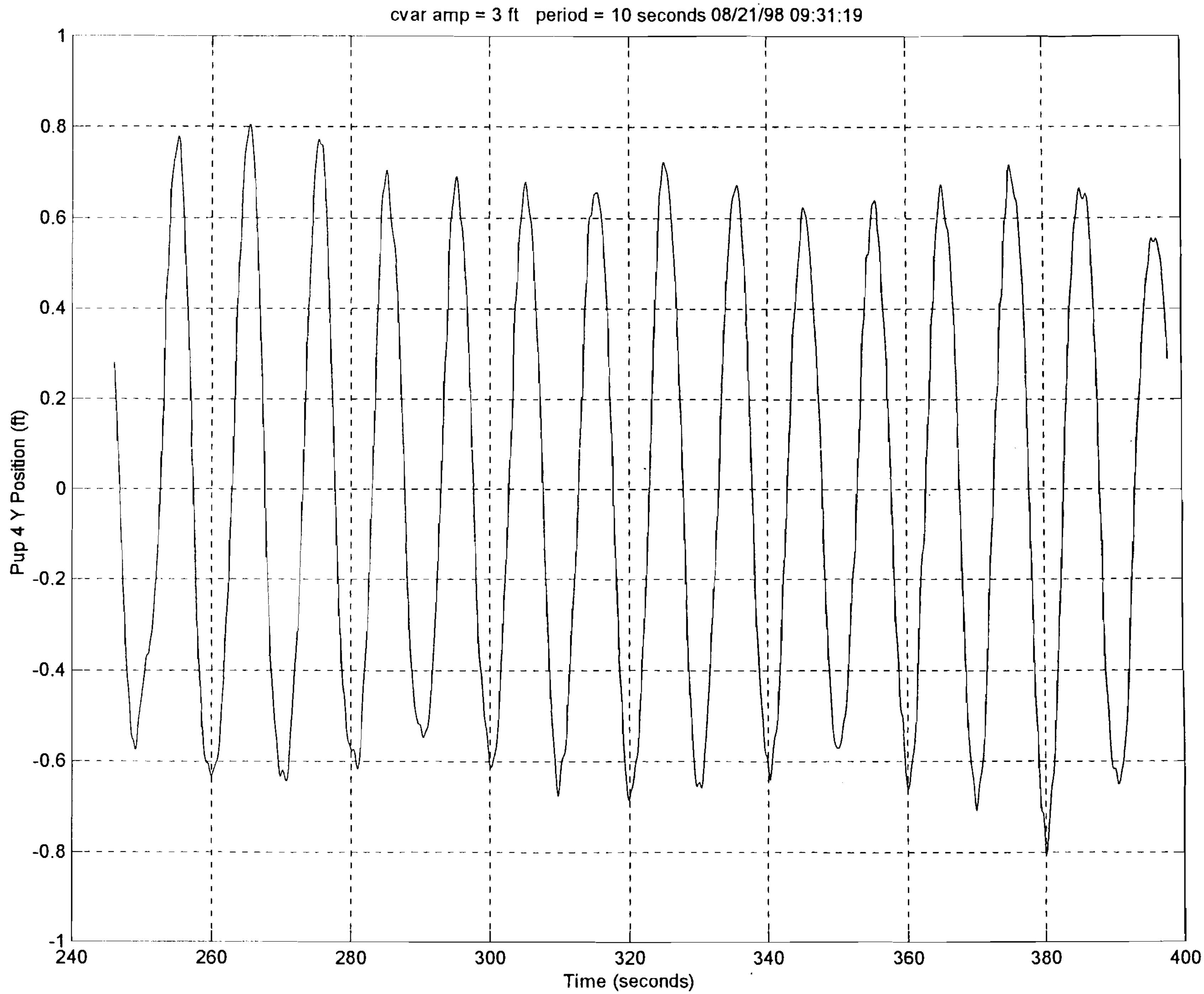

cvar amp = 3 ft   period = 10 seconds 08/21/98 09:31:19
Pup 2 X Position (ft)
Time (seconds)
8
6
4
2
0
-2
-4
-6
-8
240
260
280
300
320
340
360
380
400

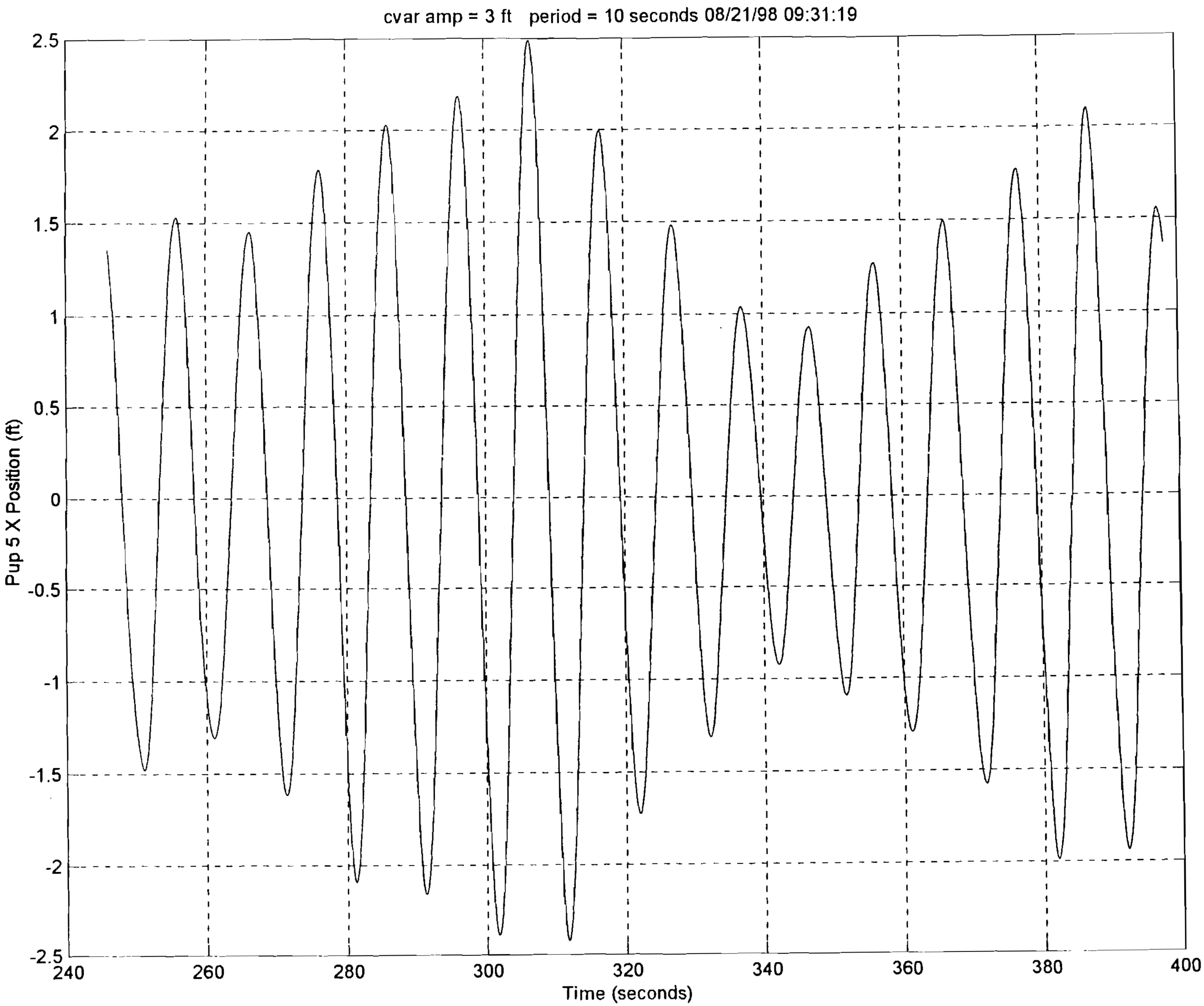

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 2 Y Position (ft)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
240
260
280
300
320
340
360
380
400
Time (seconds)


cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 3 X Position (ft)
4
3
2
1
0
-1
-2
-3
-4
240
260
280
300
320
340
360
380
400
Time (seconds)

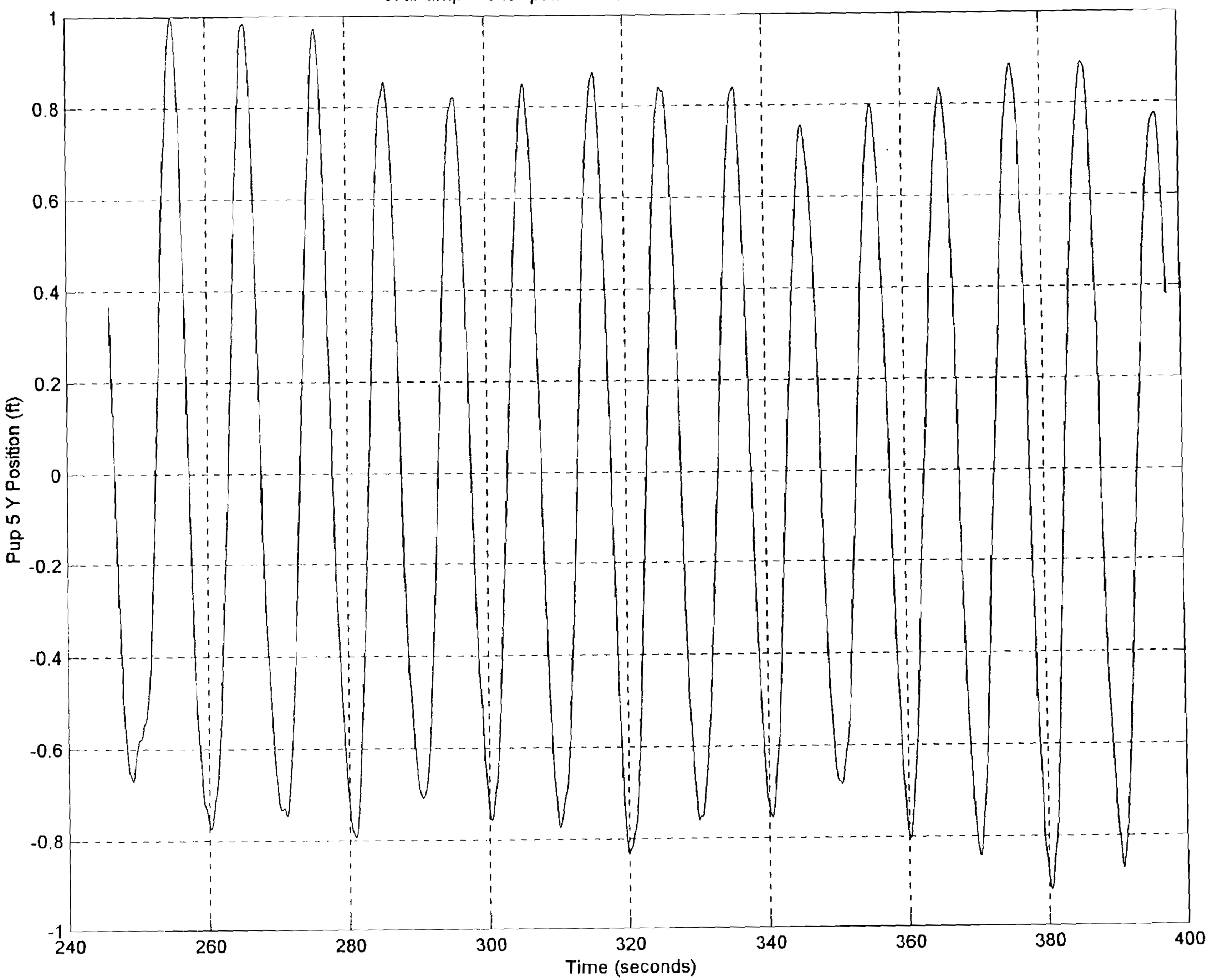

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Pup 3 Y Position (ft)
240
260
280
300
320
340
360
380
400
Time (seconds)

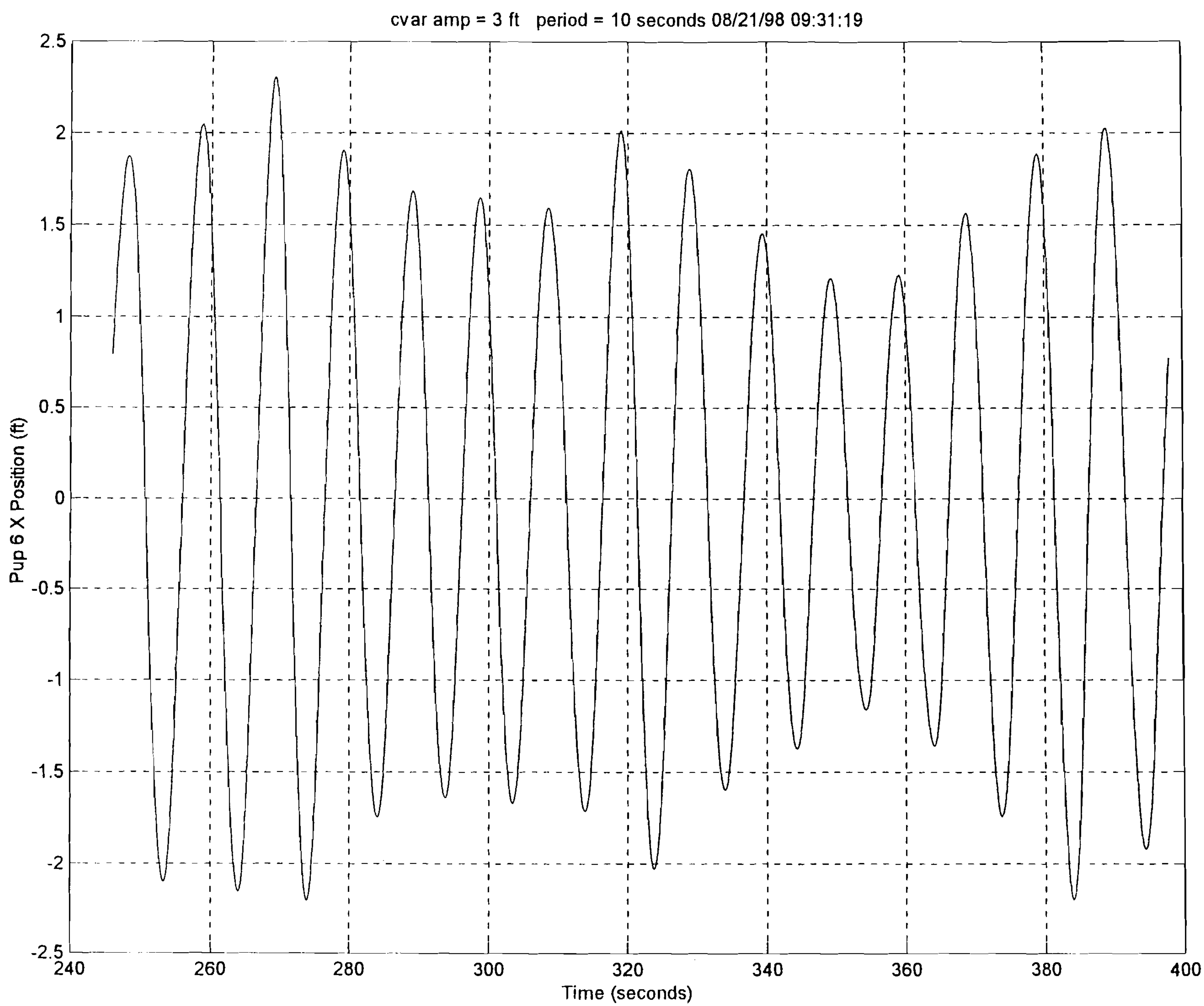

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 4 X Position (ft)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
240
260
280
300
320
340
360
380
400
Time (seconds)

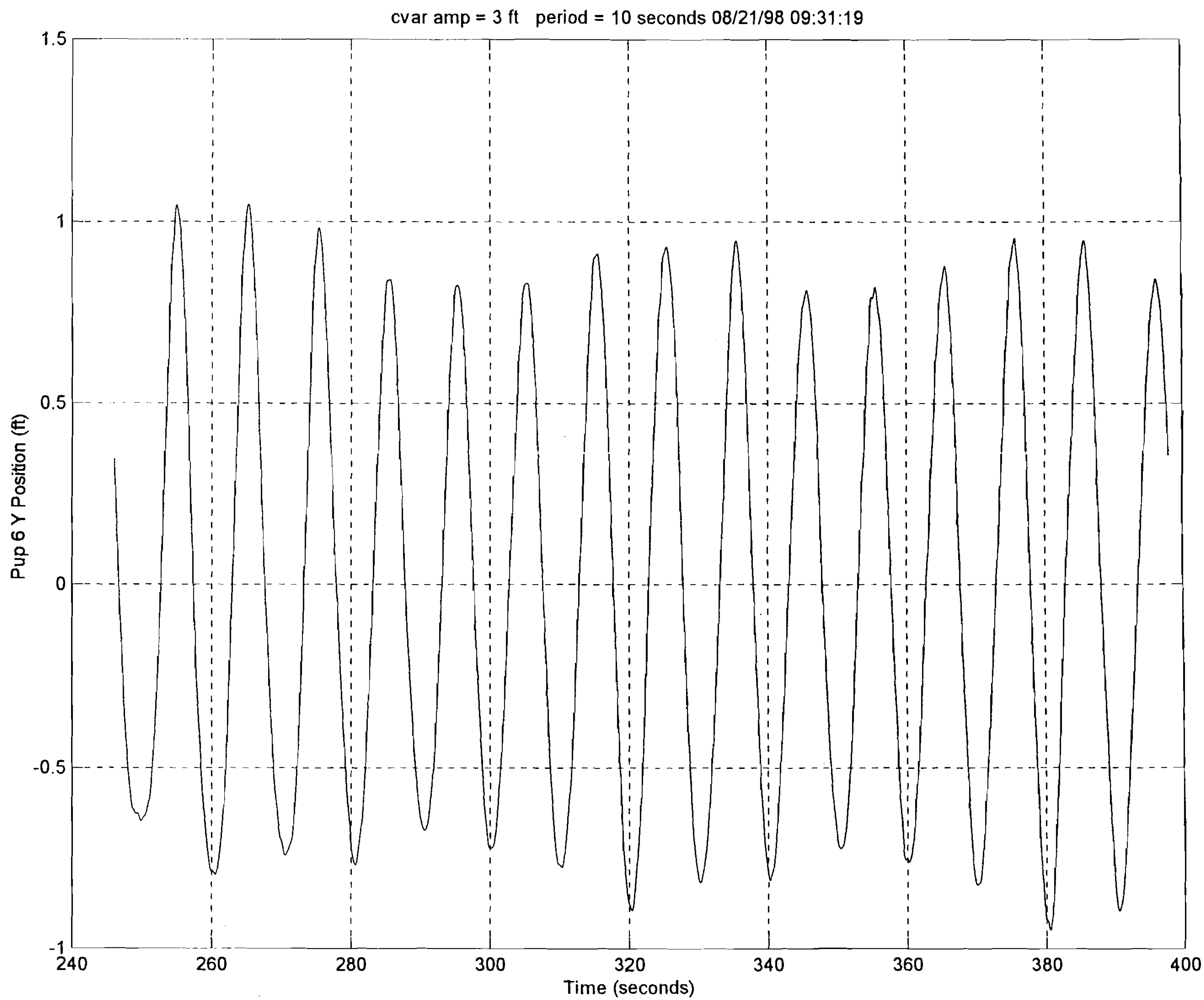

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 4 Y Position (ft)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
240
260
280
300
320
340
360
380
400
Time (seconds)

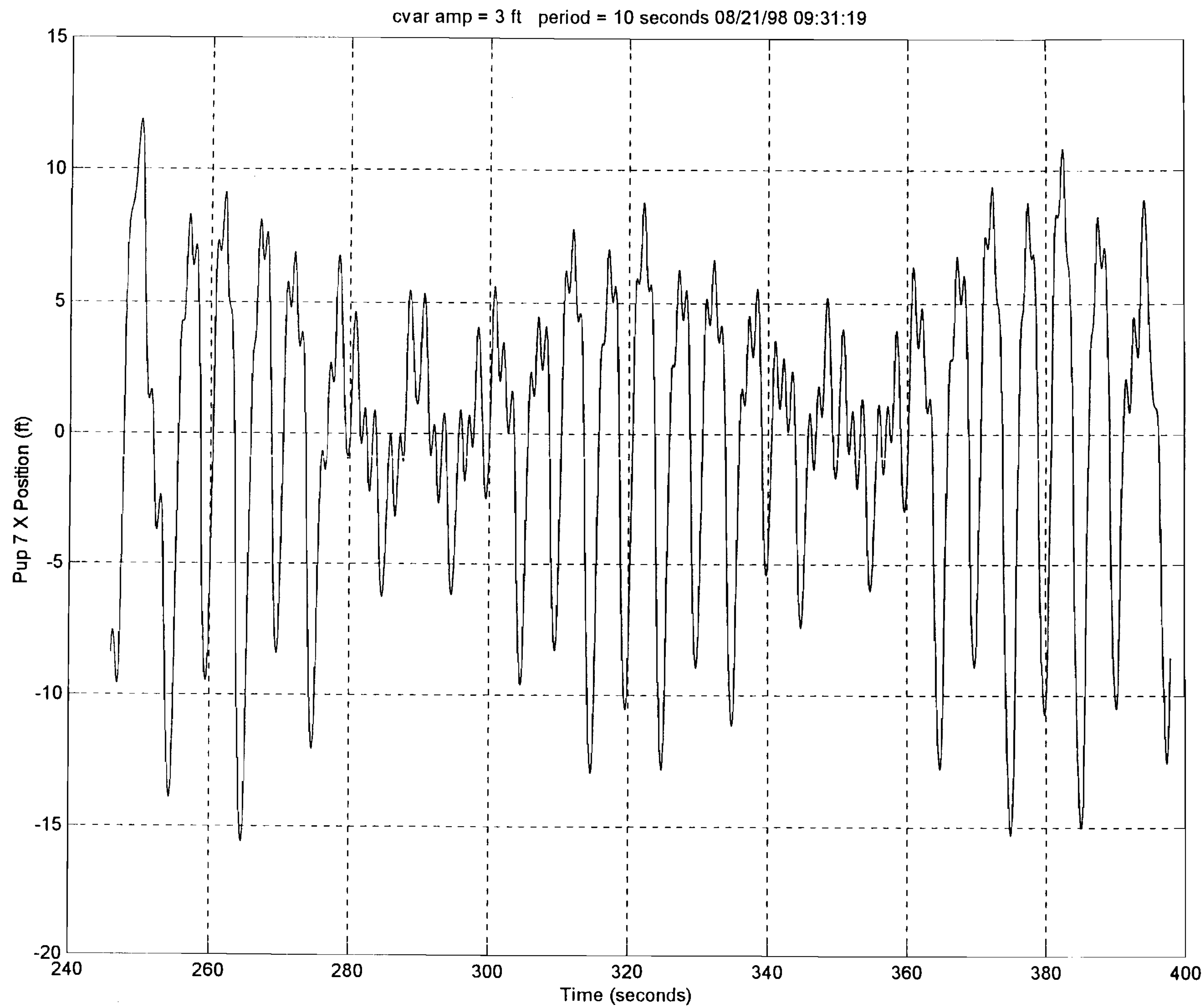

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 5 X Position (ft)
Time (seconds)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
240
260
280
300
320
340
360
380
400

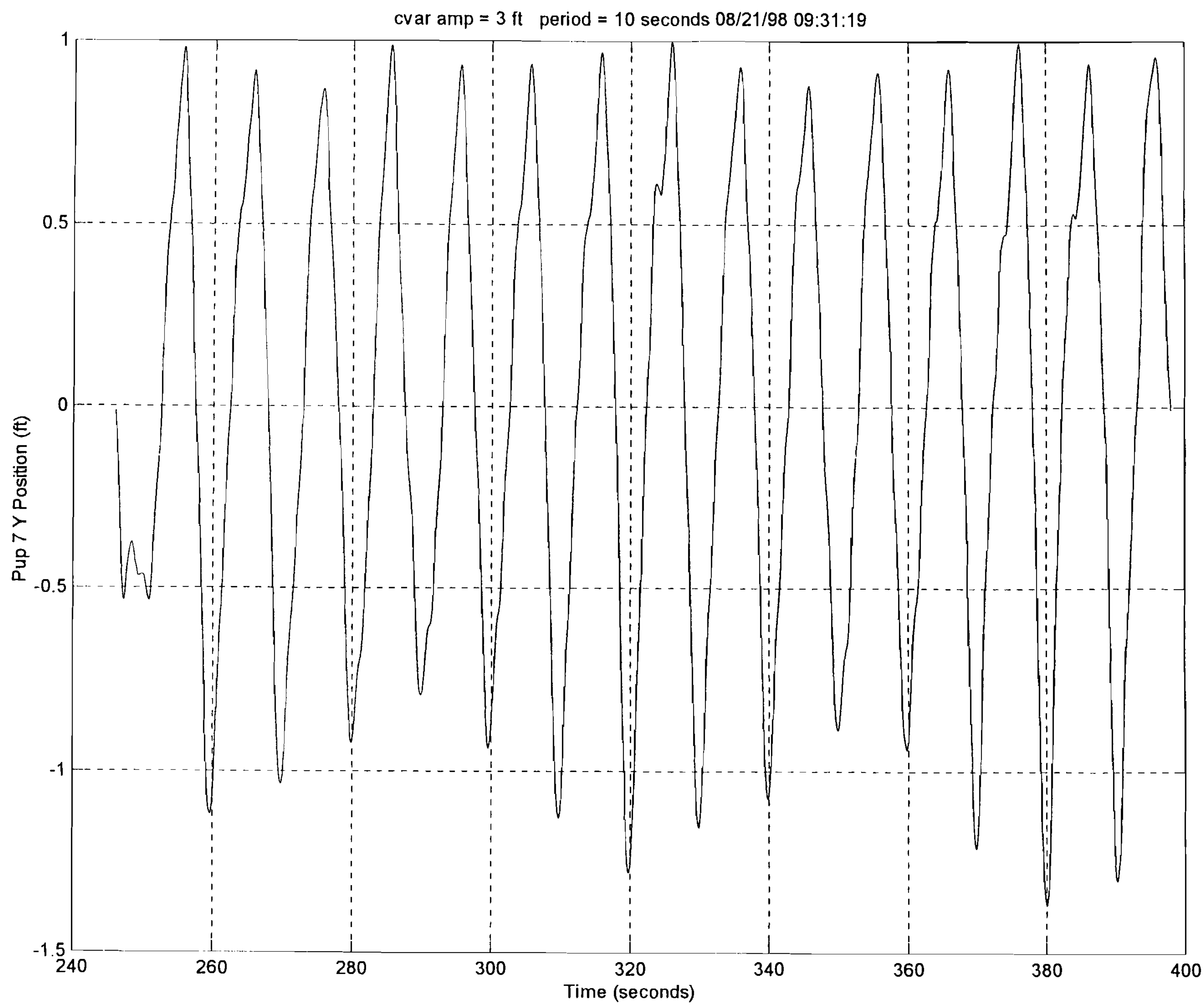
cvar amp = 3 ft   period = 10 seconds 08/21/98 09:31:19

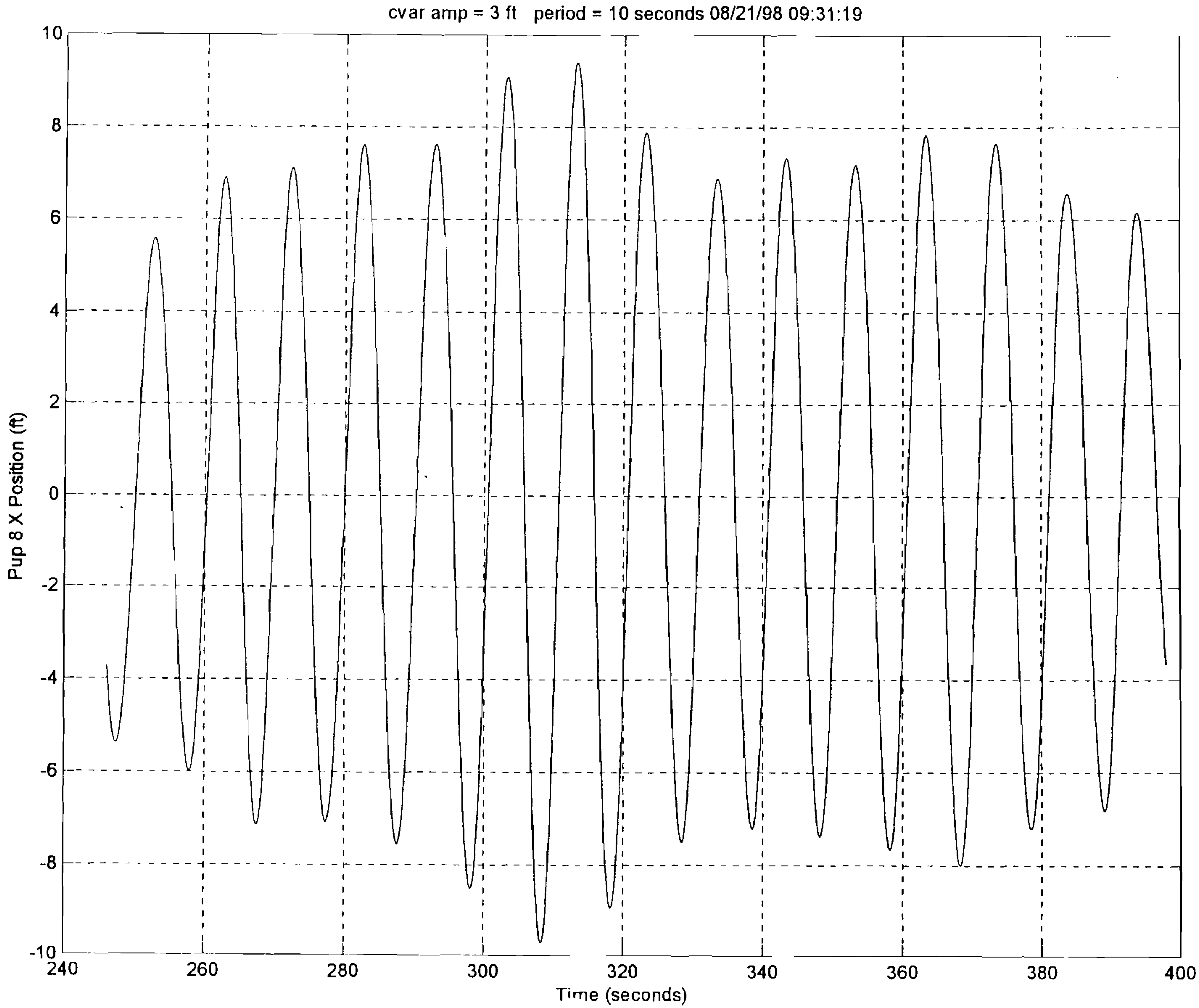


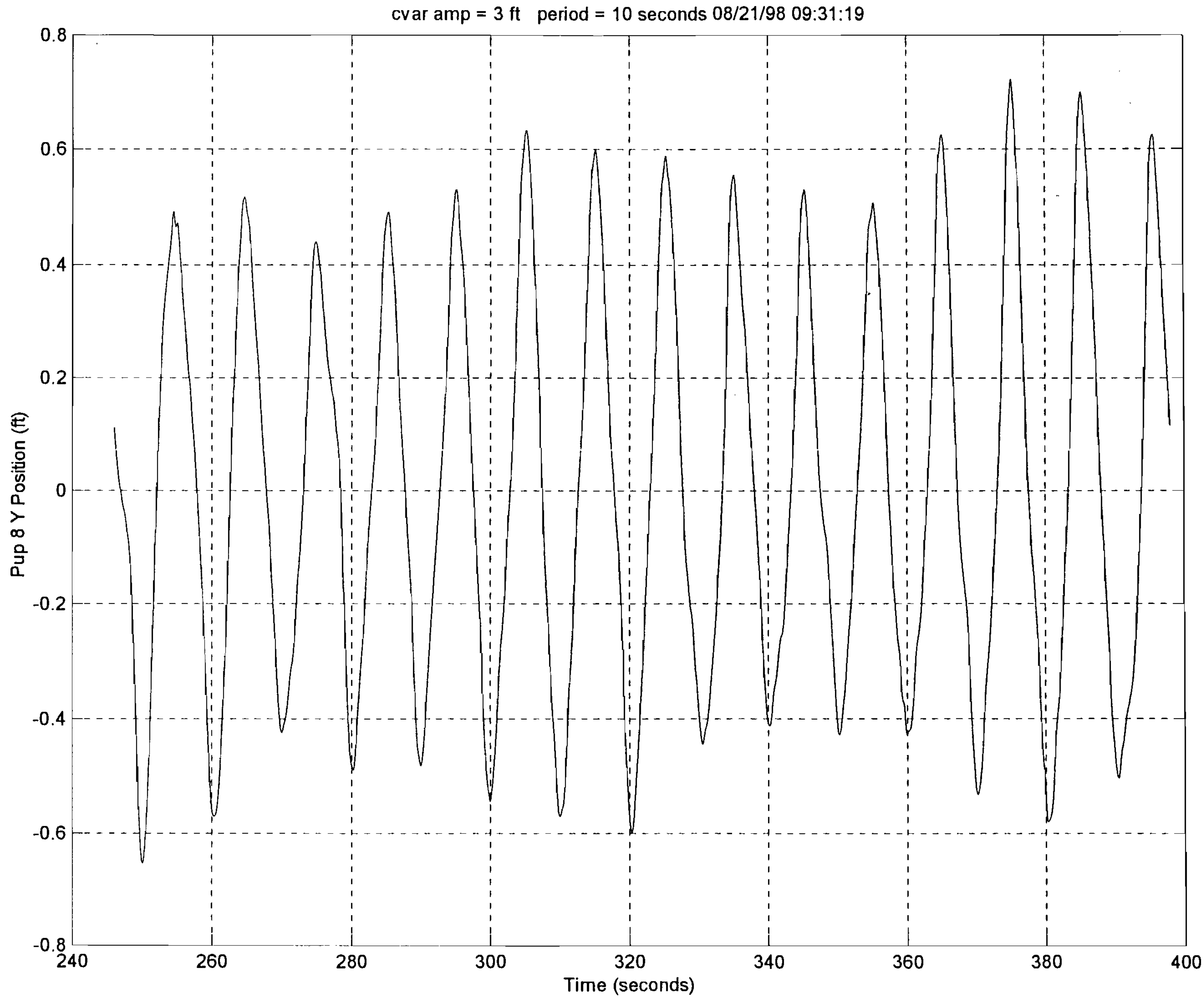

cvar amp = 3 ft   period = 10 seconds 08/21/98 09:31:19
Pup 6 X Position (ft)
Time (seconds)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
240
260
280
300
320
340
360
380
400

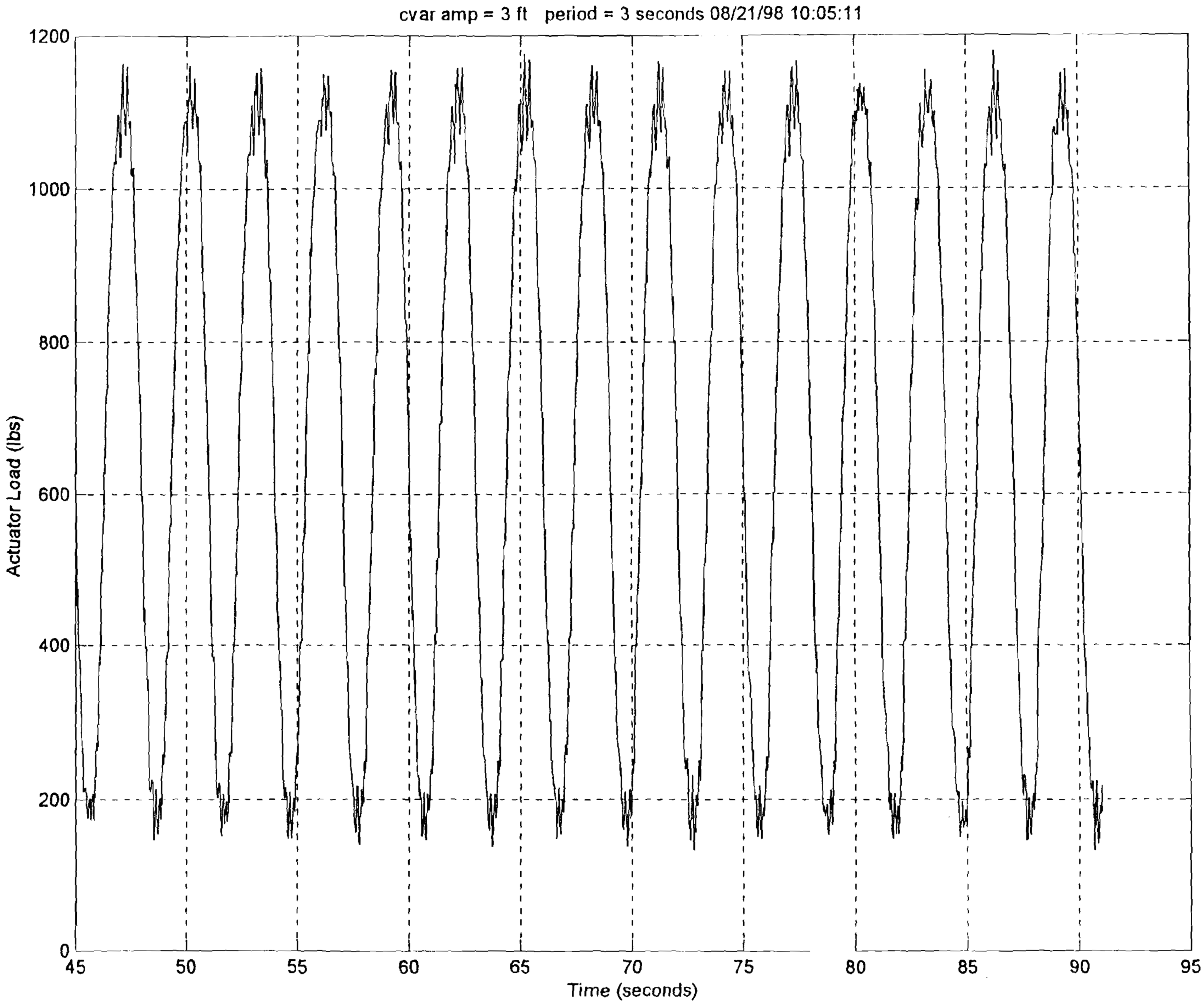

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 6 Y Position (ft)
1.5
1
0.5
0
-0.5
-1
240
260
280
300
320
340
360
380
400
Time (seconds)


cvar amp = 3 ft   period = 10 seconds 08/21/98 09:31:19
Pup 7 X Position (ft)
Time (seconds)
15
10
5
0
-5
-10
-15
-20
240
260
280
300
320
340
360
380
400

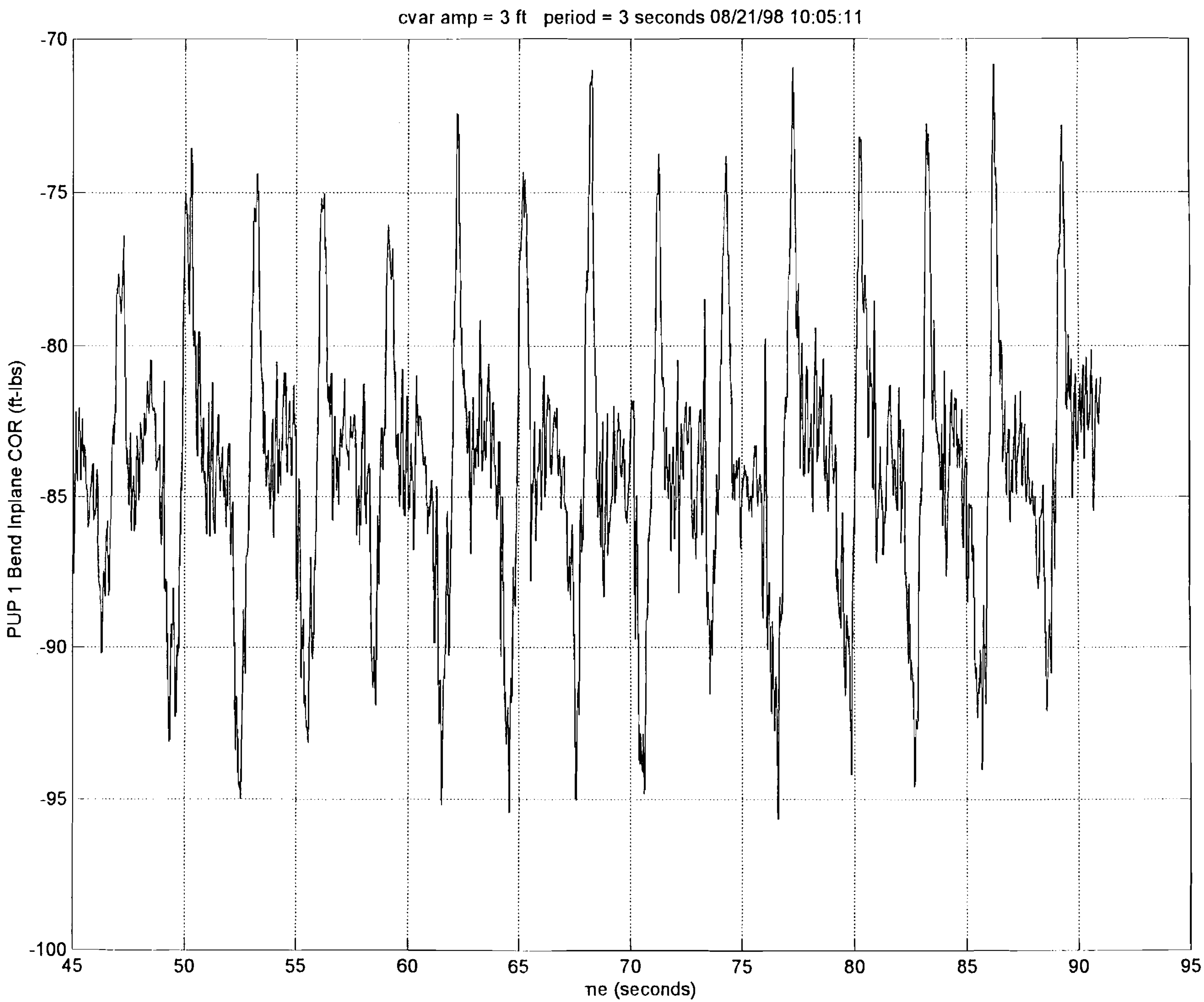

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 7 Y Position (ft)
1
0.5
0
-0.5
-1
-1.5
240
260
280
300
320
340
360
380
400
Time (seconds)

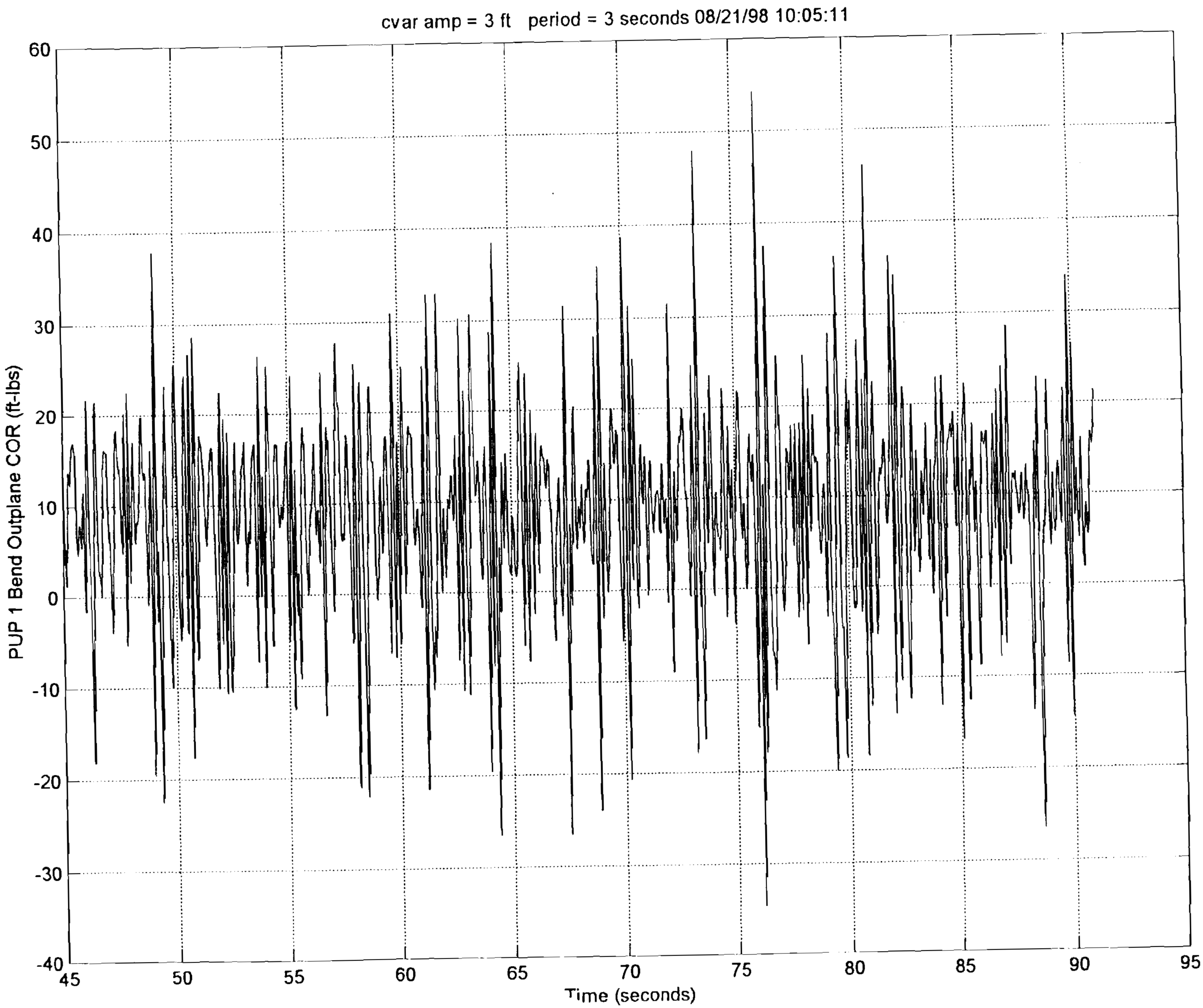

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 8 X Position (ft)
Time (seconds)
10
8
6
4
2
0
-2
-4
-6
-8
-10
240
260
280
300
320
340
360
380
400

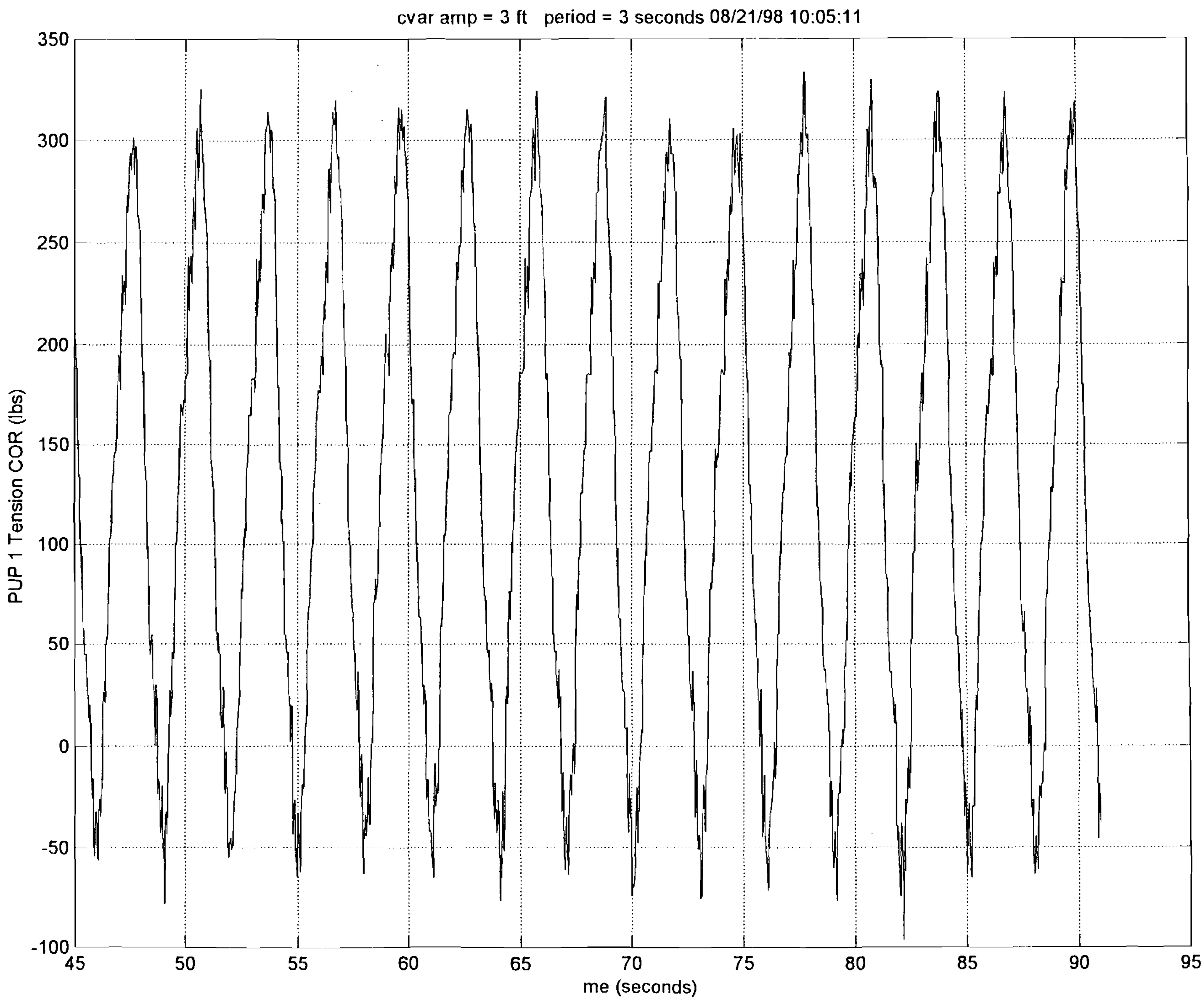

cvar amp = 3 ft period = 10 seconds 08/21/98 09:31:19
Pup 8 Y Position (ft)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
240
260
280
300
320
340
360
380
400
Time (seconds)

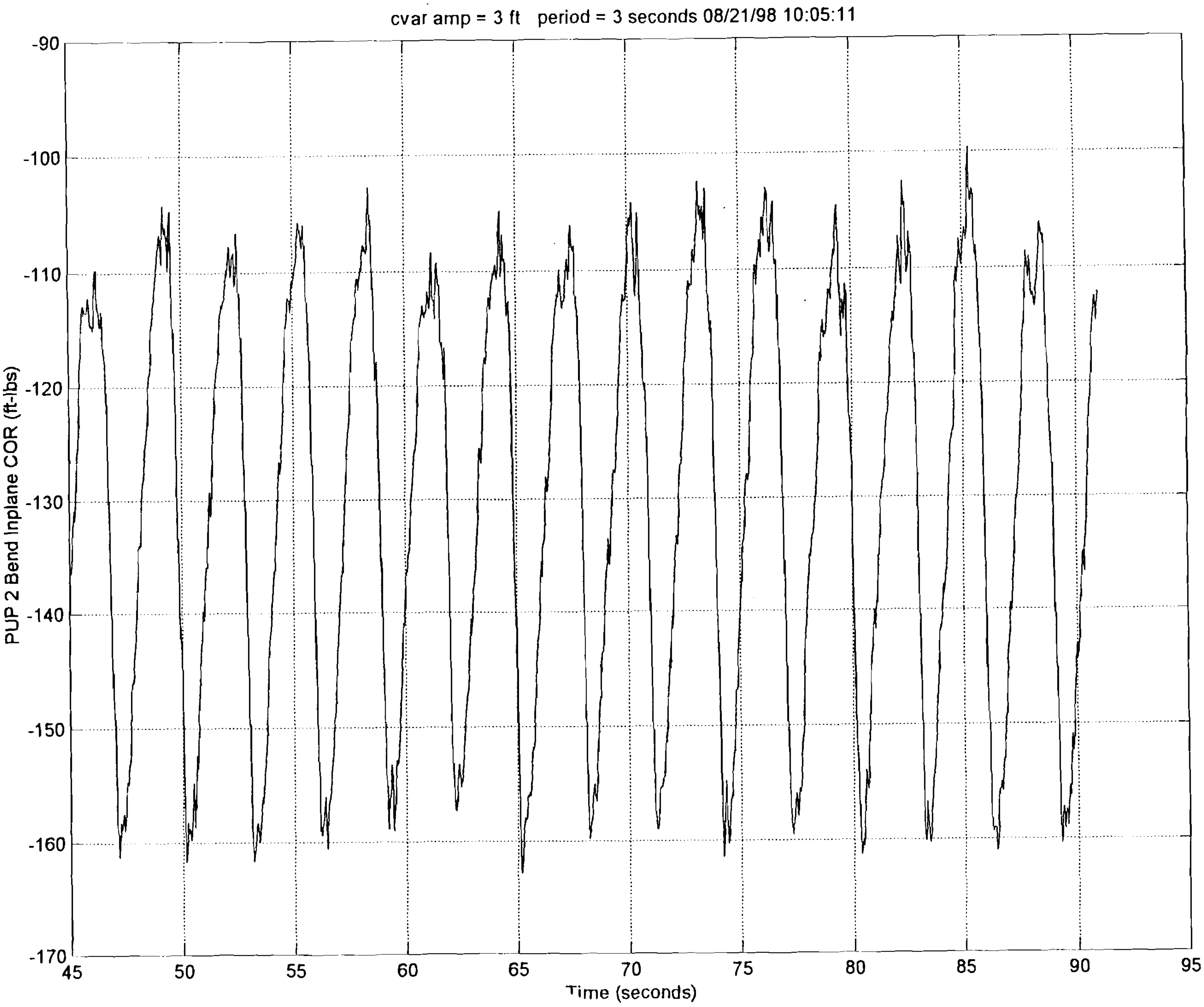


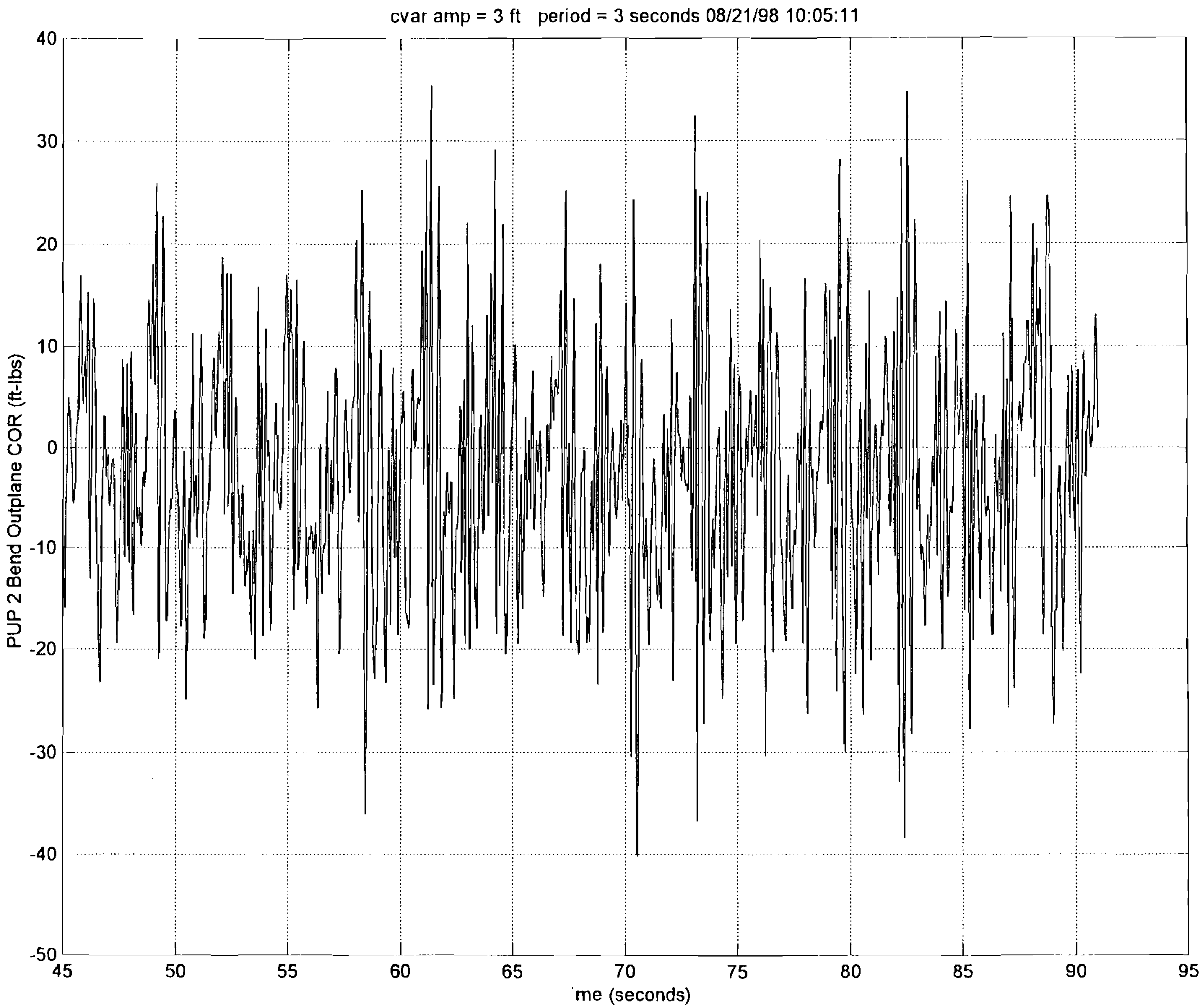
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Actuator Load (lbs)
0
200
400
600
800
1000
1200
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)

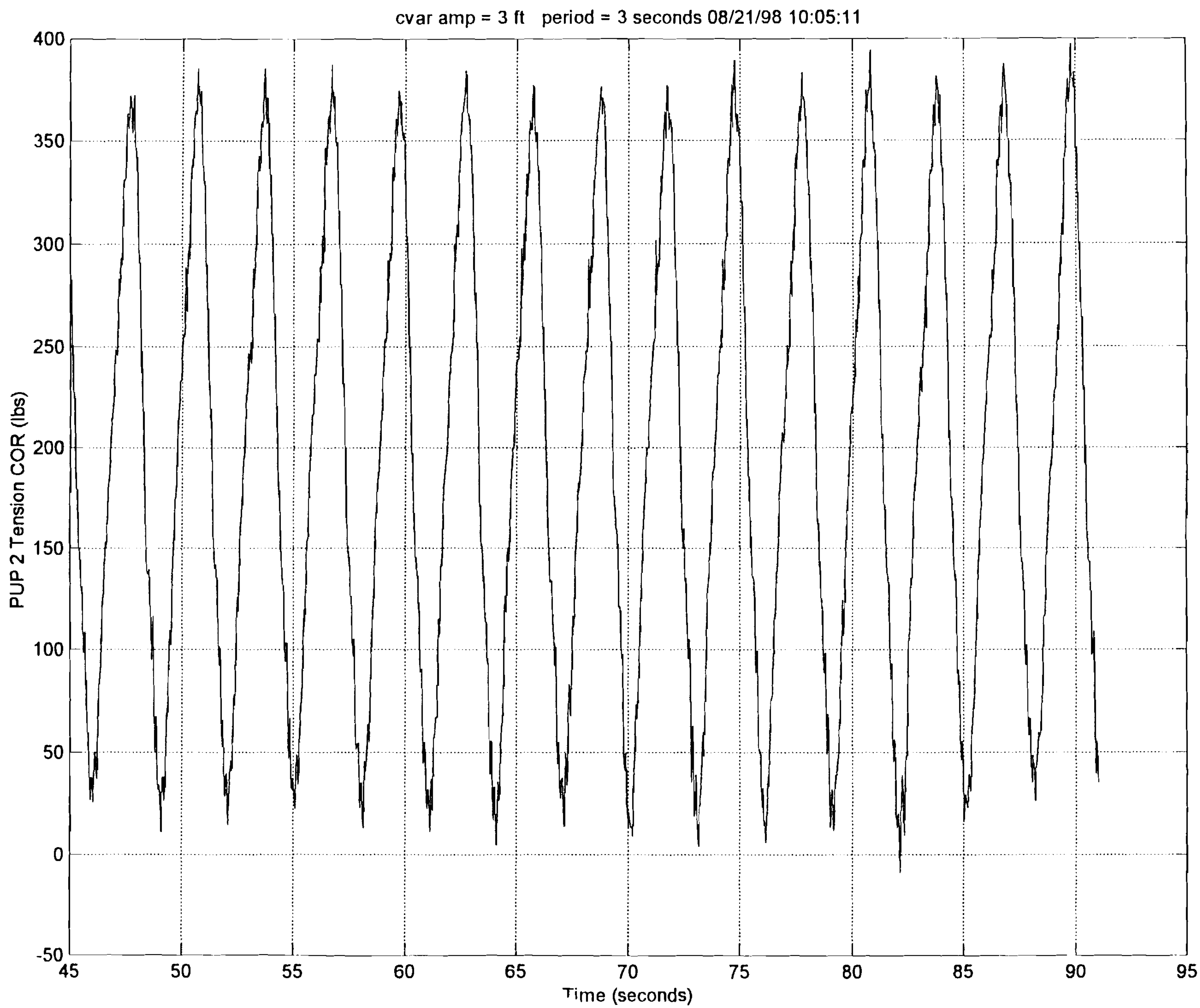

cvar amp = 3 ft   period = 3 seconds 08/21/98 10:05:11
PUP 1 Bend Inplane COR (ft-lbs)
-70
-75
-80
-85
-90
-95
-100
45
50
55
60
65
70
75
80
85
90
95
ne (seconds)

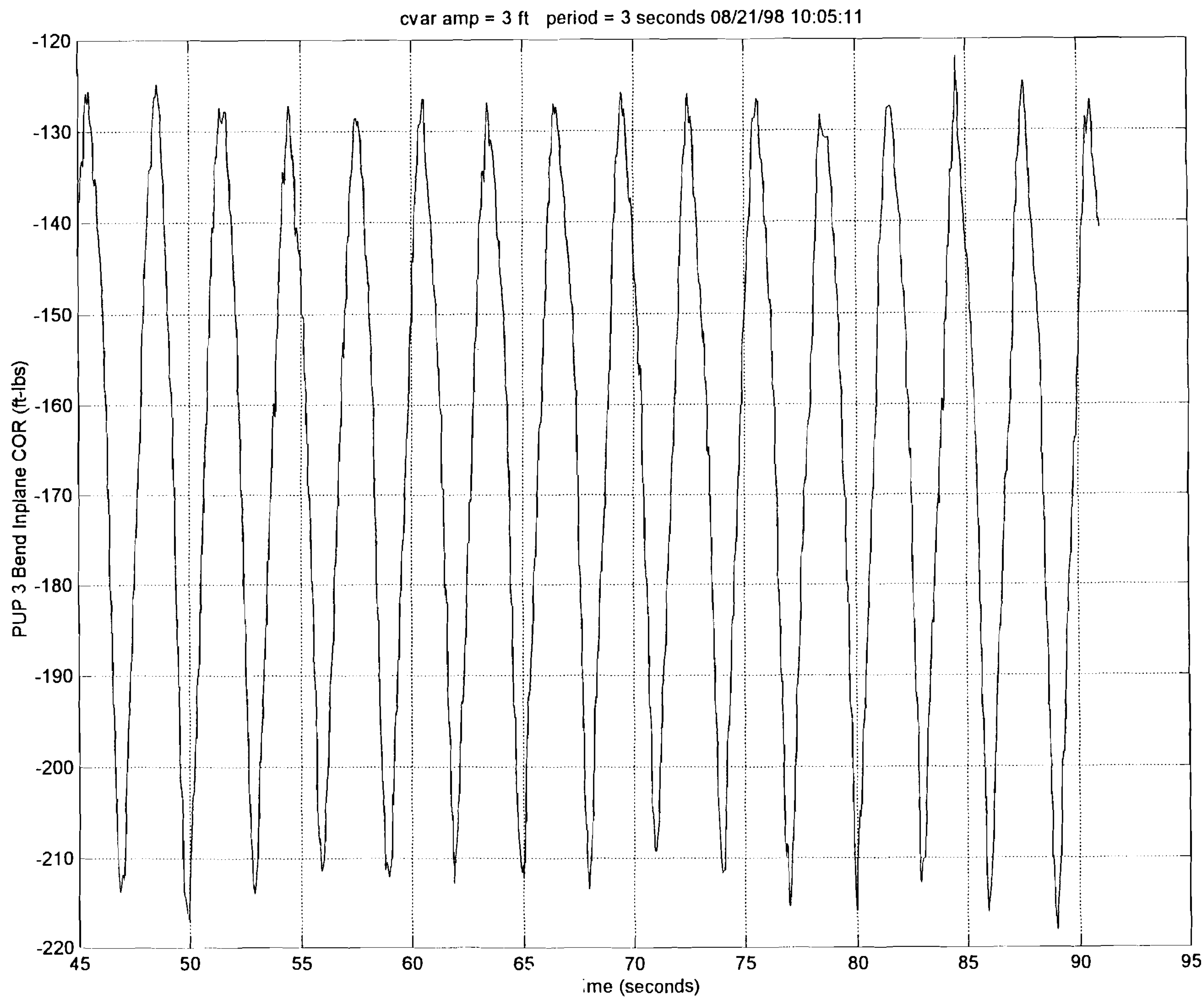

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 1 Bend Outplane COR (ft-lbs)
60
50
40
30
20
10
0
-10
-20
-30
-40
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)

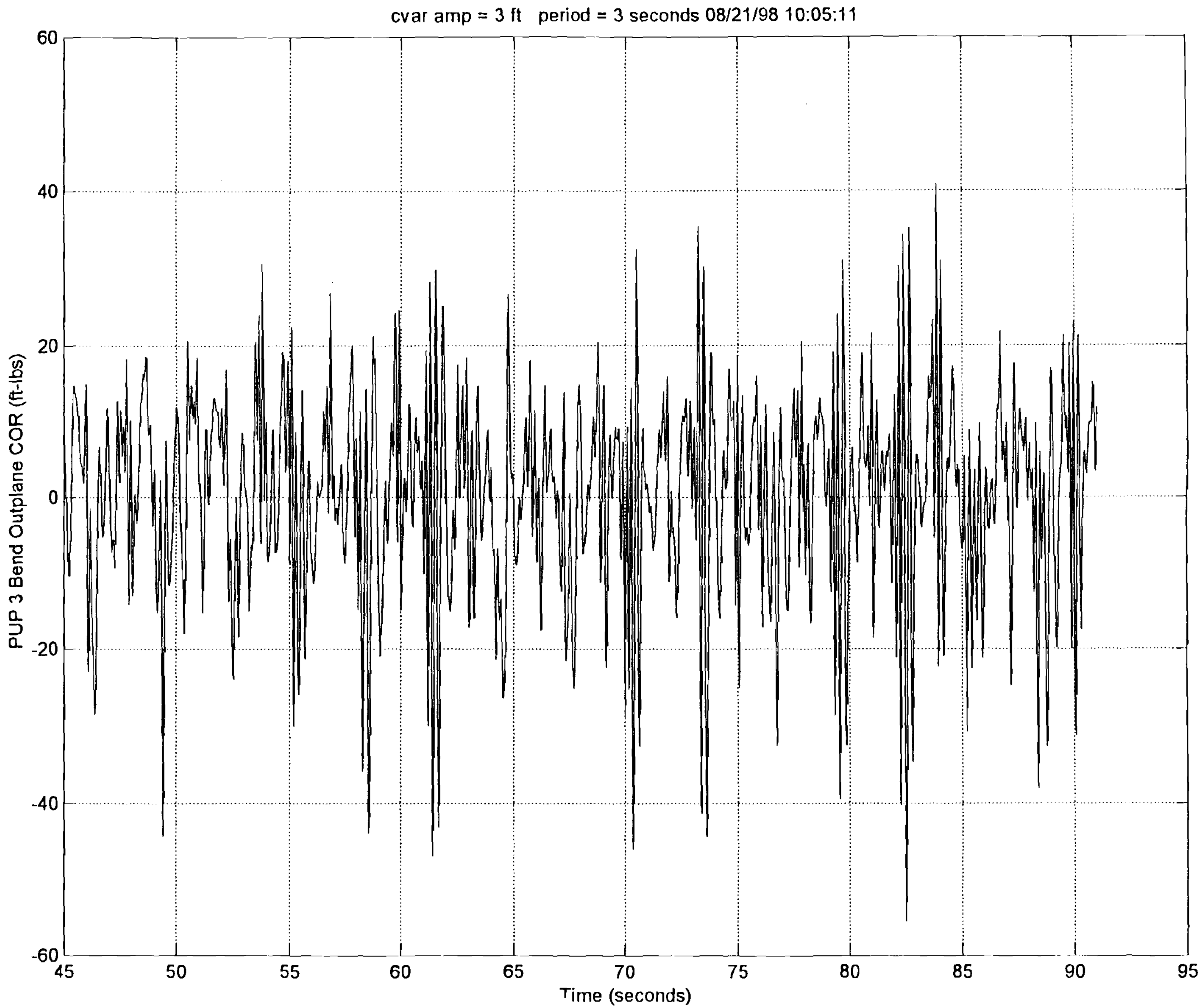

cvar amp = 3 ft   period = 3 seconds 08/21/98 10:05:11
PUP 1 Tension COR (lbs)
me (seconds)
350
300
250
200
150
100
50
0
-50
-100
45
50
55
60
65
70
75
80
85
90
95

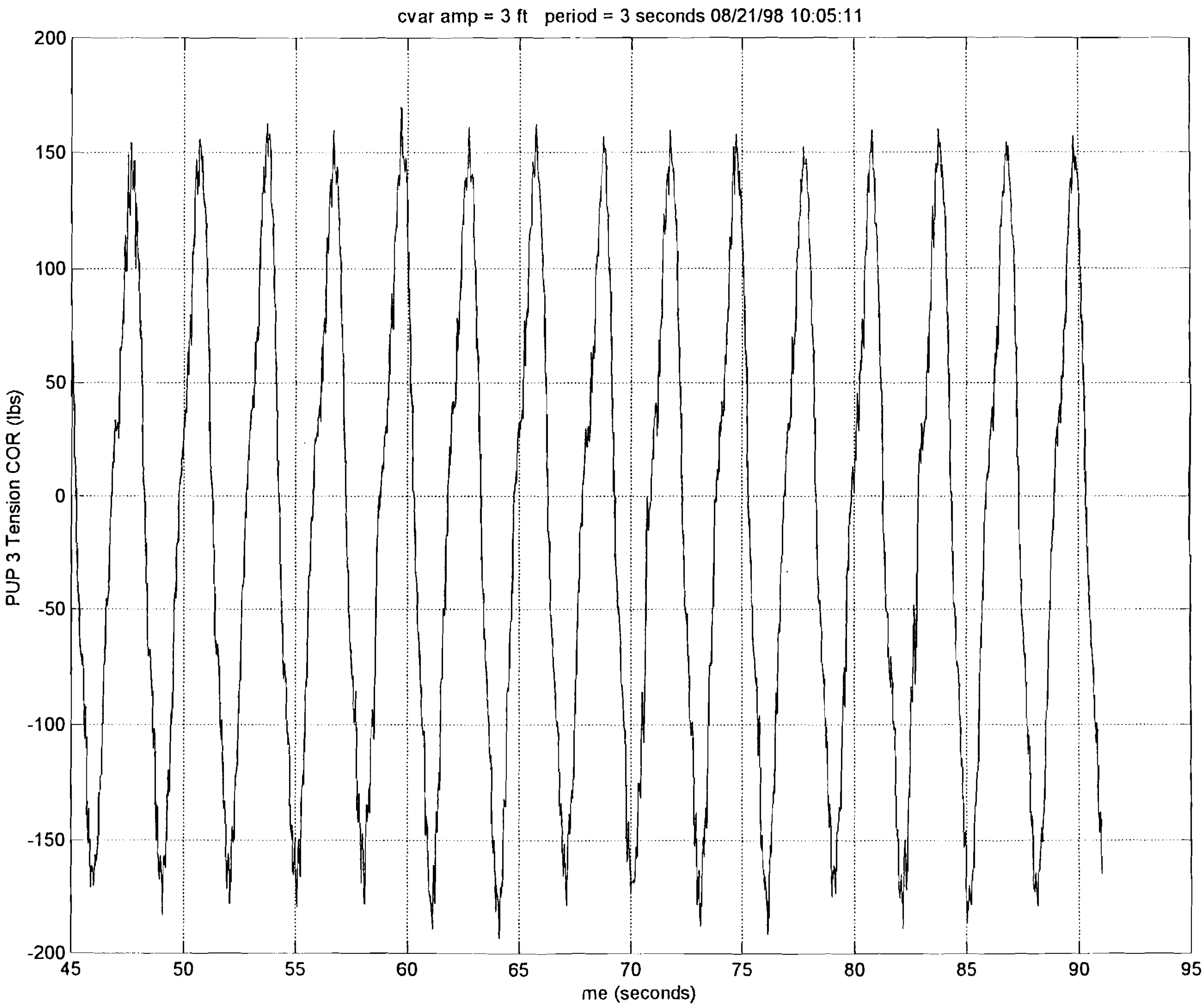

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
-90
-100
-110
-120
-130
-140
-150
-160
-170
PUP 2 Bend Inplane COR (ft-lbs)
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)

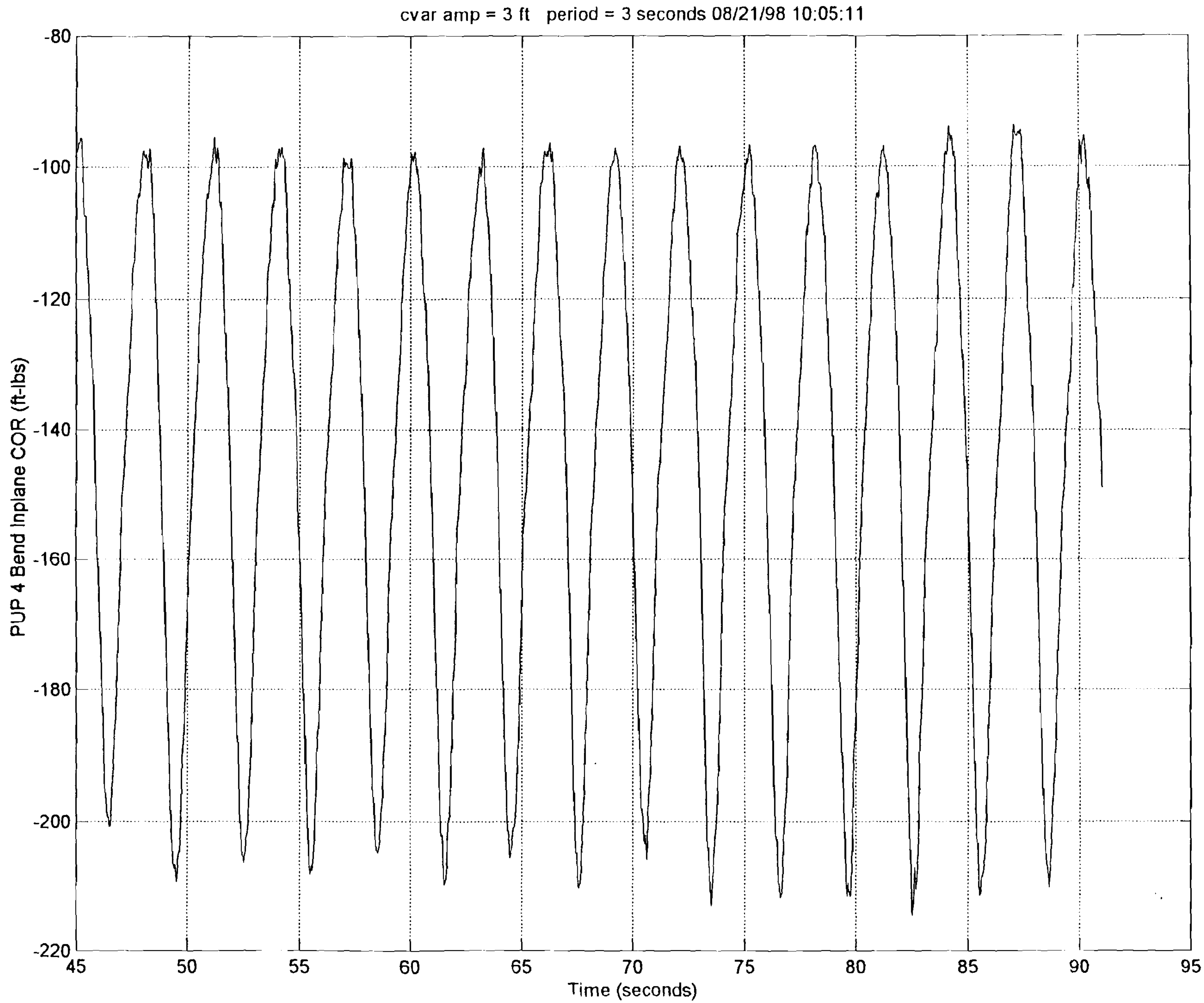

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 2 Bend Outplane COR (ft-lbs)
40
30
20
10
0
-10
-20
-30
-40
-50
45
50
55
60
65
70
75
80
85
90
95
me (seconds)

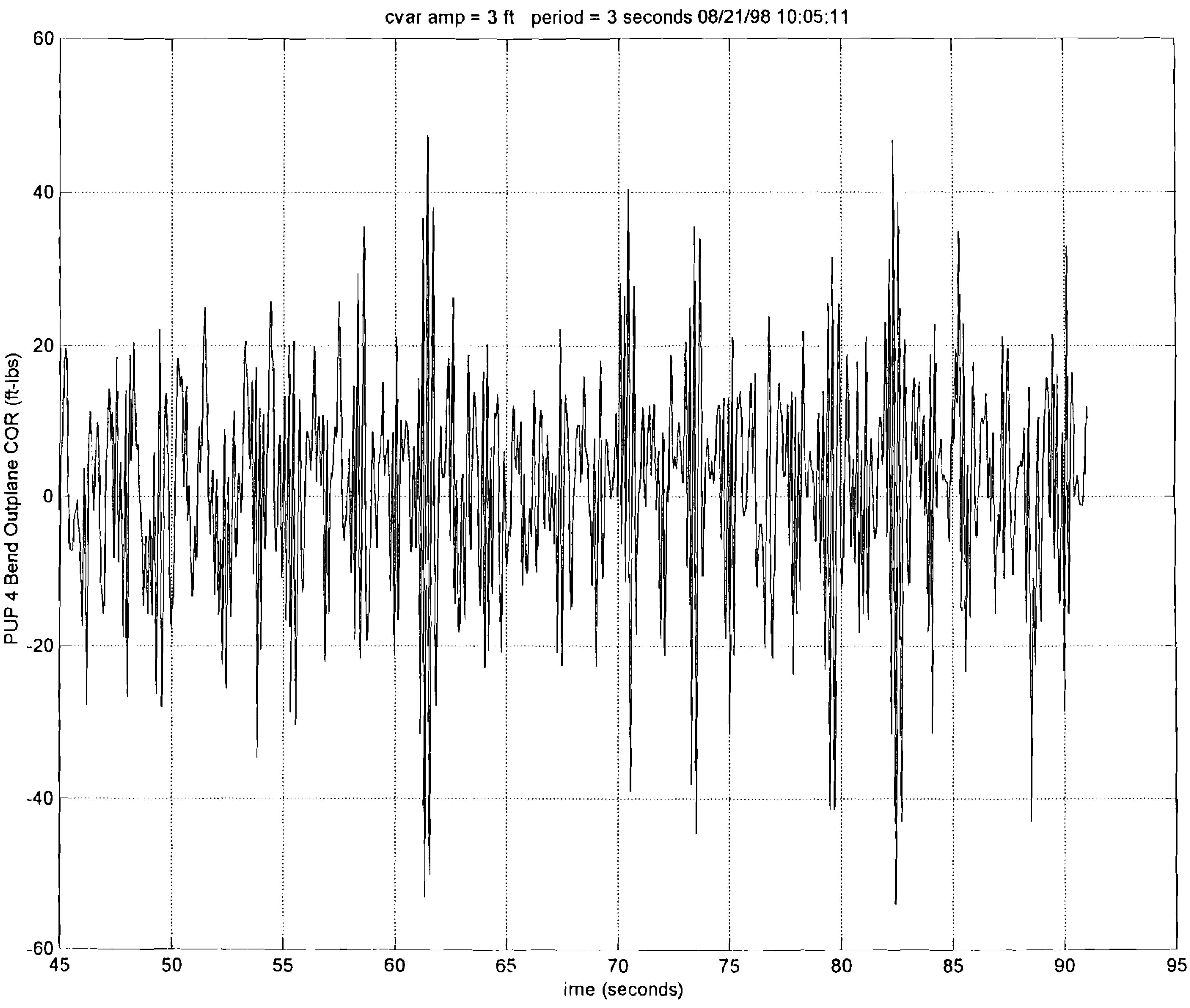

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 2 Tension COR (lbs)
Time (seconds)
400
350
300
250
200
150
100
50
0
-50
45
50
55
60
65
70
75
80
85
90
95

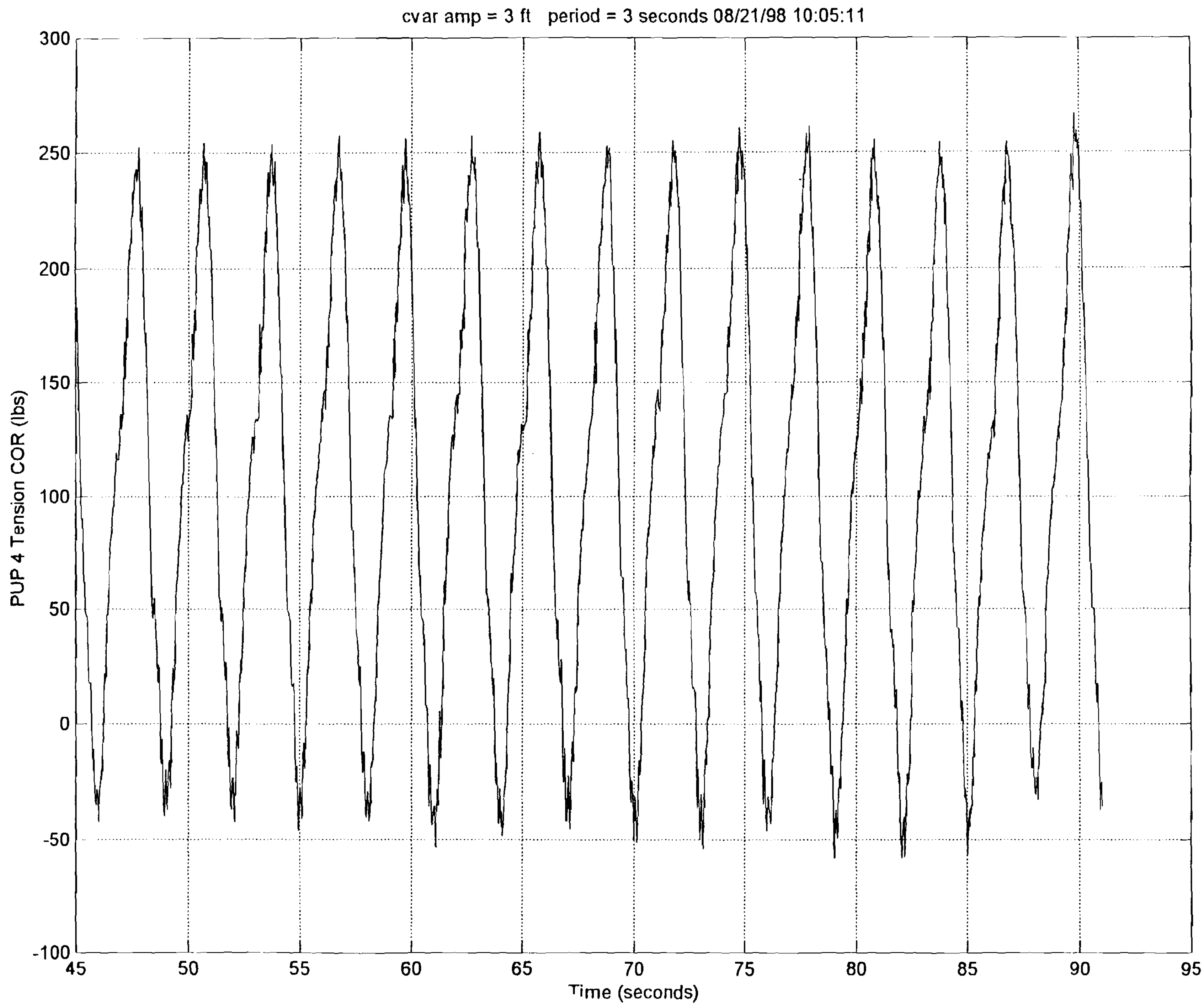

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 3 Bend Inplane COR (ft-lbs)
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
45
50
55
60
65
70
75
80
85
90
95
ime (seconds)

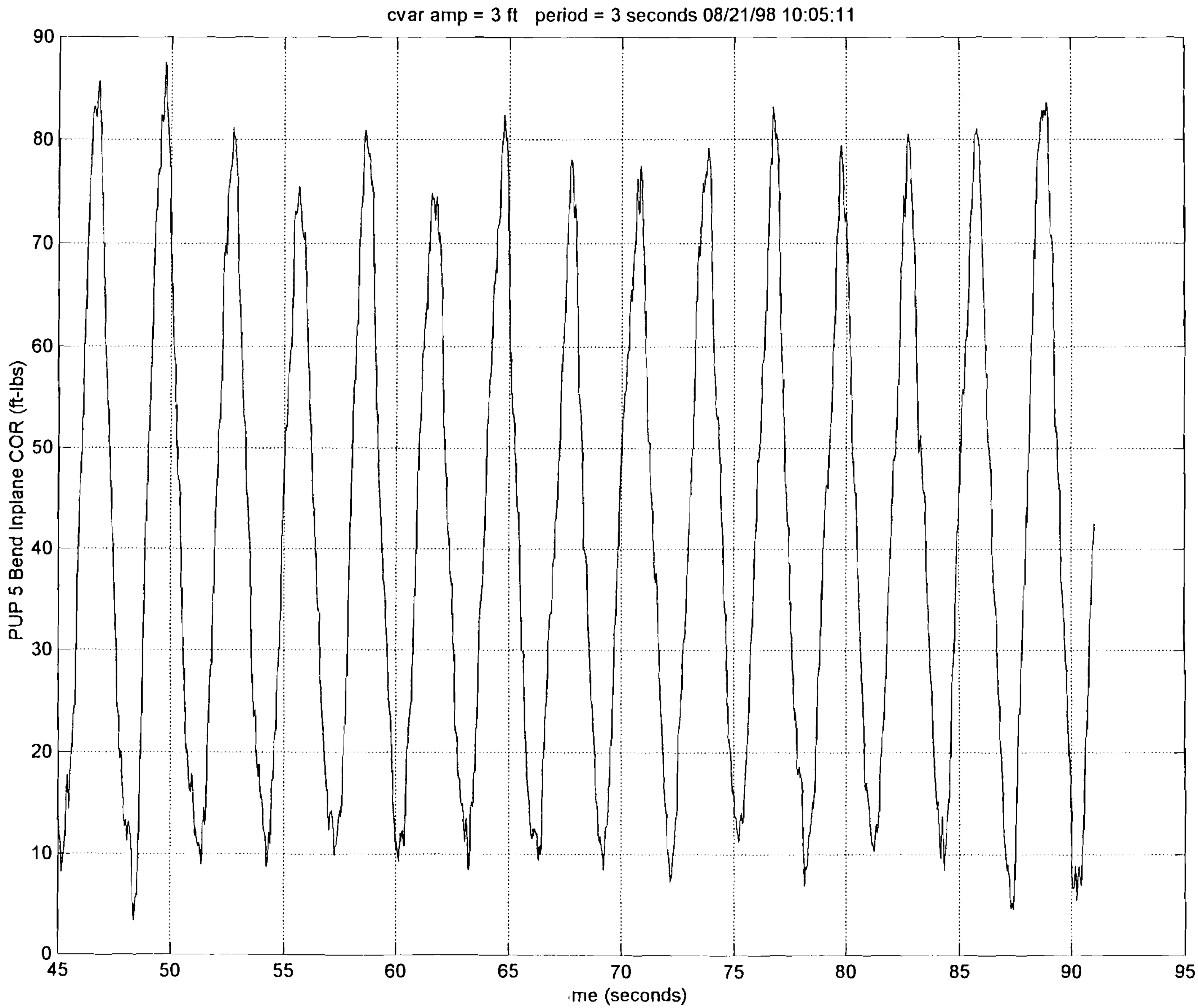

cvar amp = 3 ft   period = 3 seconds 08/21/98 10:05:11
PUP 3 Bend Outplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)

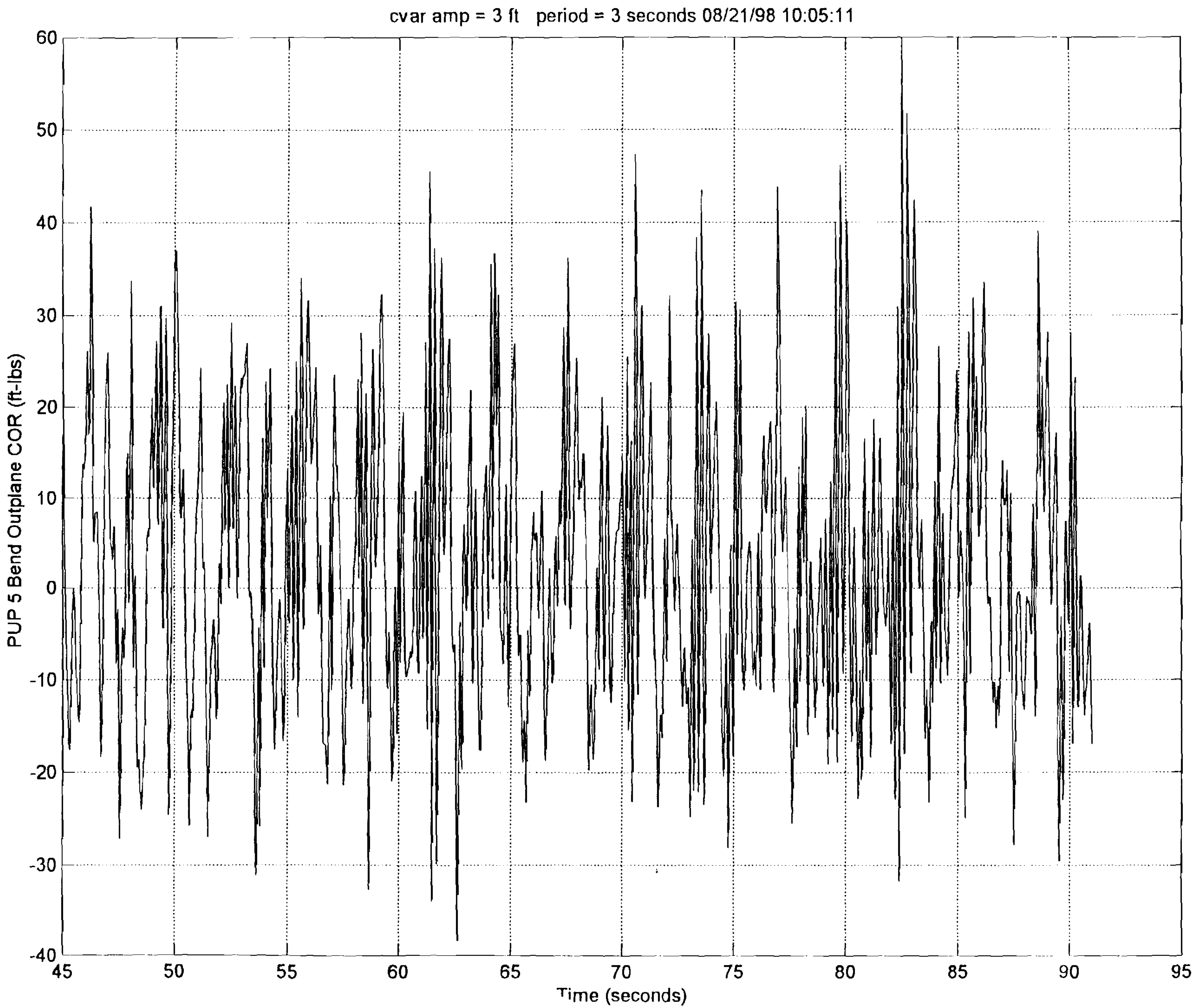

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 3 Tension COR (lbs)
200
150
100
50
0
-50
-100
-150
-200
45
50
55
60
65
70
75
80
85
90
95
me (seconds)

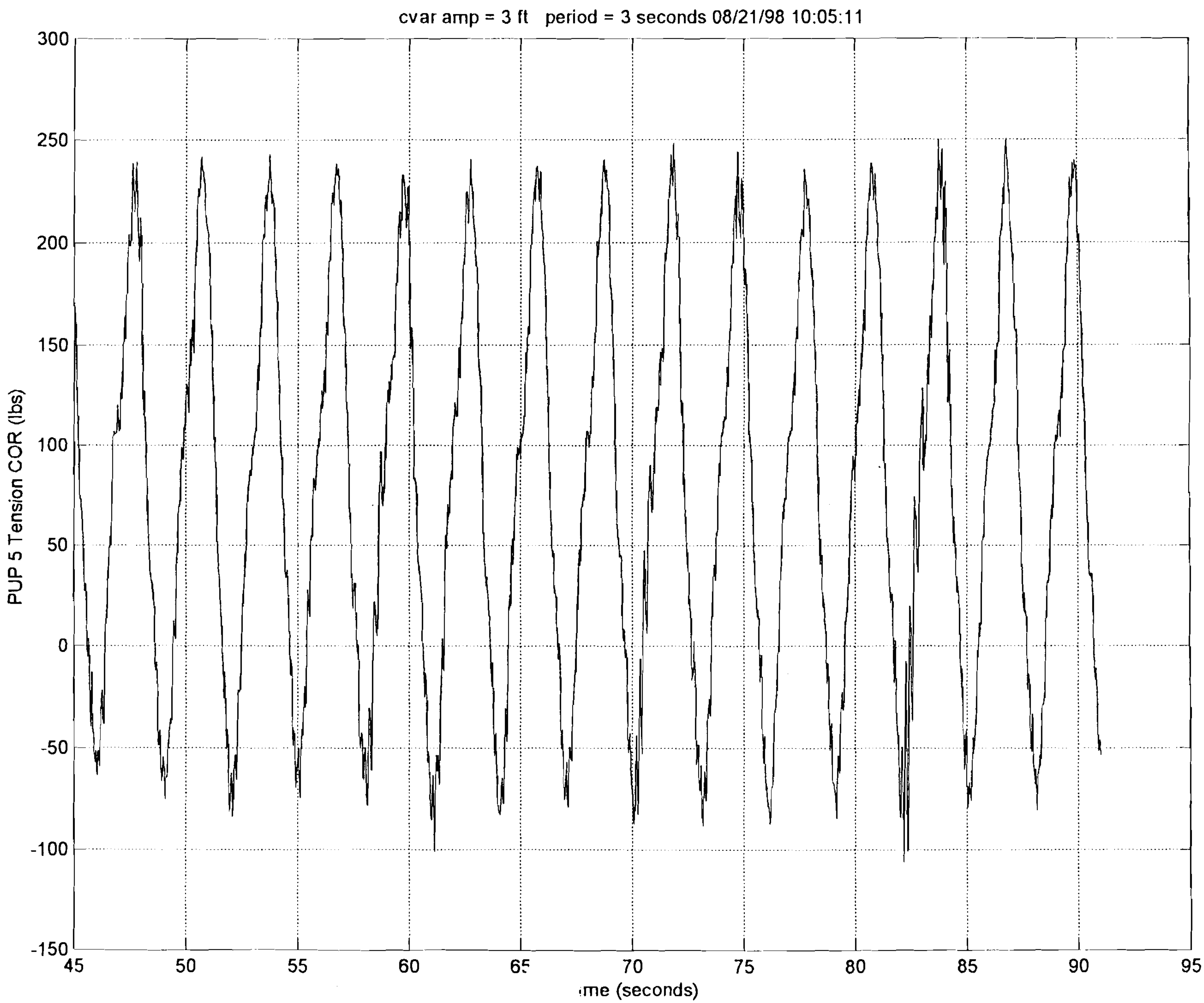

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 4 Bend Inplane COR (ft-lbs)
Time (seconds)
-80
-100
-120
-140
-160
-180
-200
-220
45
50
55
60
65
70
75
80
85
90
95

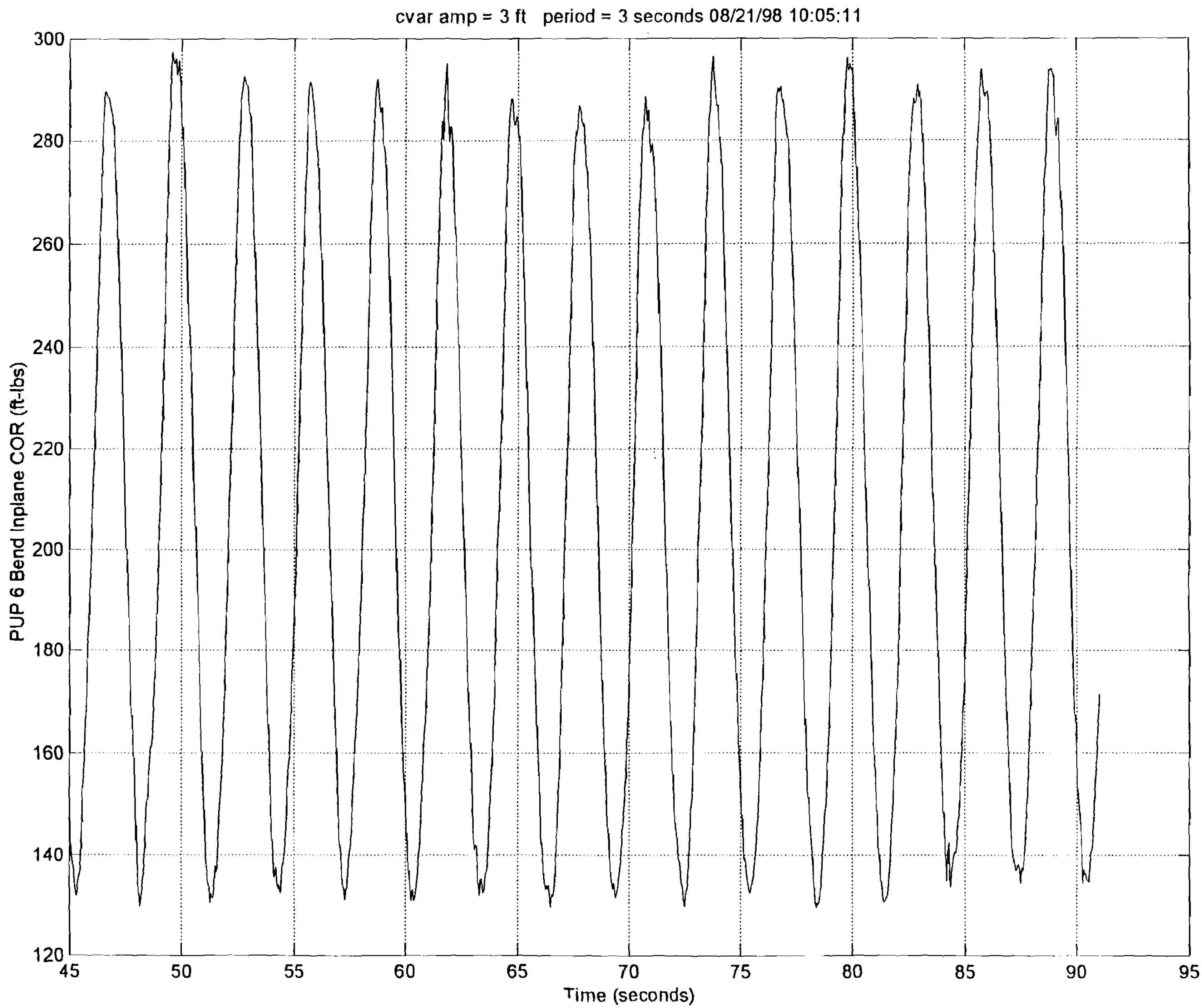

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 4 Bend Outplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
45
50
55
60
65
70
75
80
85
90
95
ime (seconds)

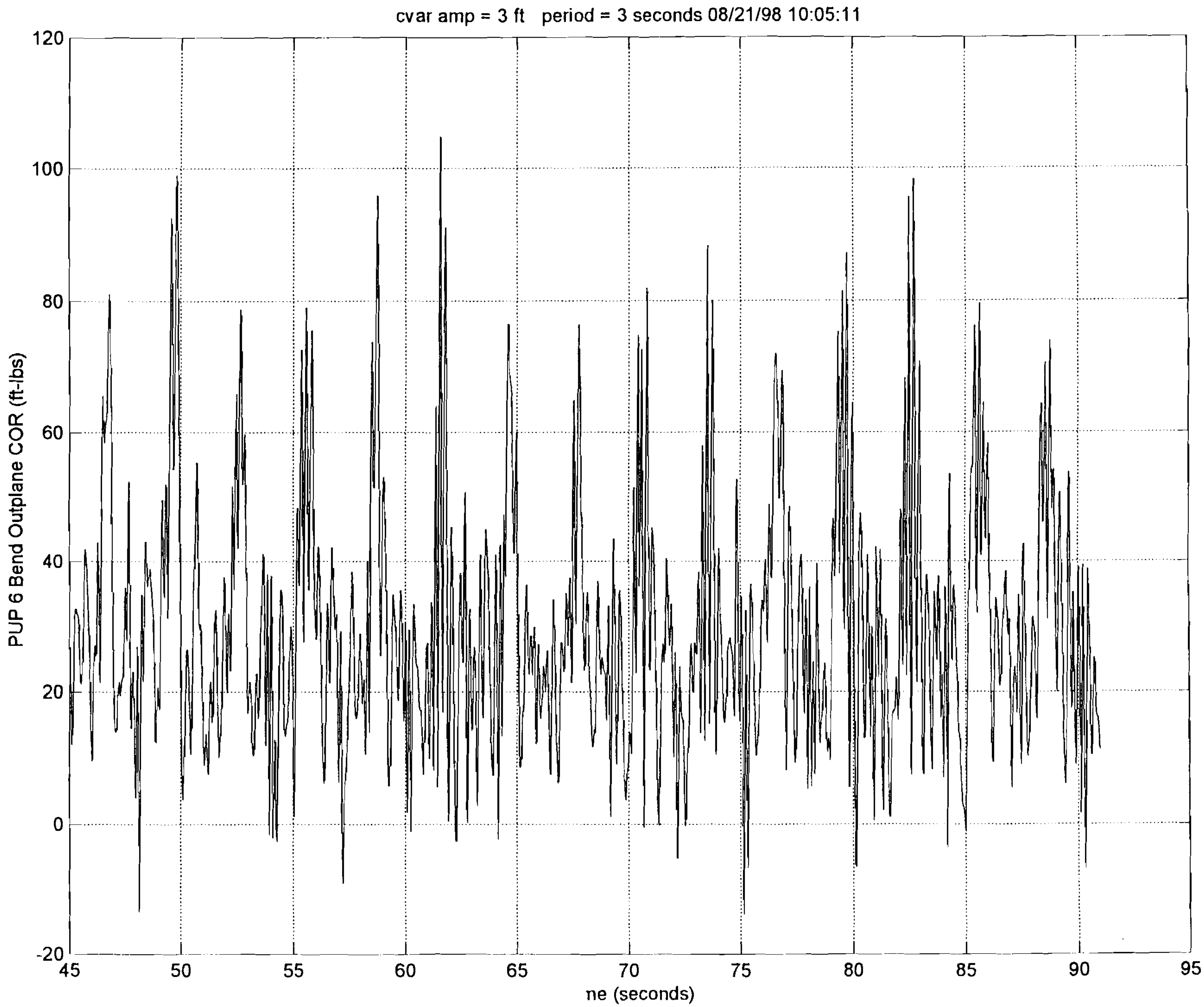

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 4 Tension COR (lbs)
300
250
200
150
100
50
0
-50
-100
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)

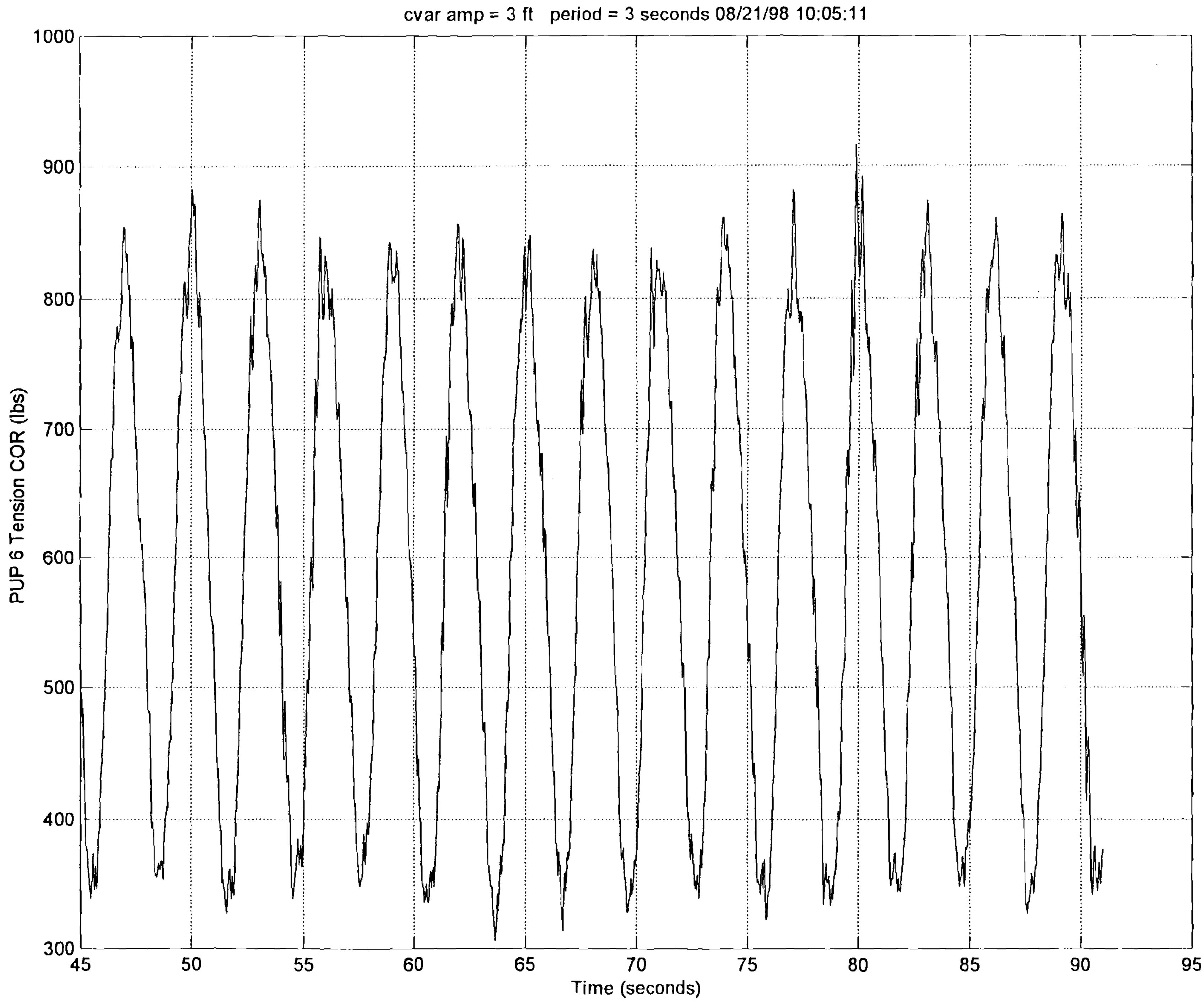

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 5 Bend Inplane COR (ft-lbs)
90
80
70
60
50
40
30
20
10
0
45
50
55
60
65
70
75
80
85
90
95
me (seconds)


cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 5 Bend Outplane COR (ft-lbs)
Time (seconds)
60
50
40
30
20
10
0
-10
-20
-30
-40
45
50
55
60
65
70
75
80
85
90
95

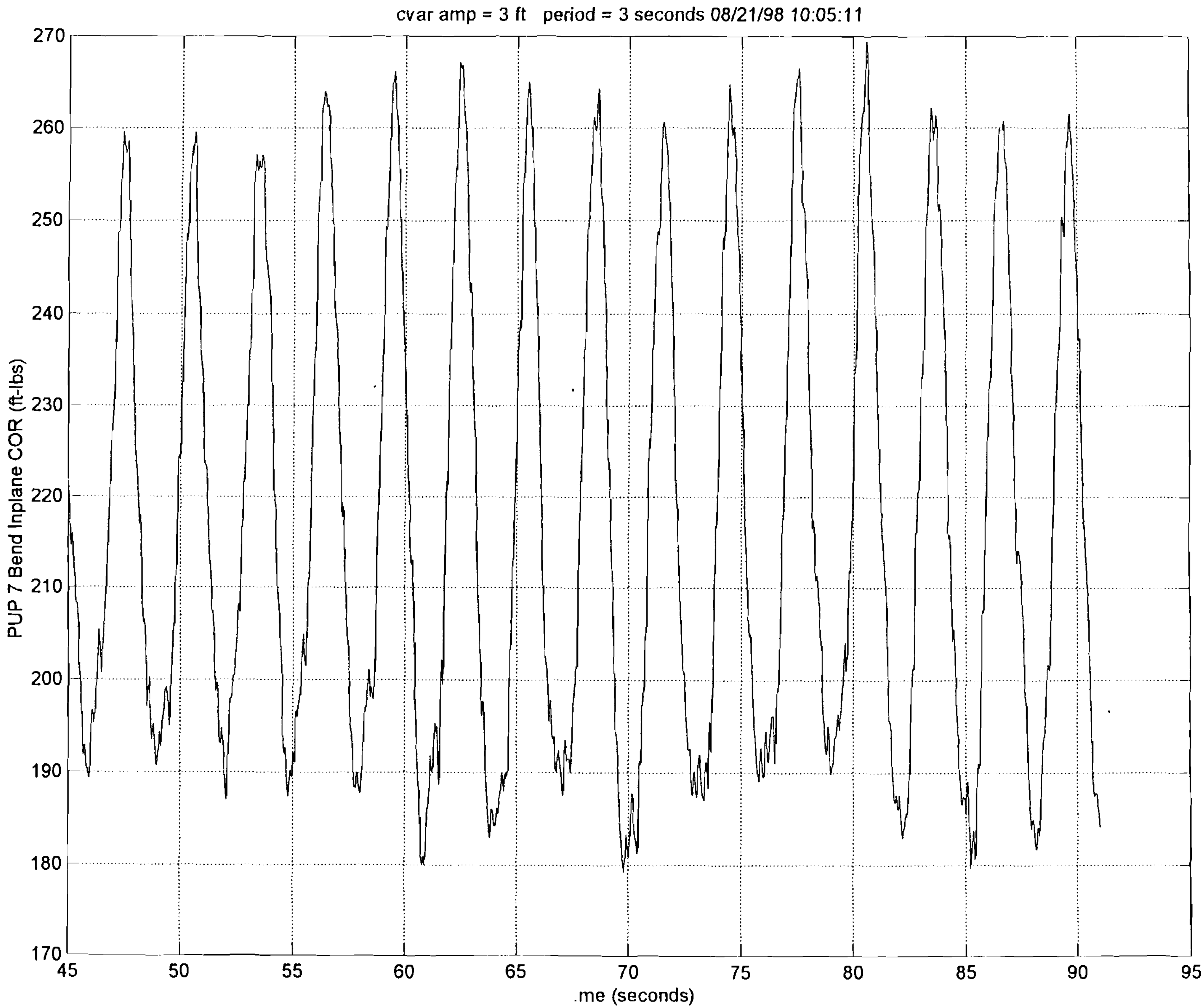

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 5 Tension COR (lbs)
300
250
200
150
100
50
0
-50
-100
-150
45
50
55
60
65
70
75
80
85
90
95
ime (seconds)


cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 6 Bend Inplane COR (ft-lbs)
Time (seconds)
300
280
260
240
220
200
180
160
140
120
45
50
55
60
65
70
75
80
85
90
95


cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 6 Bend Outplane COR (ft-lbs)
ne (seconds)
120
100
80
60
40
20
0
-20
45
50
55
60
65
70
75
80
85
90
95

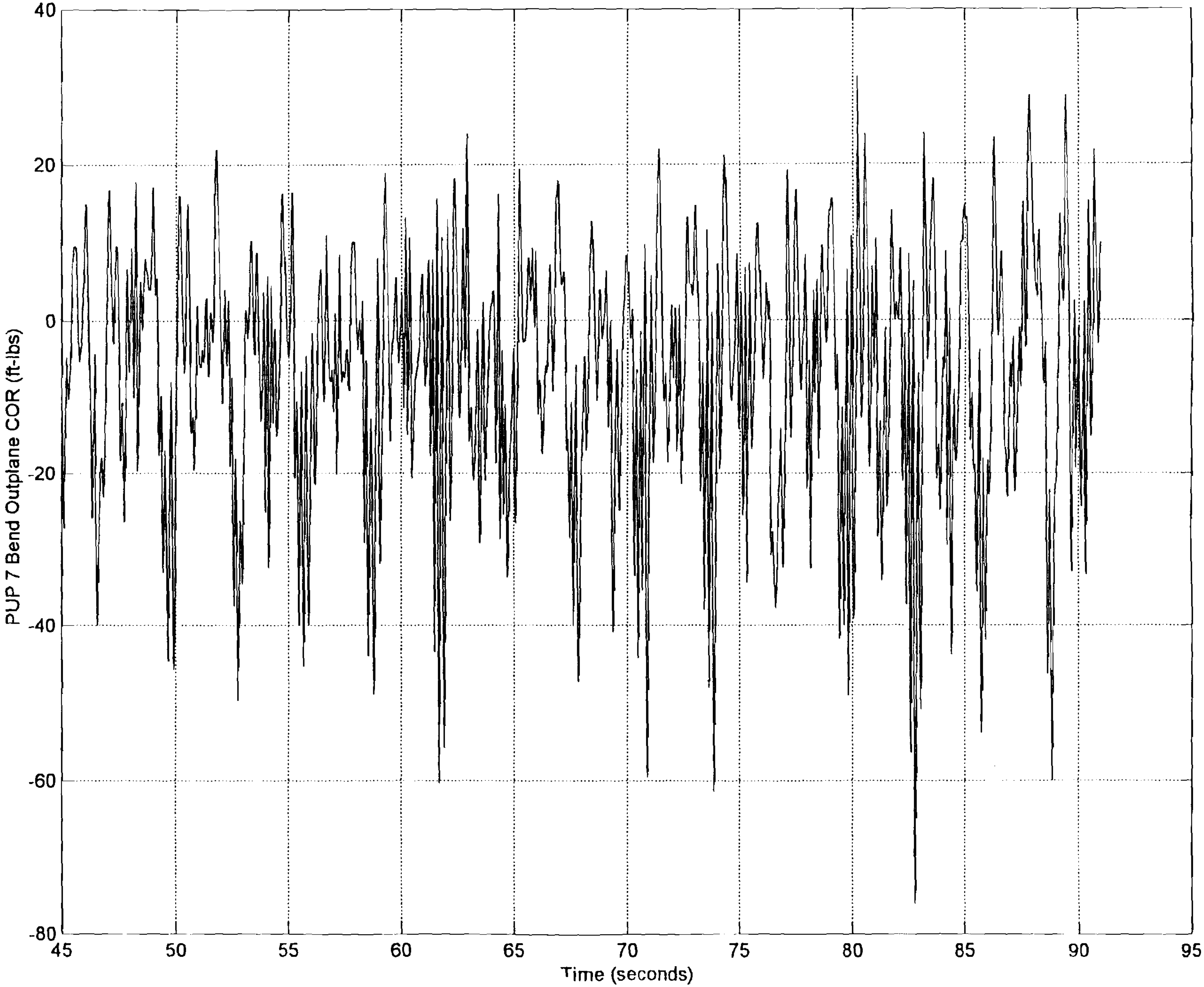


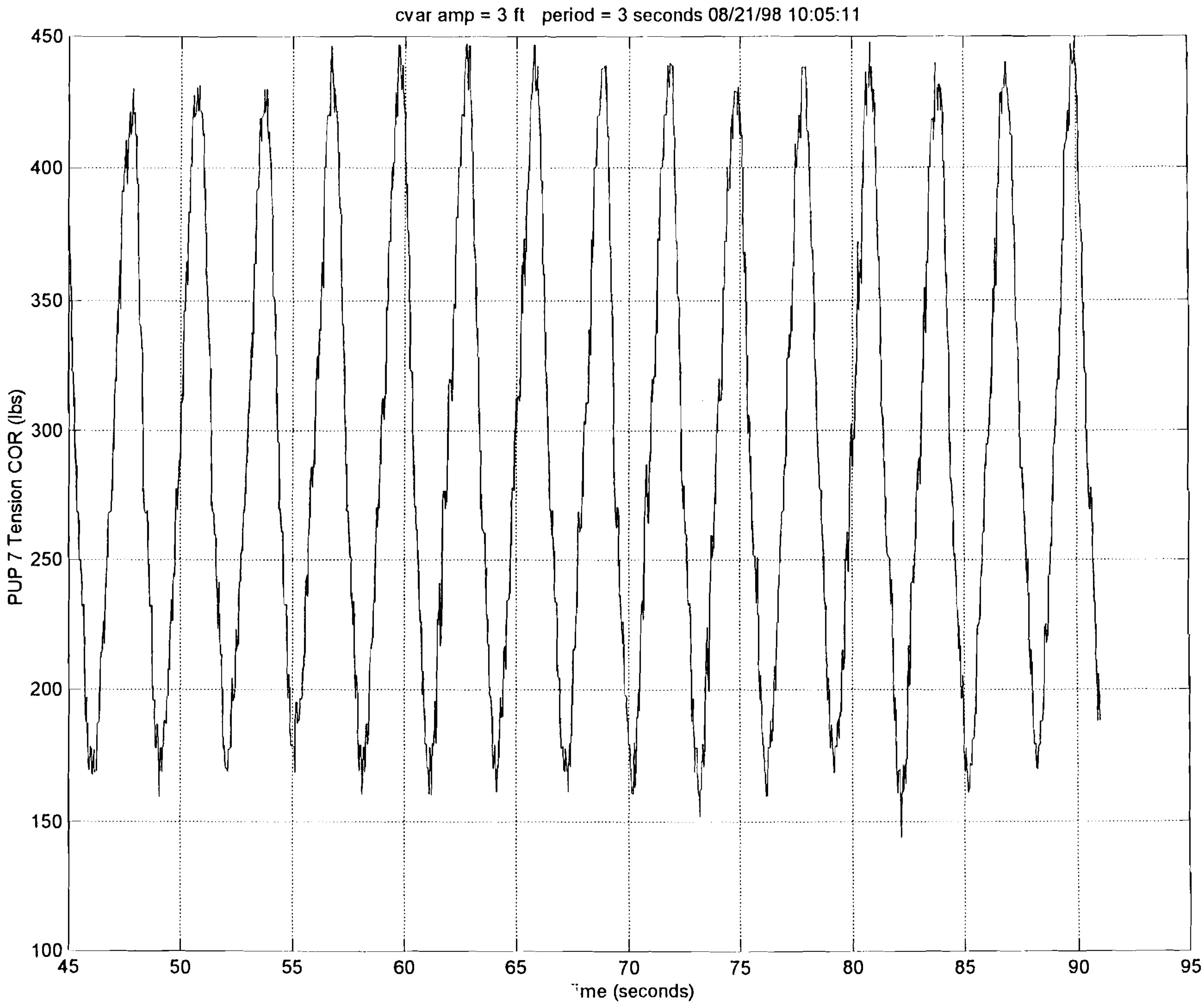
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 6 Tension COR (lbs)
1000
900
800
700
600
500
400
300
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)



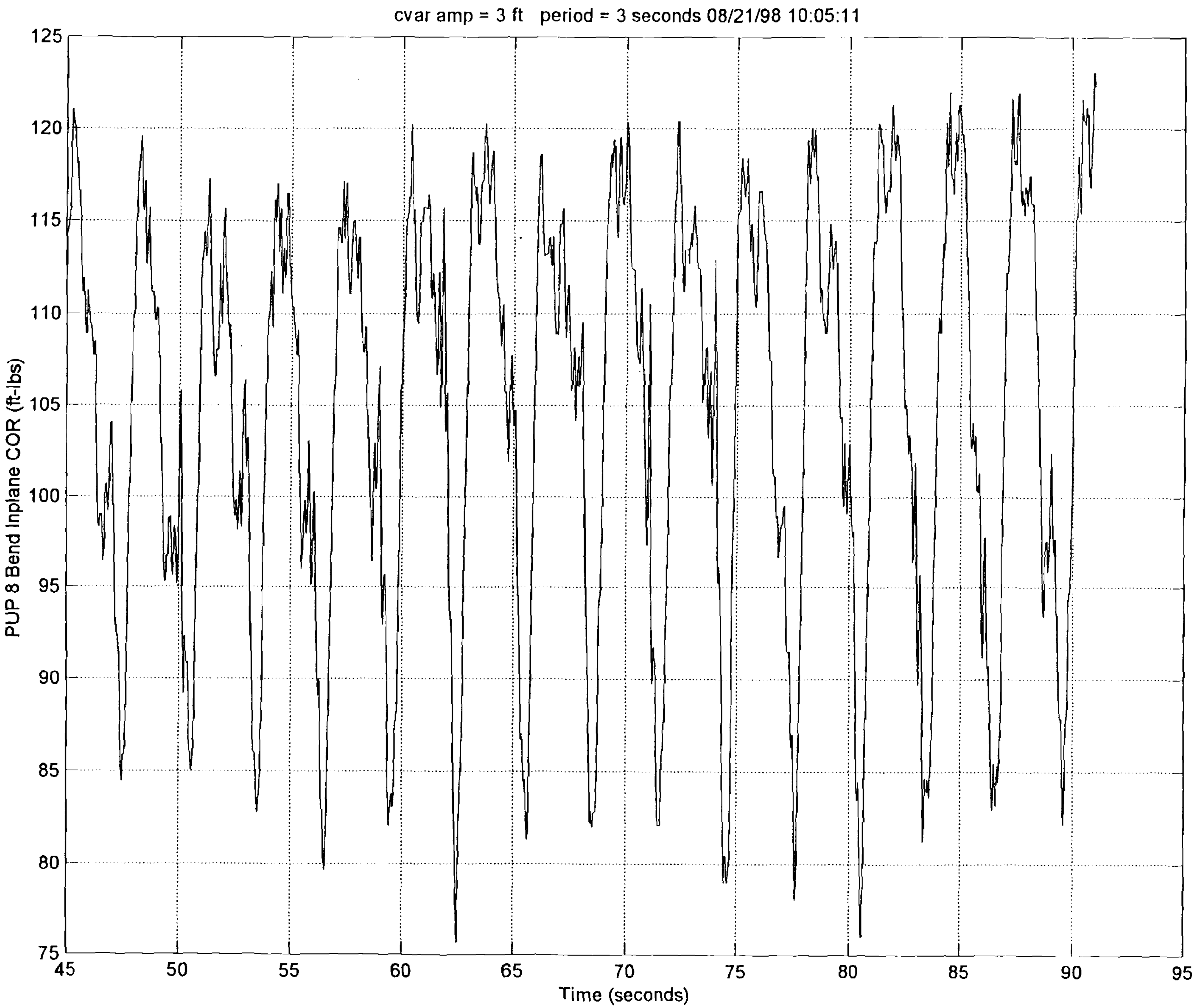
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 7 Bend Inplane COR (ft-lbs)
270
260
250
240
230
220
210
200
190
180
170
45
50
55
60
65
70
75
80
85
90
95
.me (seconds)

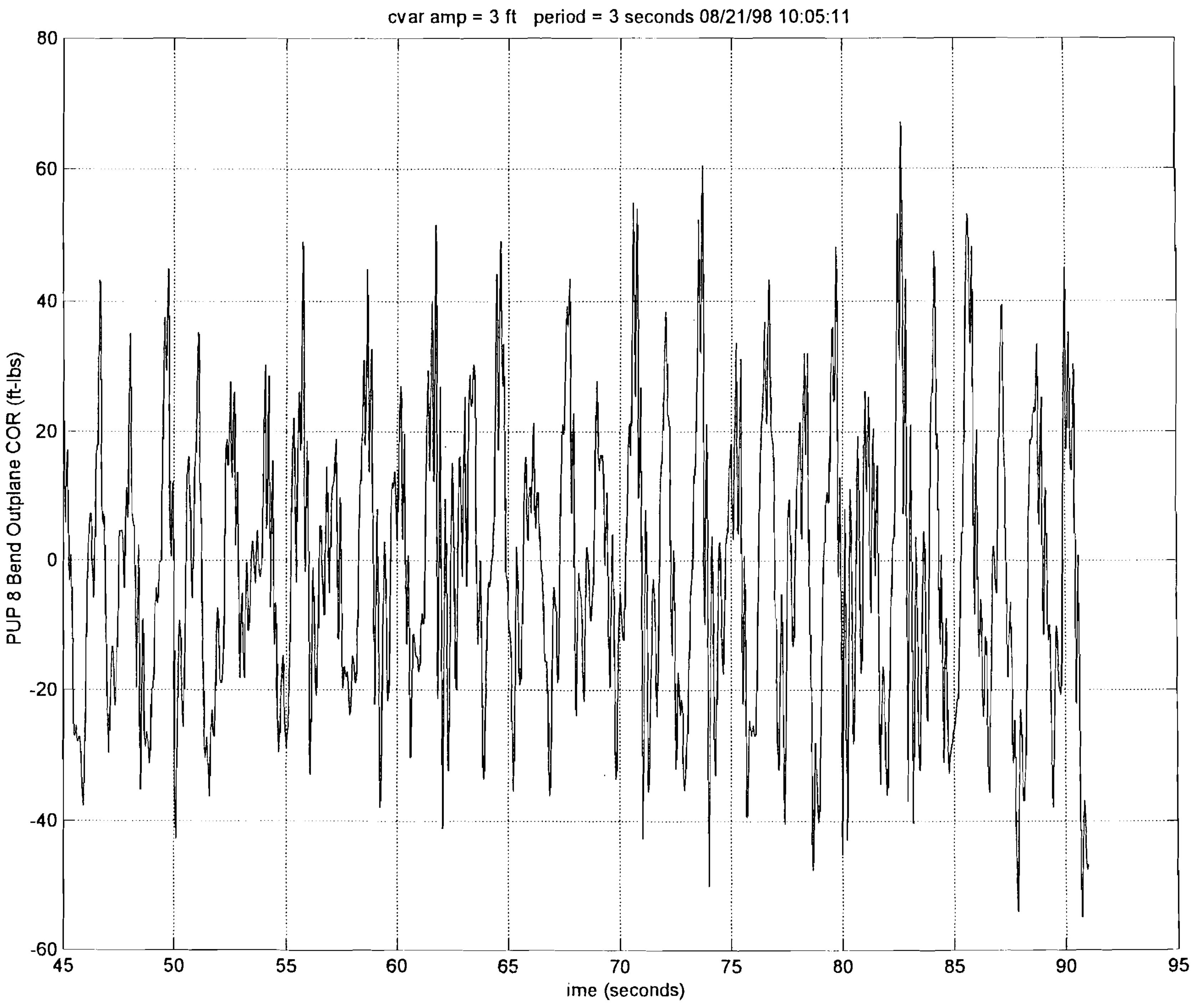
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11

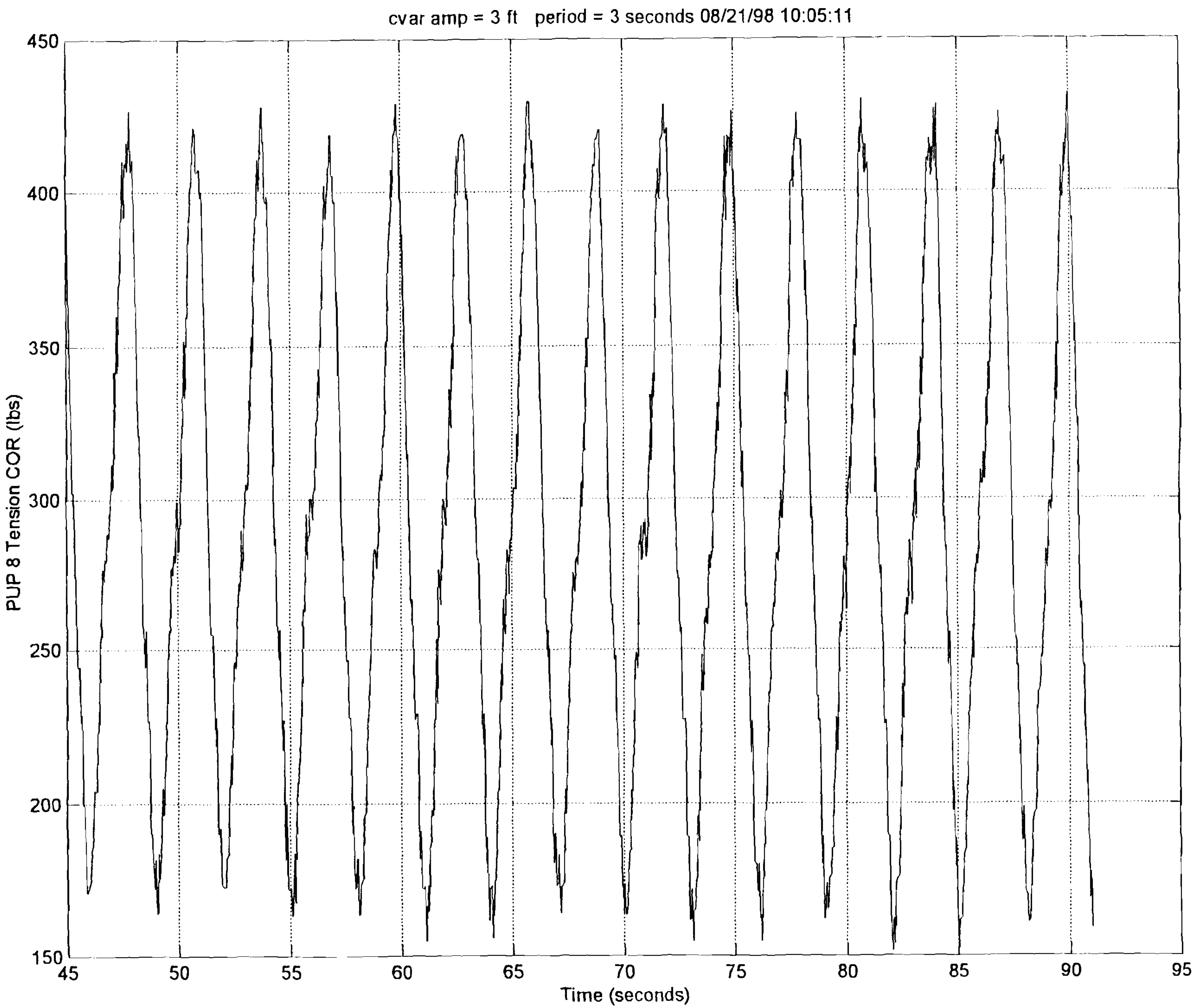




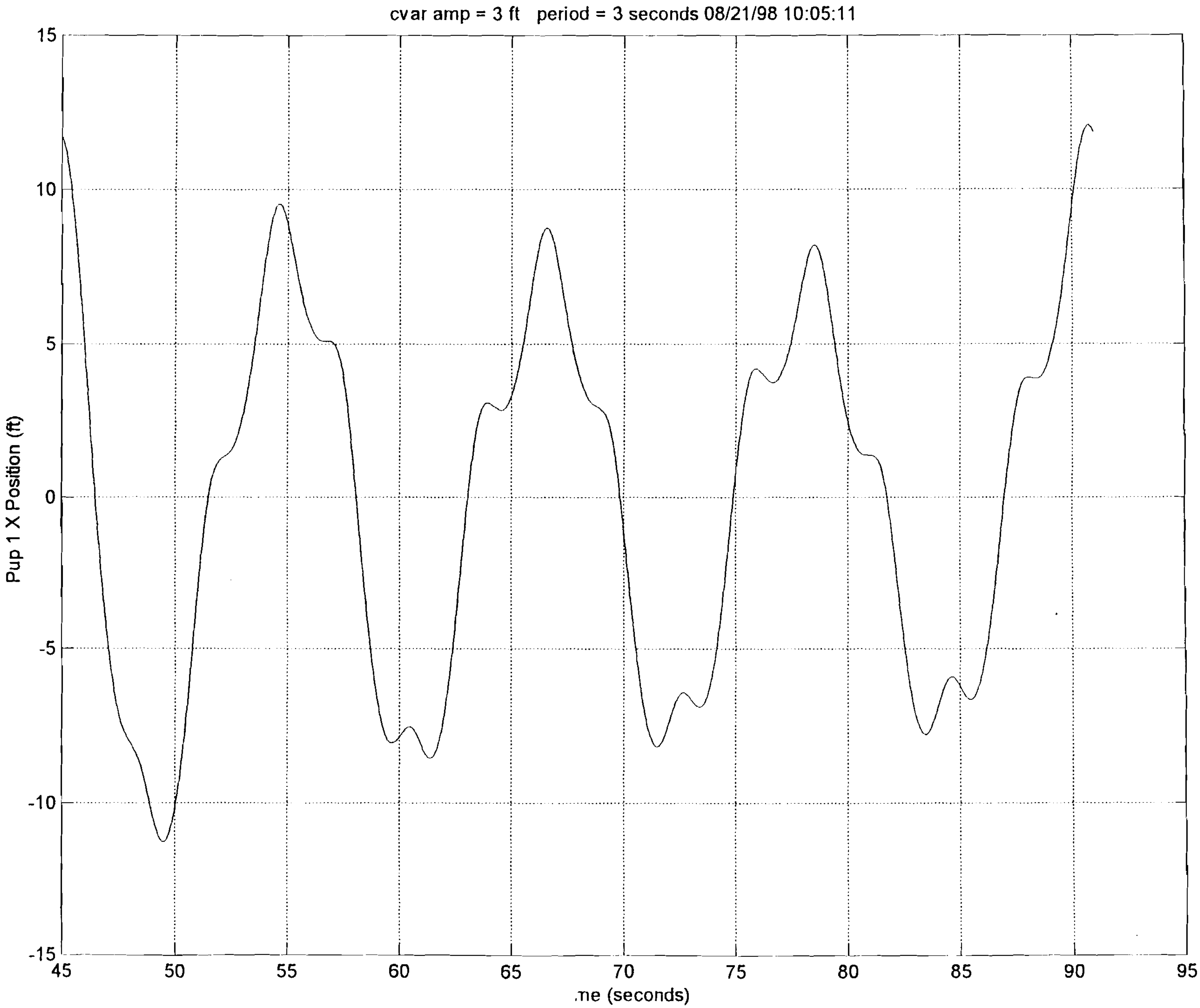
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 7 Tension COR (lbs)
450
400
350
300
250
200
150
100
45
50
55
60
65
70
75
80
85
90
95
ime (seconds)

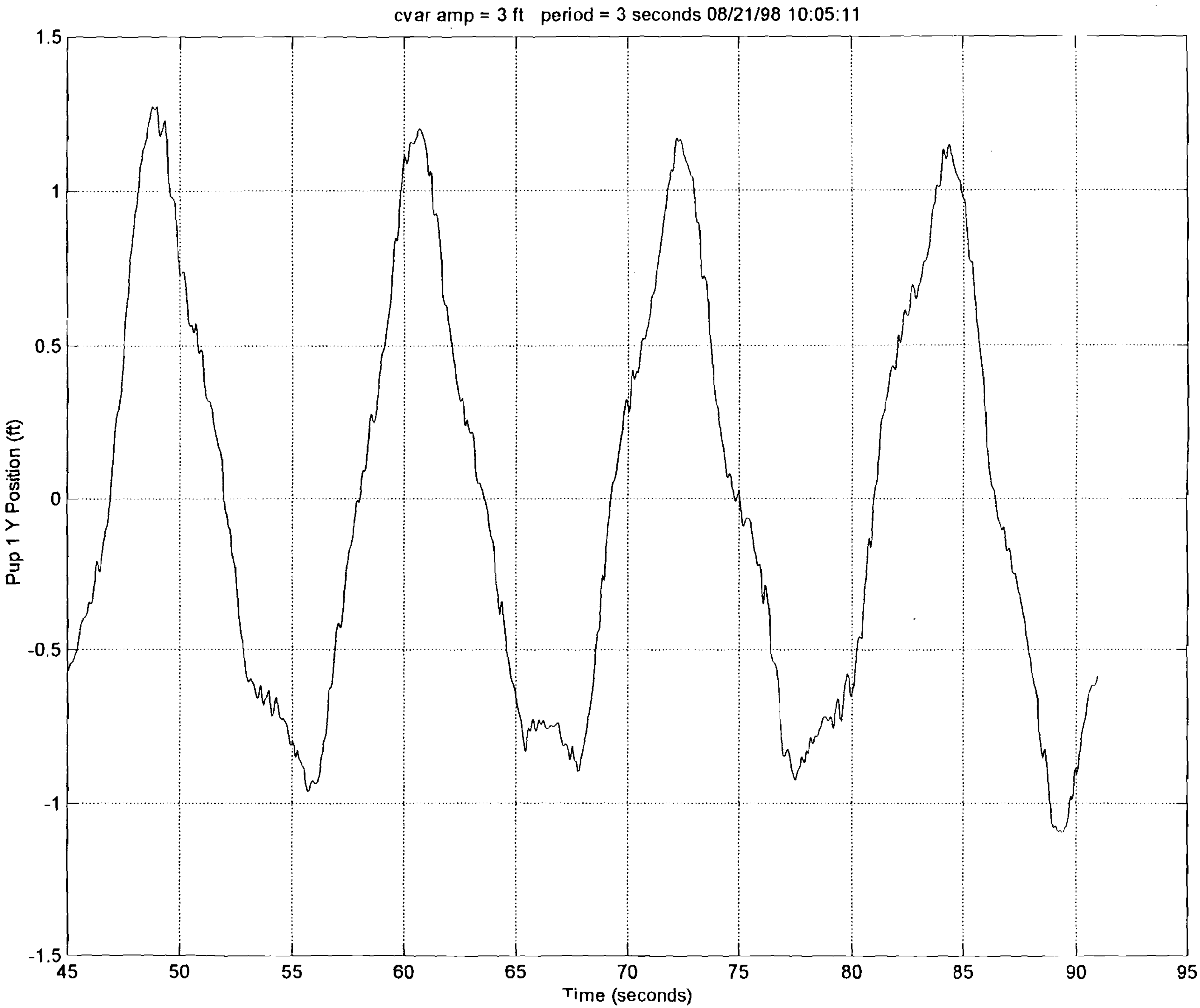

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 8 Bend Inplane COR (ft-lbs)
Time (seconds)
125
120
115
110
105
100
95
90
85
80
75
45
50
55
60
65
70
75
80
85
90
95

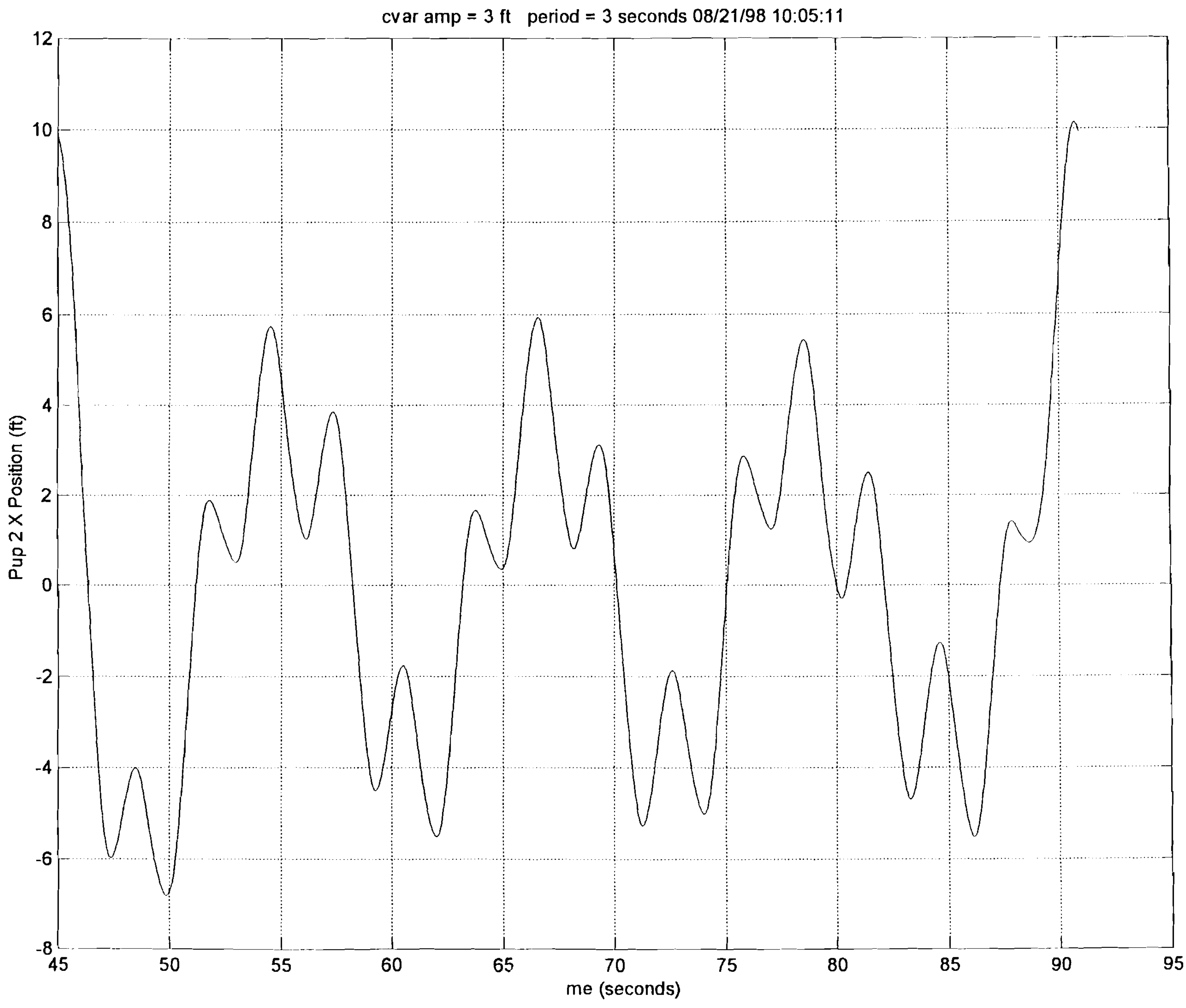

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 8 Bend Outplane COR (ft-lbs)
ime (seconds)
80
60
40
20
0
-20
-40
-60
45
50
55
60
65
70
75
80
85
90
95

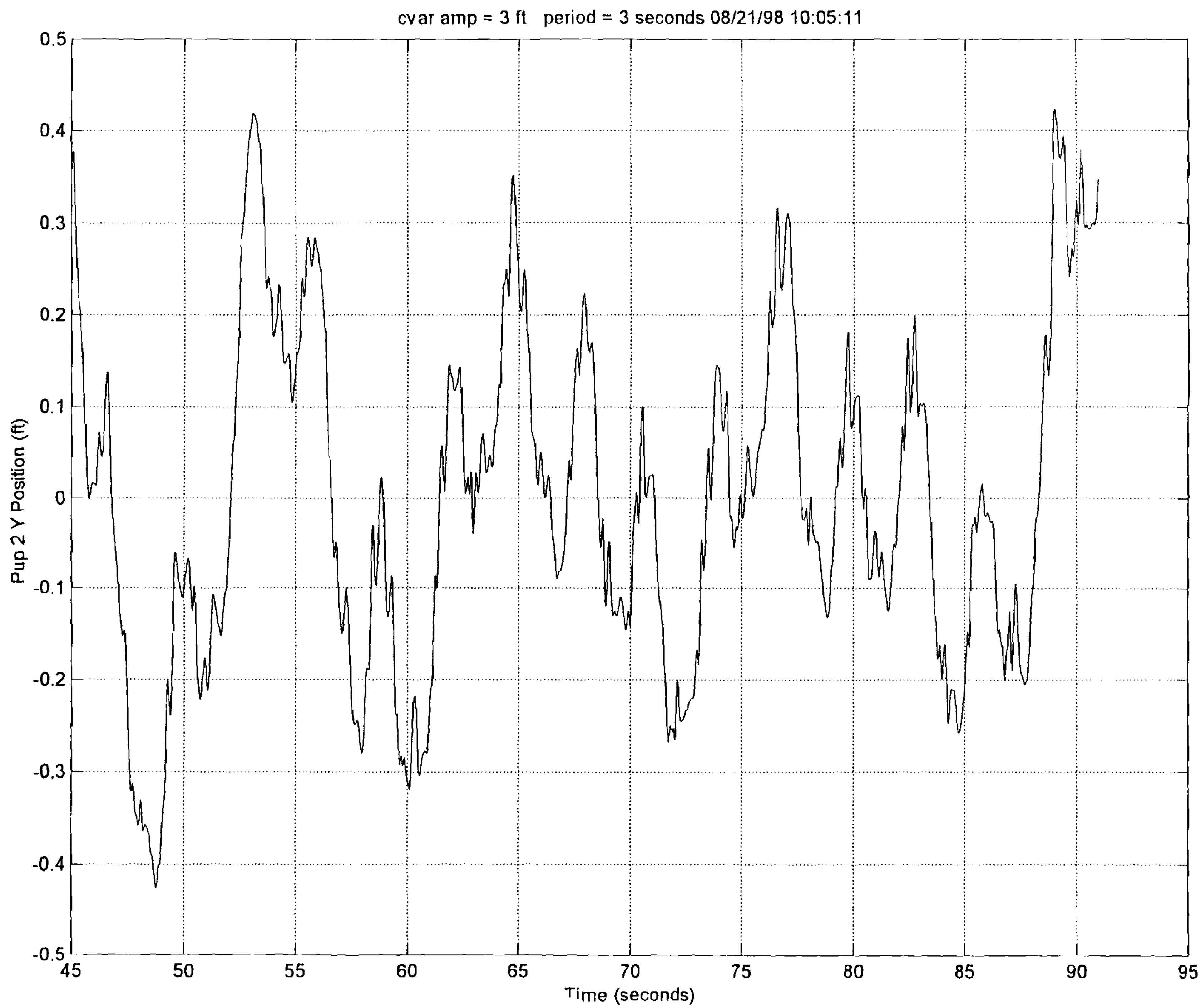


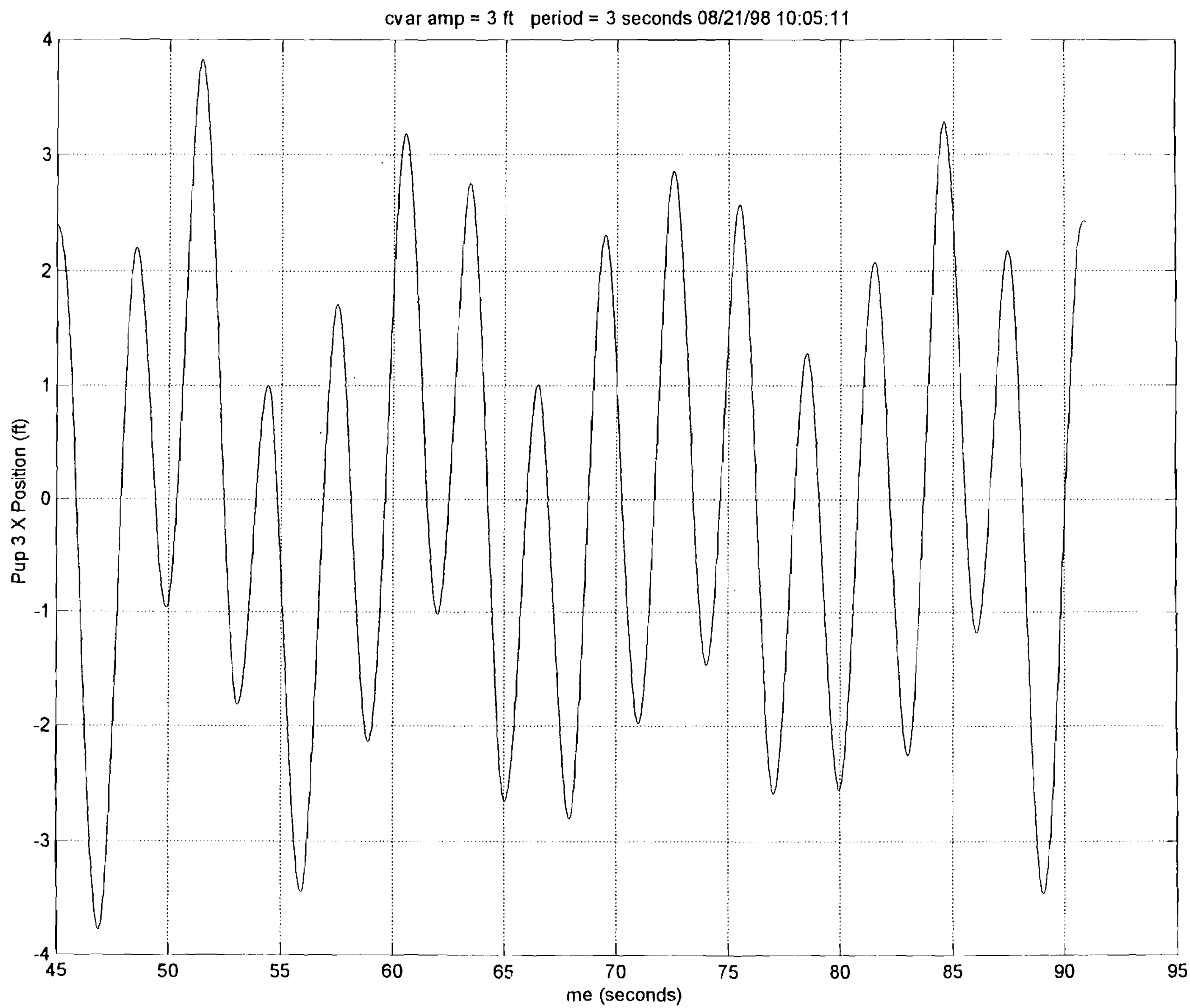
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
PUP 8 Tension COR (lbs)
Time (seconds)
450
400
350
300
250
200
150
45
50
55
60
65
70
75
80
85
90
95

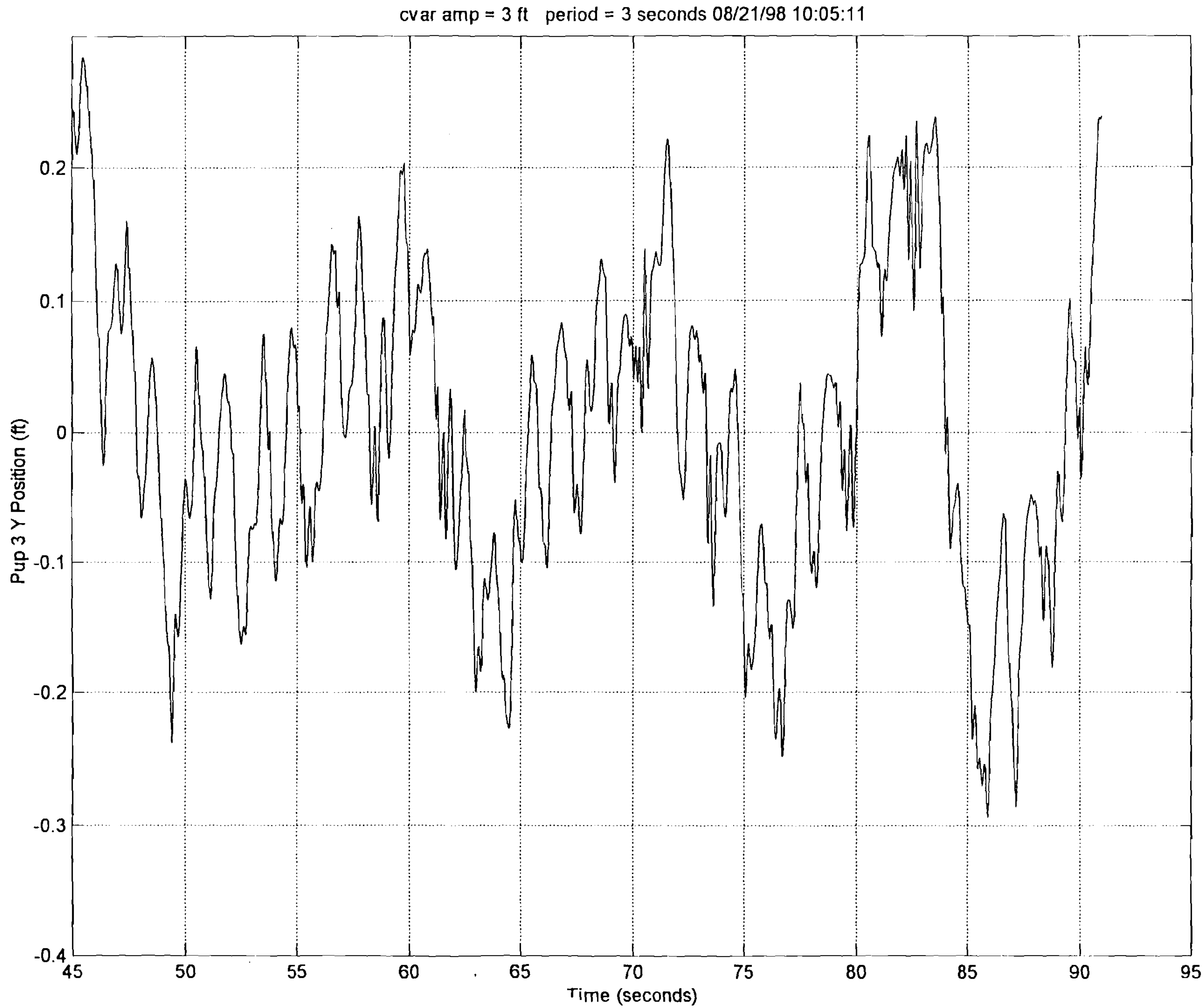

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 1 X Position (ft)
15
10
5
0
-5
-10
-15
45
50
55
60
65
70
75
80
85
90
95
.me (seconds)

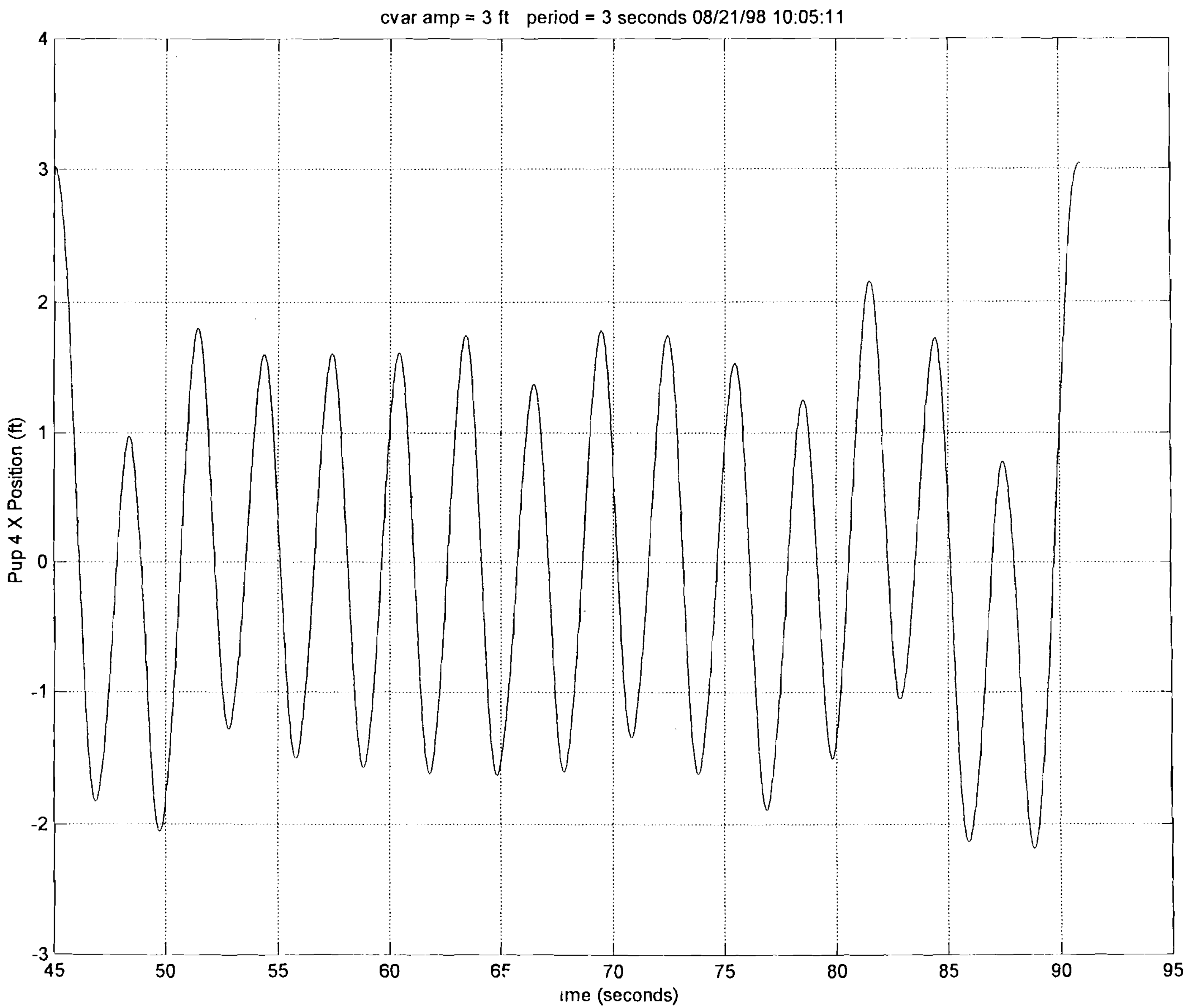

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 1 Y Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
-1.5
45
50
55
60
65
70
75
80
85
90
95


cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 2 X Position (ft)
me (seconds)
12
10
8
6
4
2
0
-2
-4
-6
-8
45
50
55
60
65
70
75
80
85
90
95

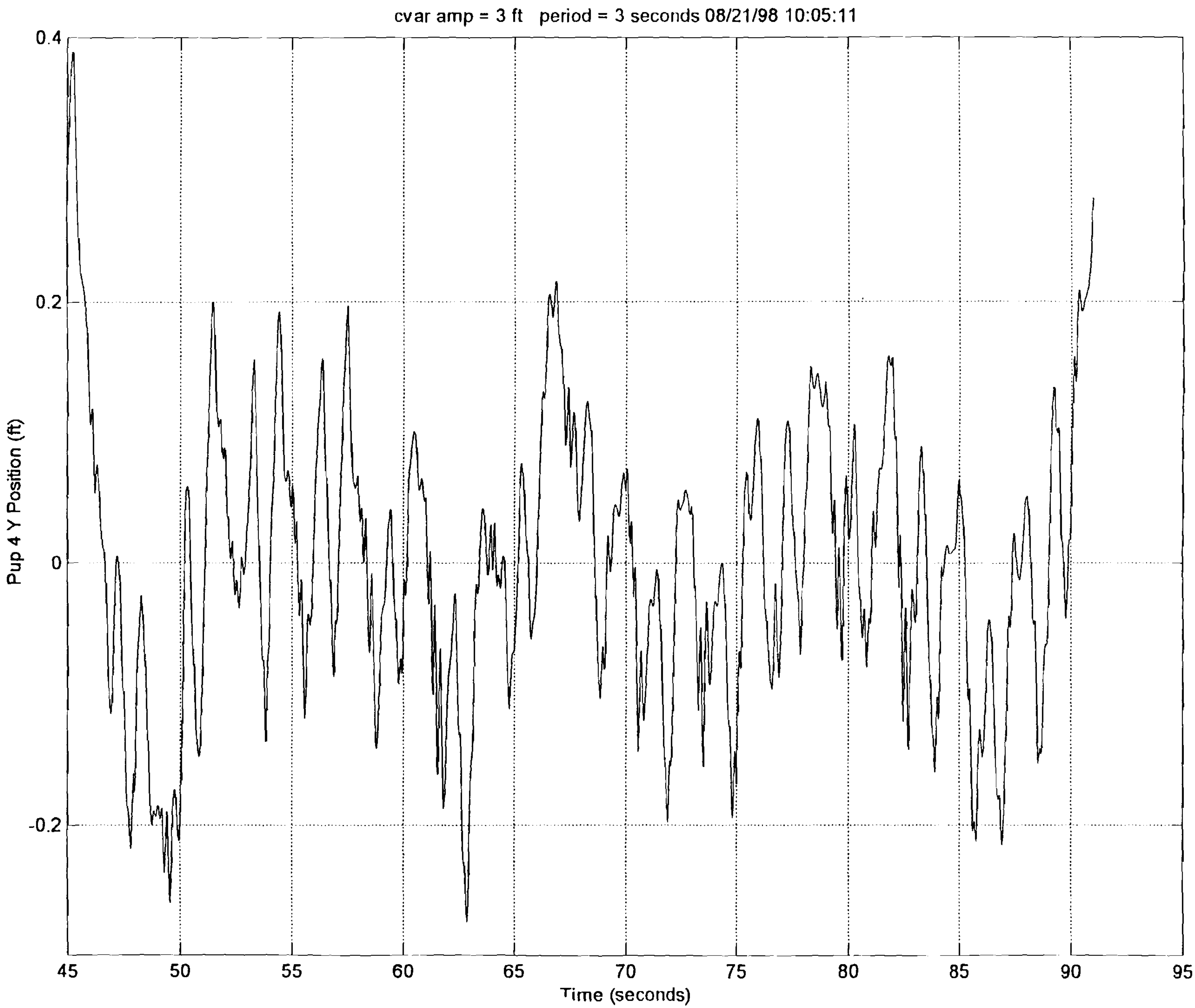

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 2 Y Position (ft)
Time (seconds)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
45
50
55
60
65
70
75
80
85
90
95

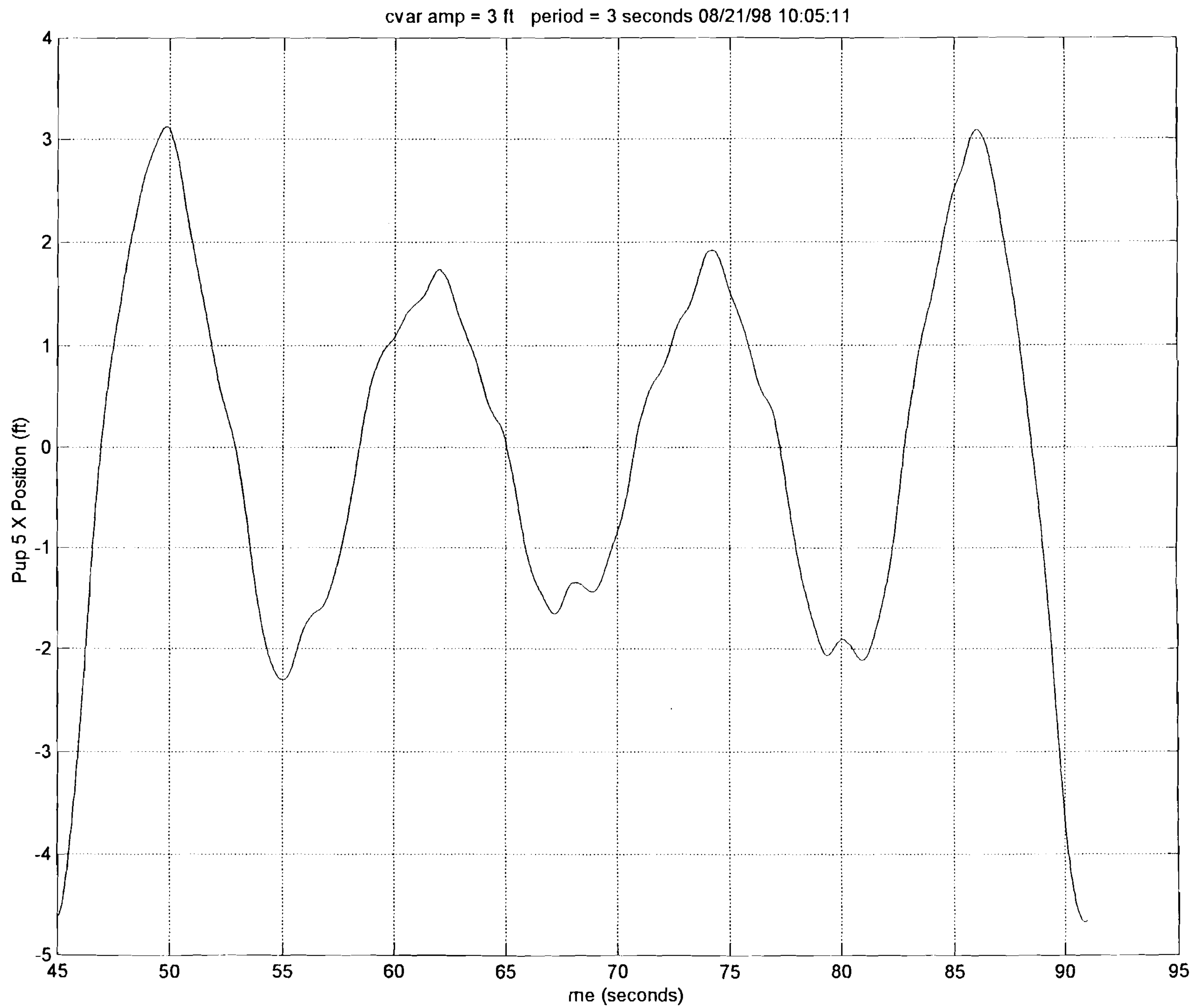

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 3 X Position (ft)
4
3
2
1
0
-1
-2
-3
-4
45
50
55
60
65
70
75
80
85
90
95
me (seconds)

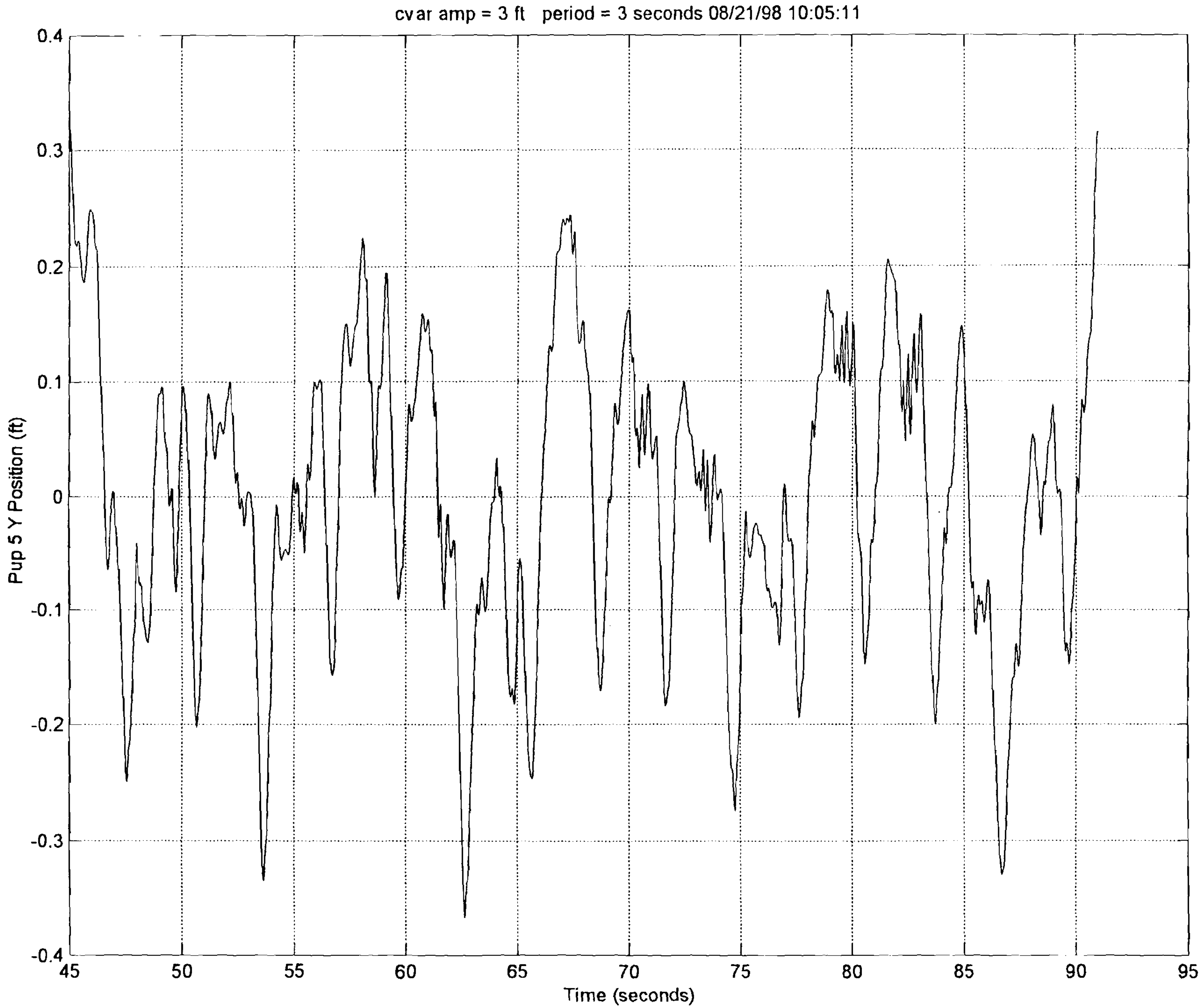

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 3 Y Position (ft)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
45
50
55
60
65
70
75
80
85
90
95
Time (seconds)



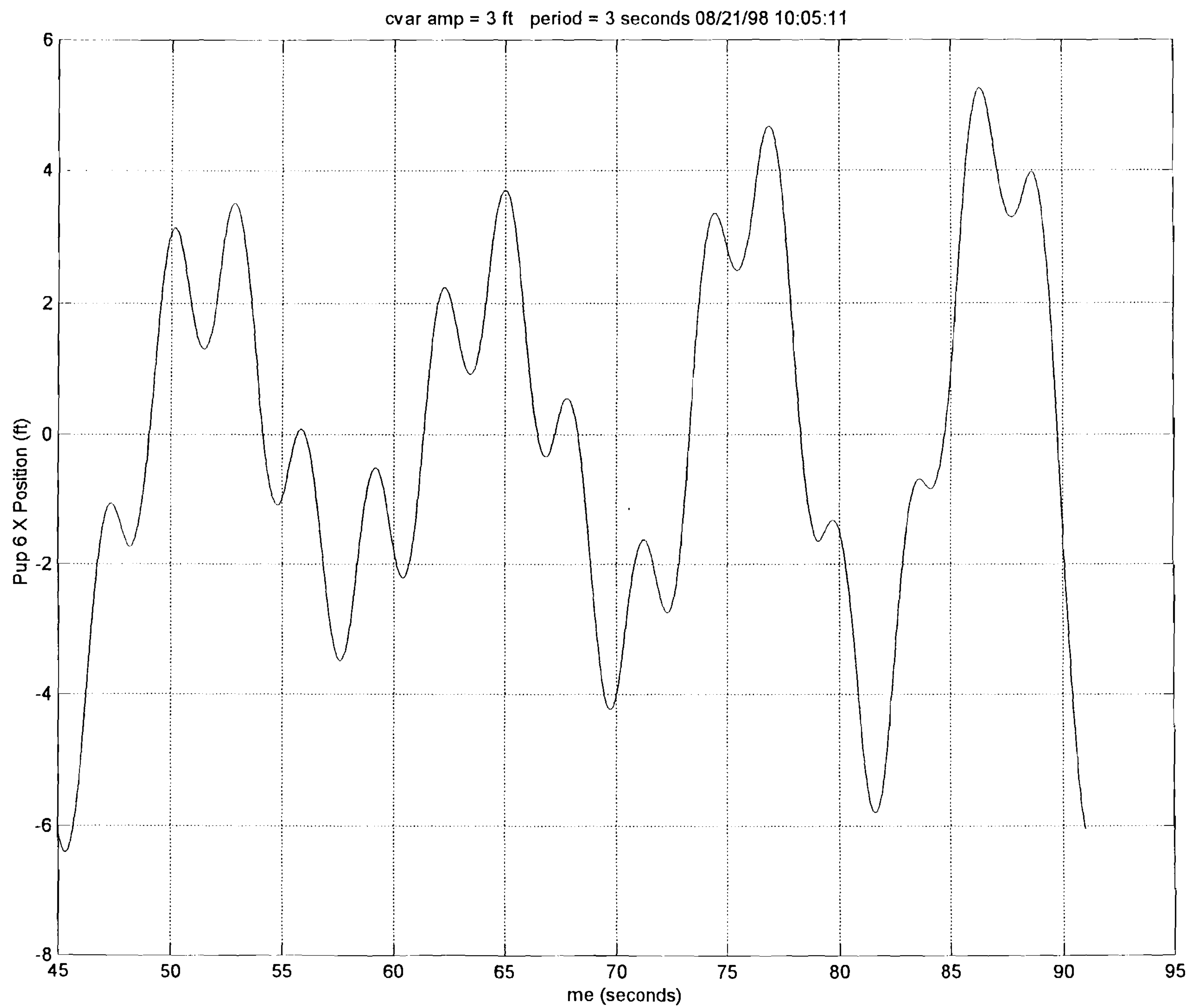
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 4 X Position (ft)
4
3
2
1
0
-1
-2
-3
45
50
55
60
65
70
75
80
85
90
95
ime (seconds)

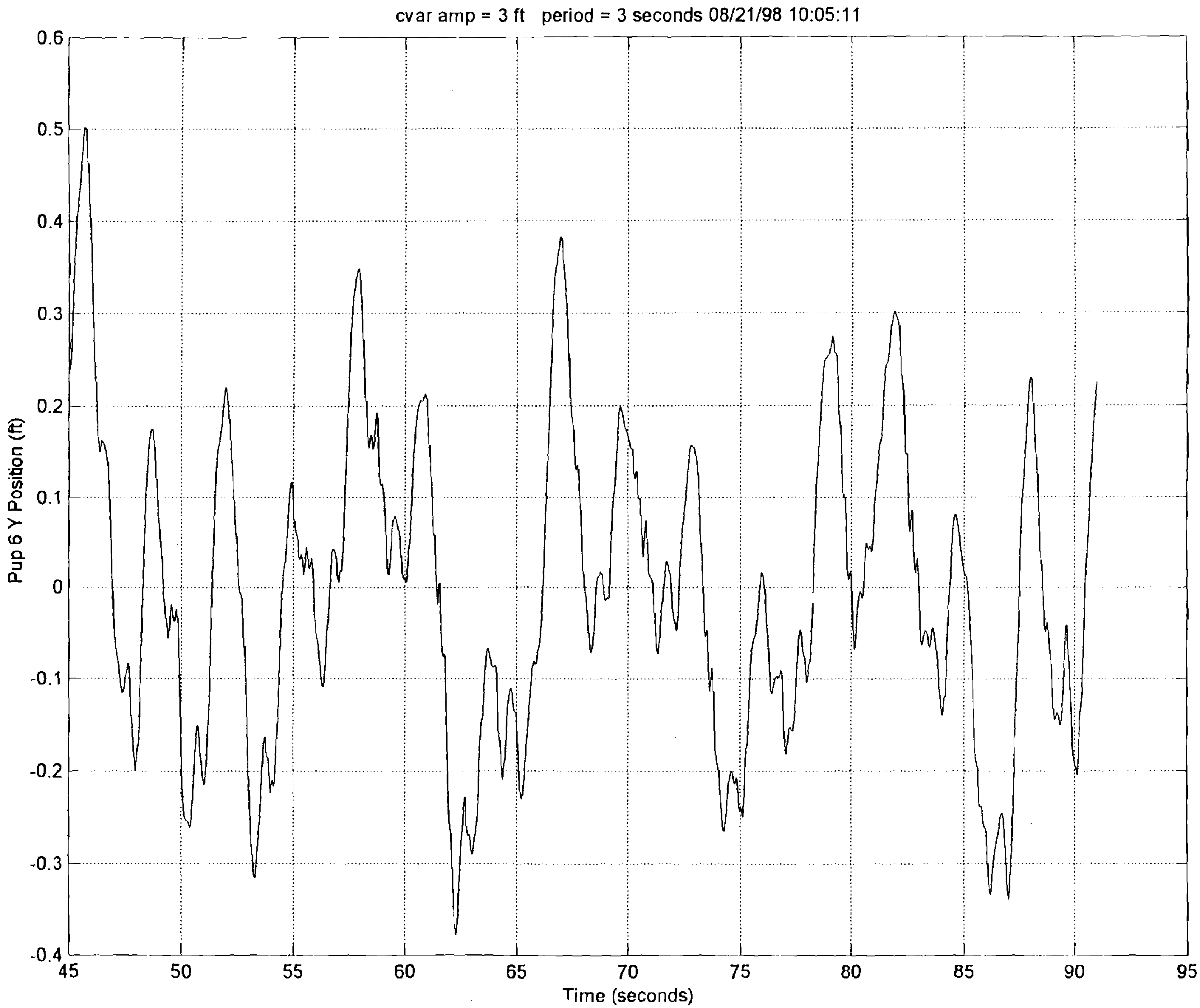

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 4 Y Position (ft)
Time (seconds)
0.4
0.2
0
-0.2
45
50
55
60
65
70
75
80
85
90
95

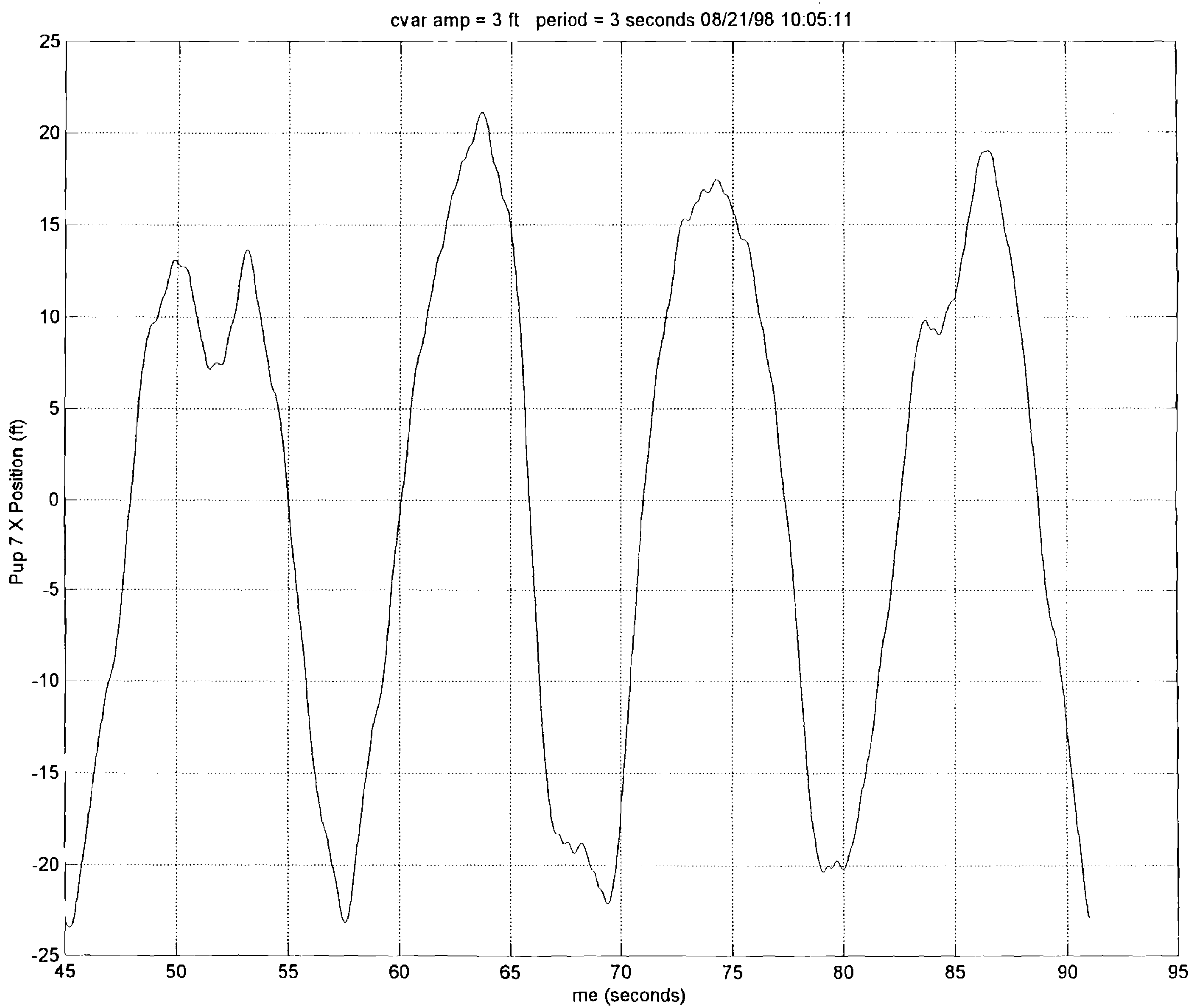

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 5 X Position (ft)
4
3
2
1
0
-1
-2
-3
-4
-5
45
50
55
60
65
70
75
80
85
90
95
me (seconds)

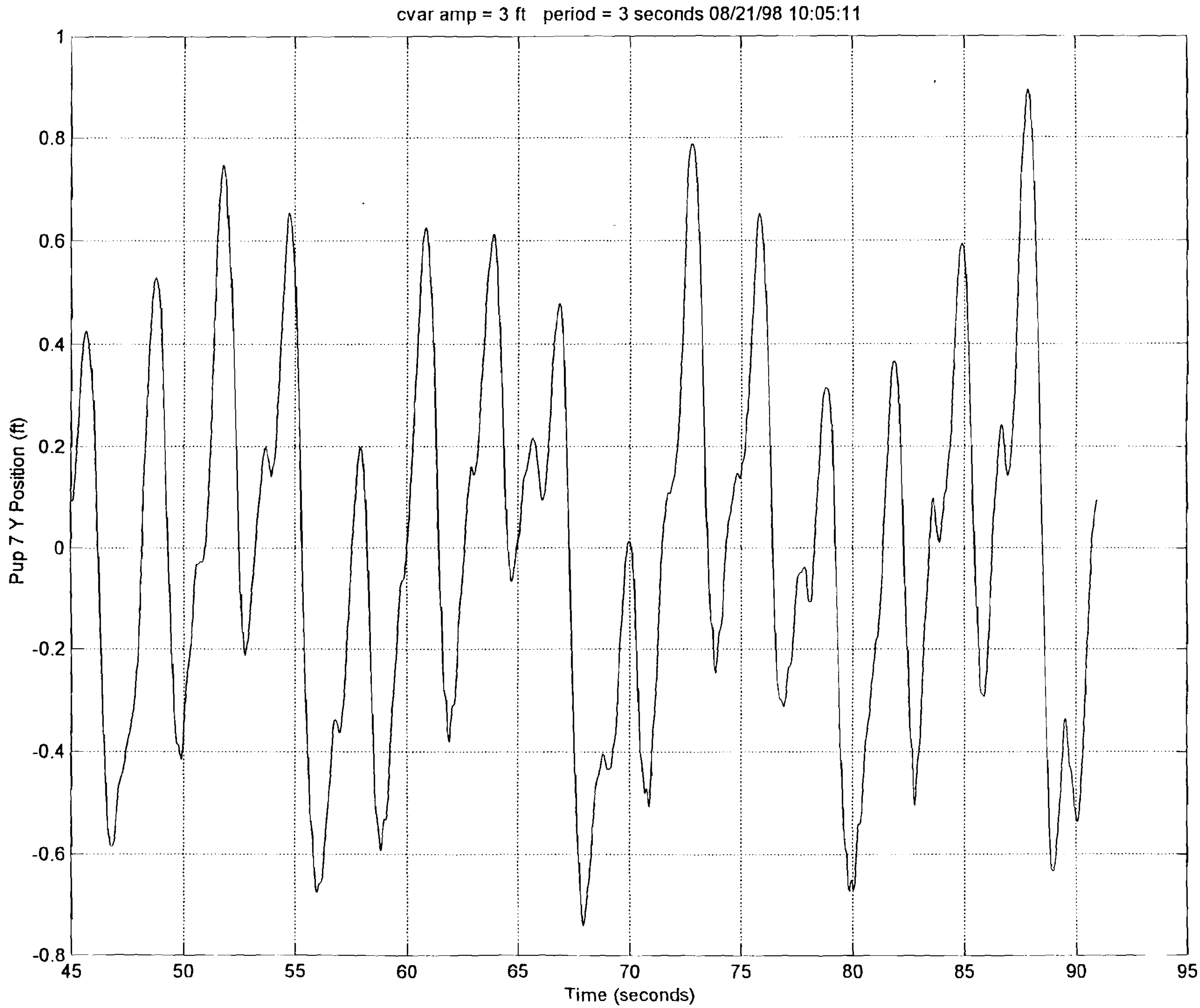


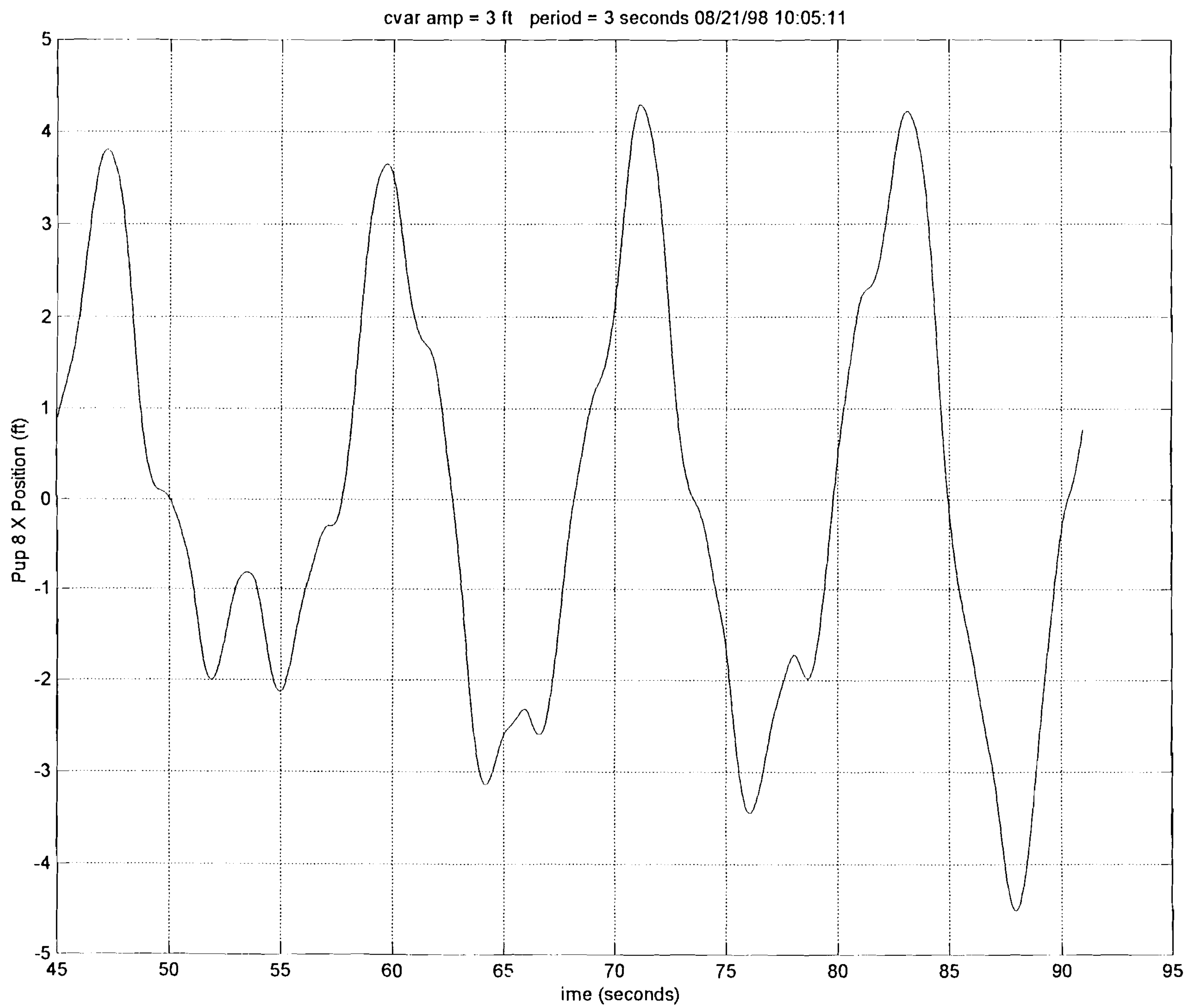
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 5 Y Position (ft)
Time (seconds)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
45
50
55
60
65
70
75
80
85
90
95


cvar amp = 3 ft   period = 3 seconds 08/21/98 10:05:11
Pup 6 X Position (ft)
me (seconds)
6
4
2
0
-2
-4
-6
-8
45
50
55
60
65
70
75
80
85
90
95

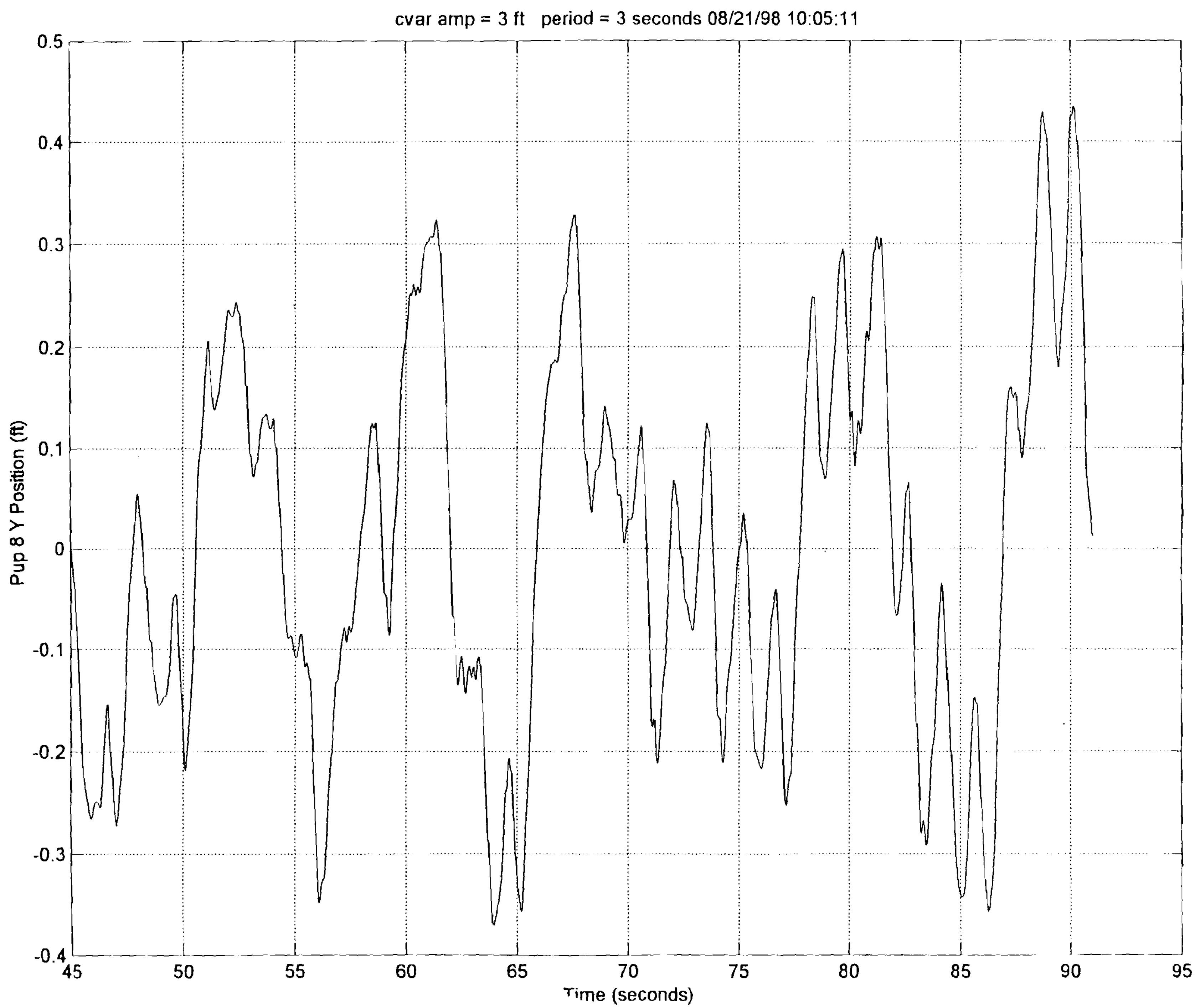

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 6 Y Position (ft)
Time (seconds)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
45
50
55
60
65
70
75
80
85
90
95


cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 7 X Position (ft)
25
20
15
10
5
0
-5
-10
-15
-20
-25
45
50
55
60
65
70
75
80
85
90
95
me (seconds)

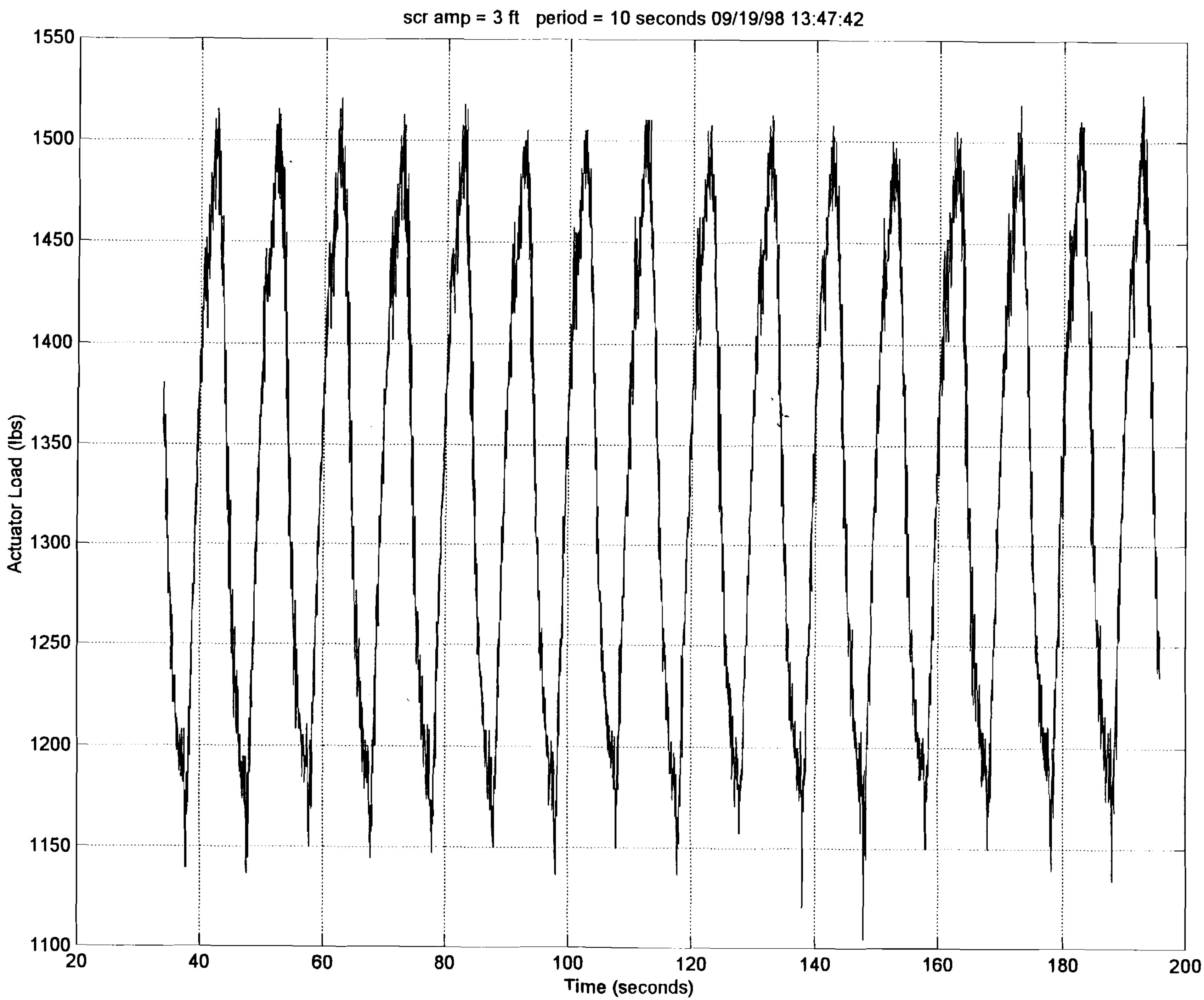

cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 7 Y Position (ft)
Time (seconds)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
45
50
55
60
65
70
75
80
85
90
95

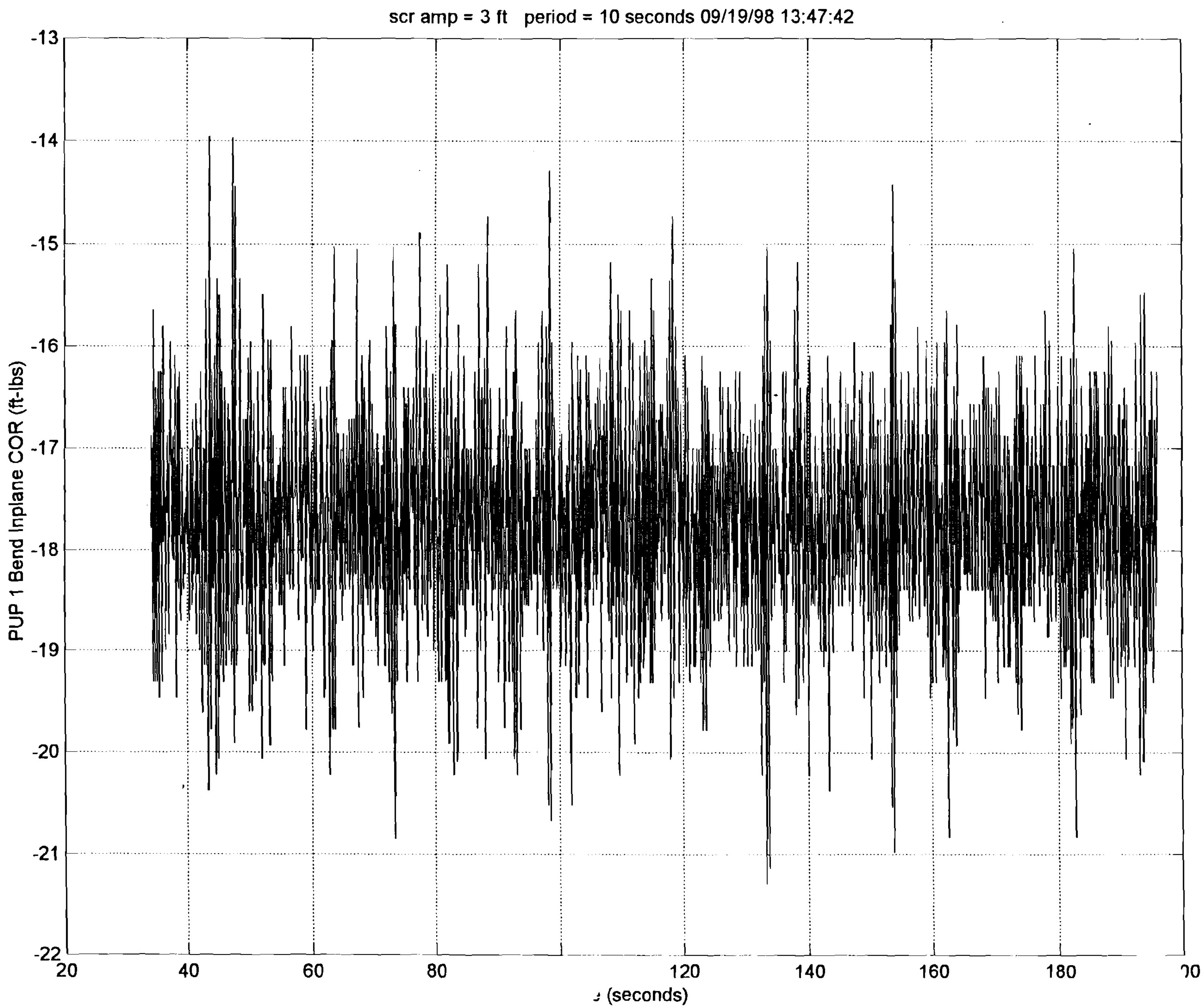


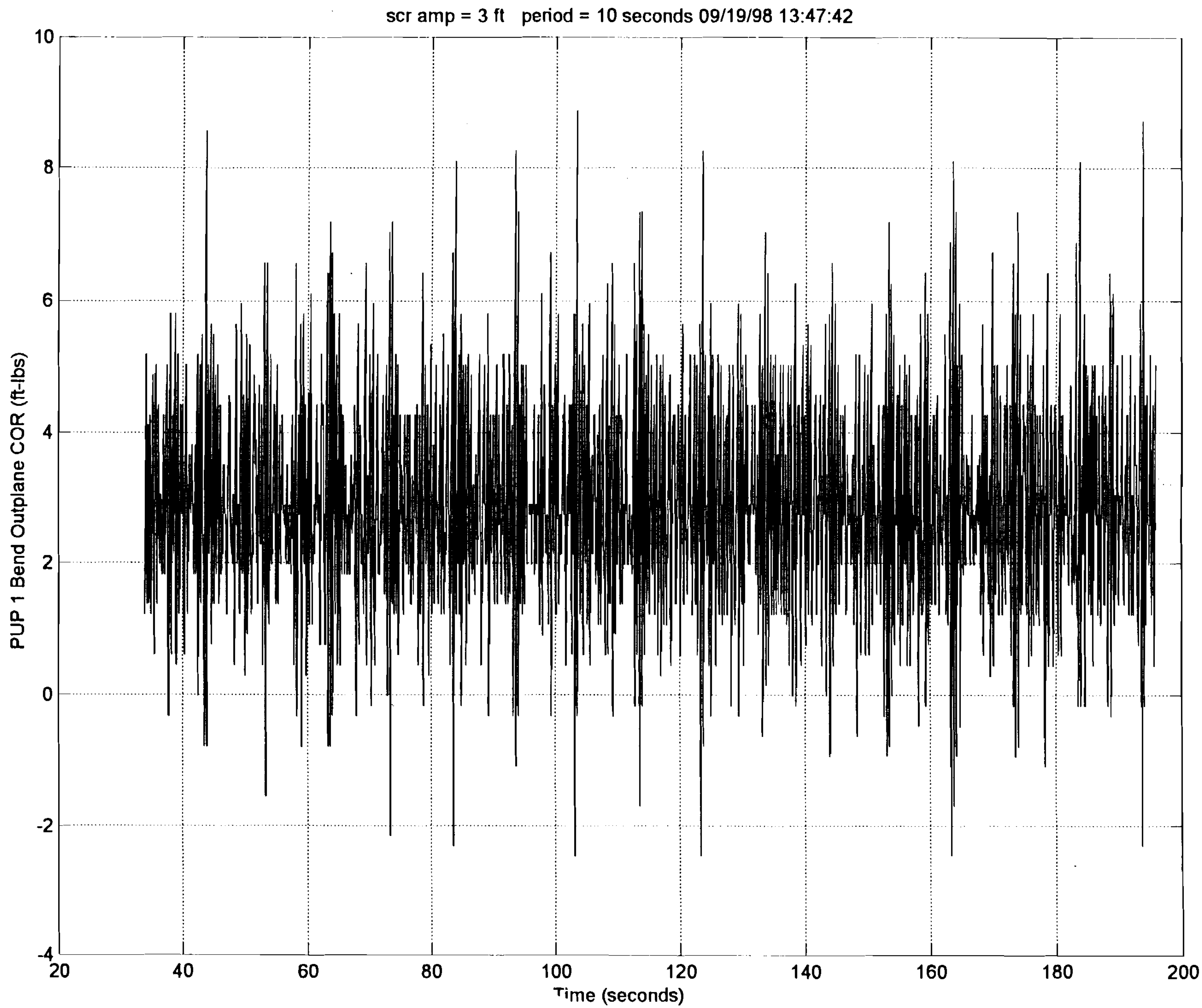
cvar amp = 3 ft period = 3 seconds 08/21/98 10:05:11
Pup 8 X Position (ft)
ime (seconds)
5
4
3
2
1
0
-1
-2
-3
-4
-5
45
50
55
60
65
70
75
80
85
90
95

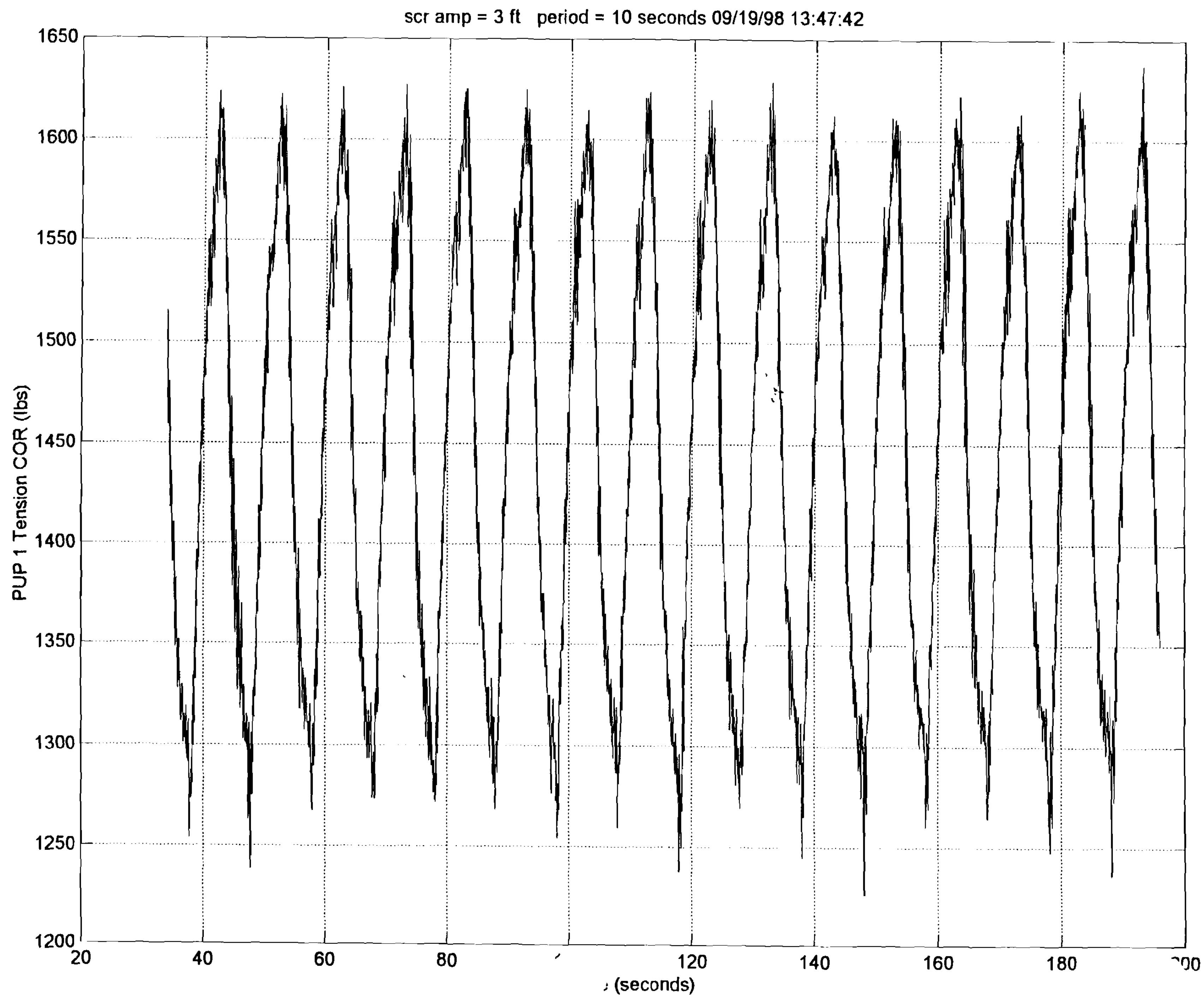


cvar amp = 3 ft   period = 3 seconds 08/21/98 10:05:11
Pup 8 Y Position (ft)
Time (seconds)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
45
50
55
60
65
70
75
80
85
90
95

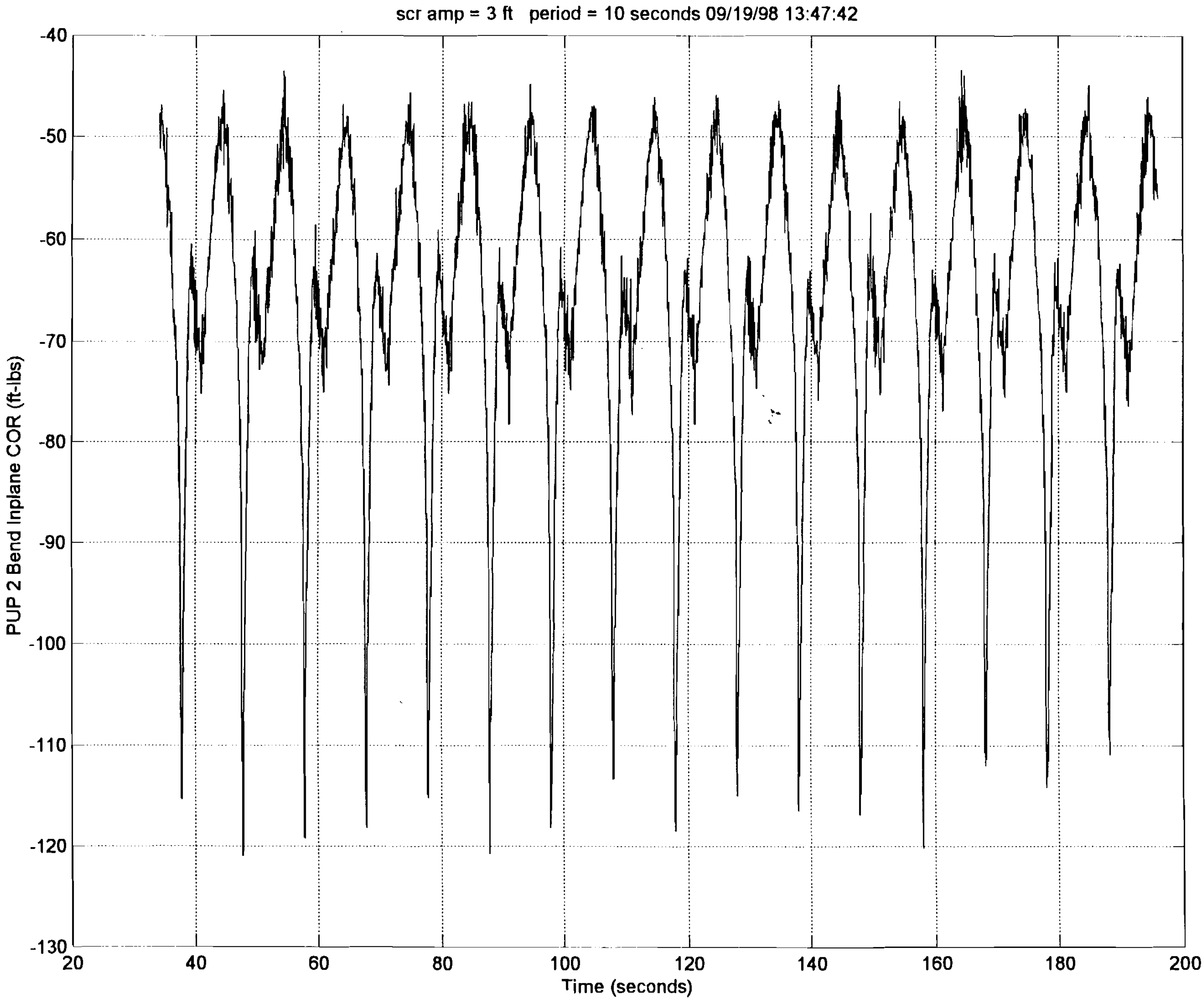

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Actuator Load (lbs)
1550
1500
1450
1400
1350
1300
1250
1200
1150
1100
20
40
60
80
100
120
140
160
180
200
Time (seconds)

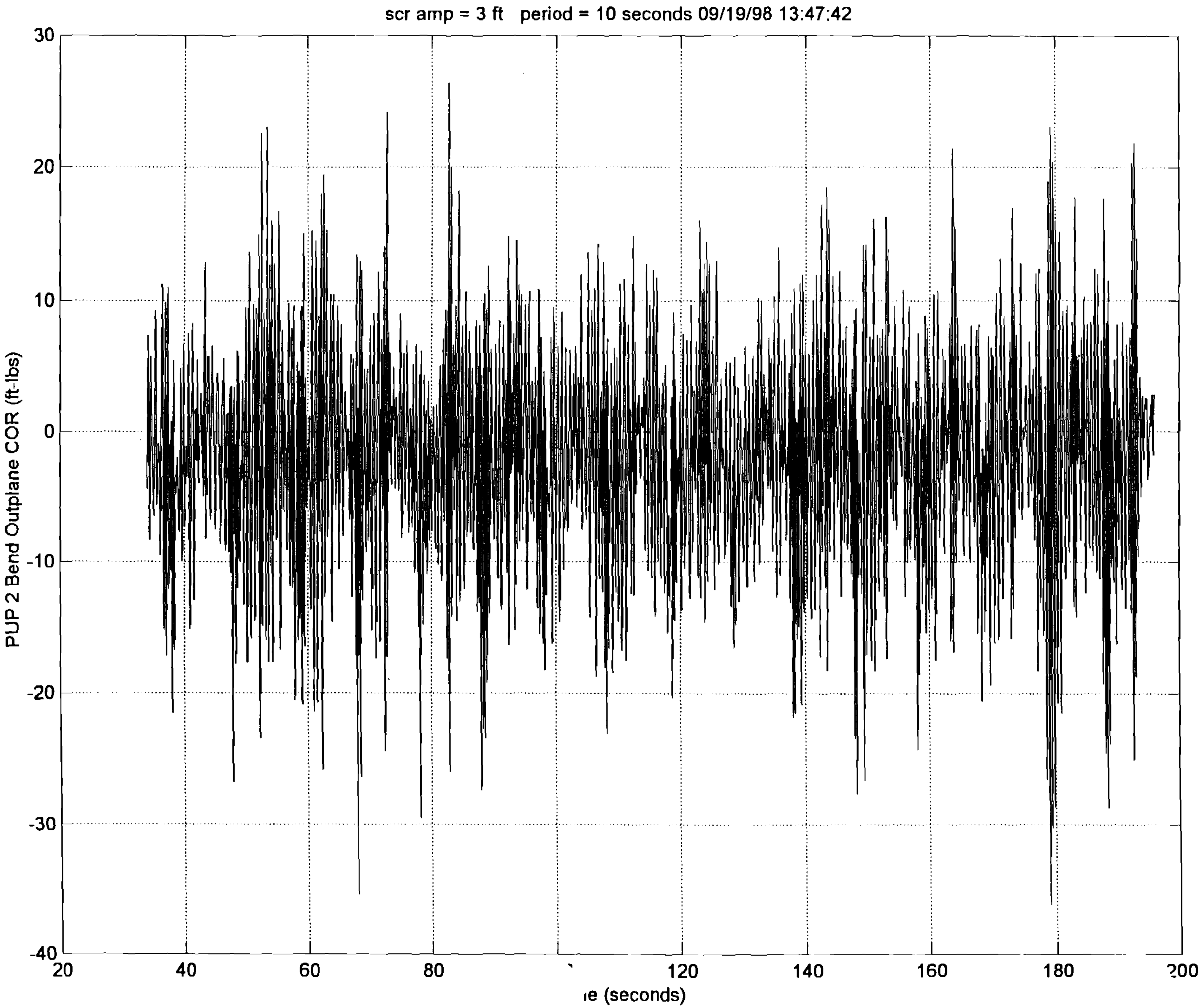

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 1 Bend Inplane COR (ft-lbs)
-13
-14
-15
-16
-17
-18
-19
-20
-21
-22
20
40
60
80
120
140
160
180
(seconds)

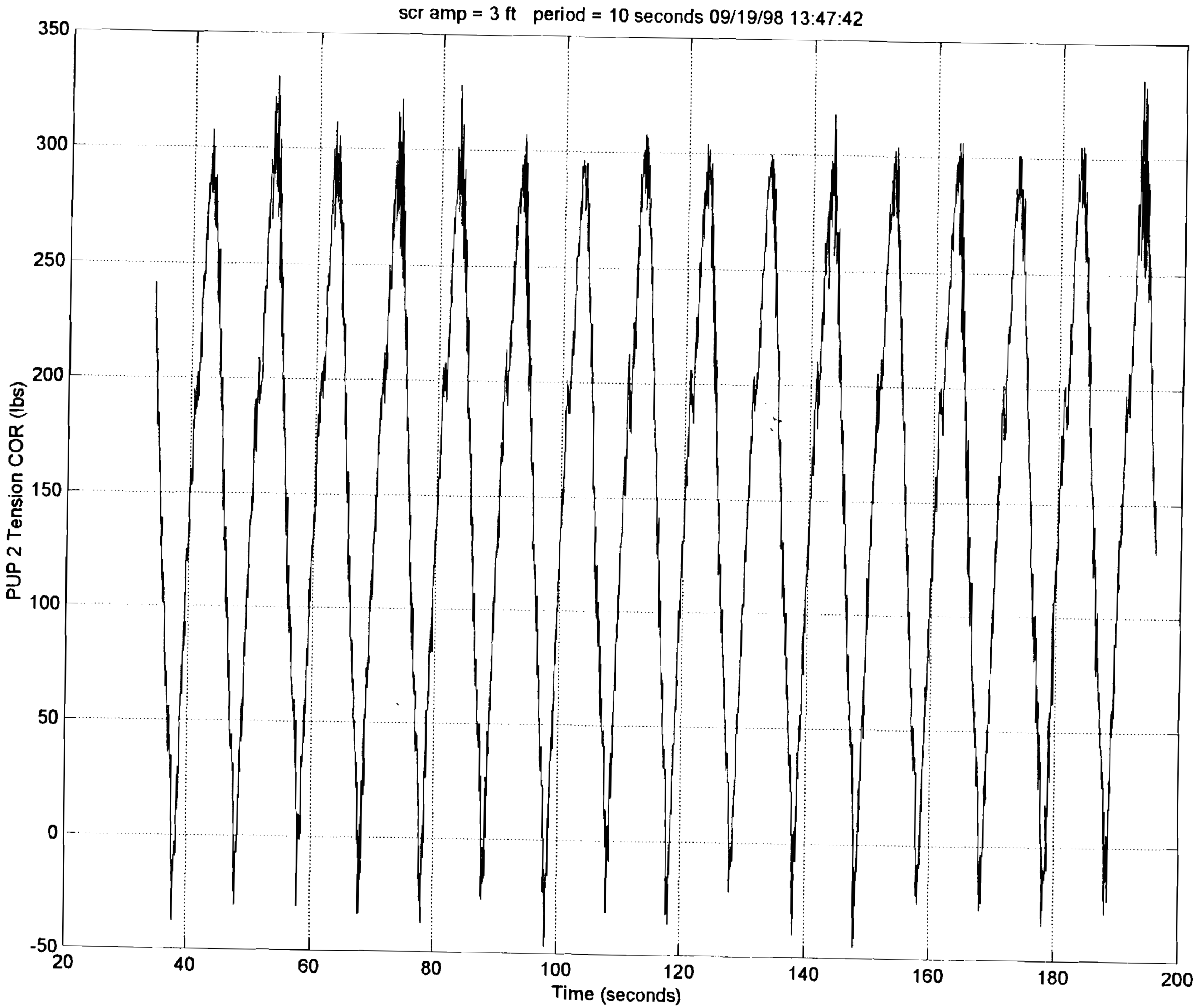

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 1 Bend Outplane COR (ft-lbs)
Time (seconds)
10
8
6
4
2
0
-2
-4
20
40
60
80
100
120
140
160
180
200

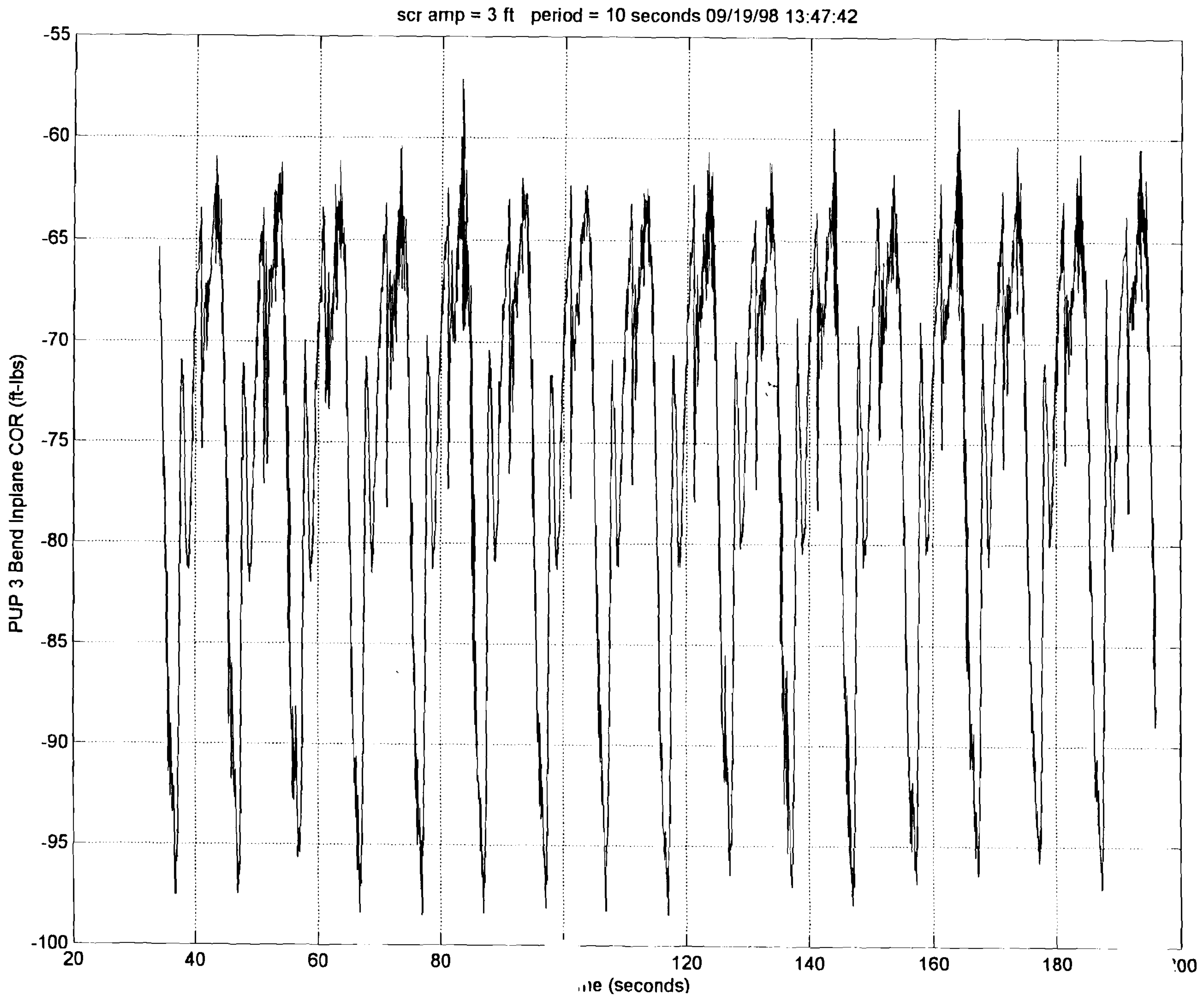


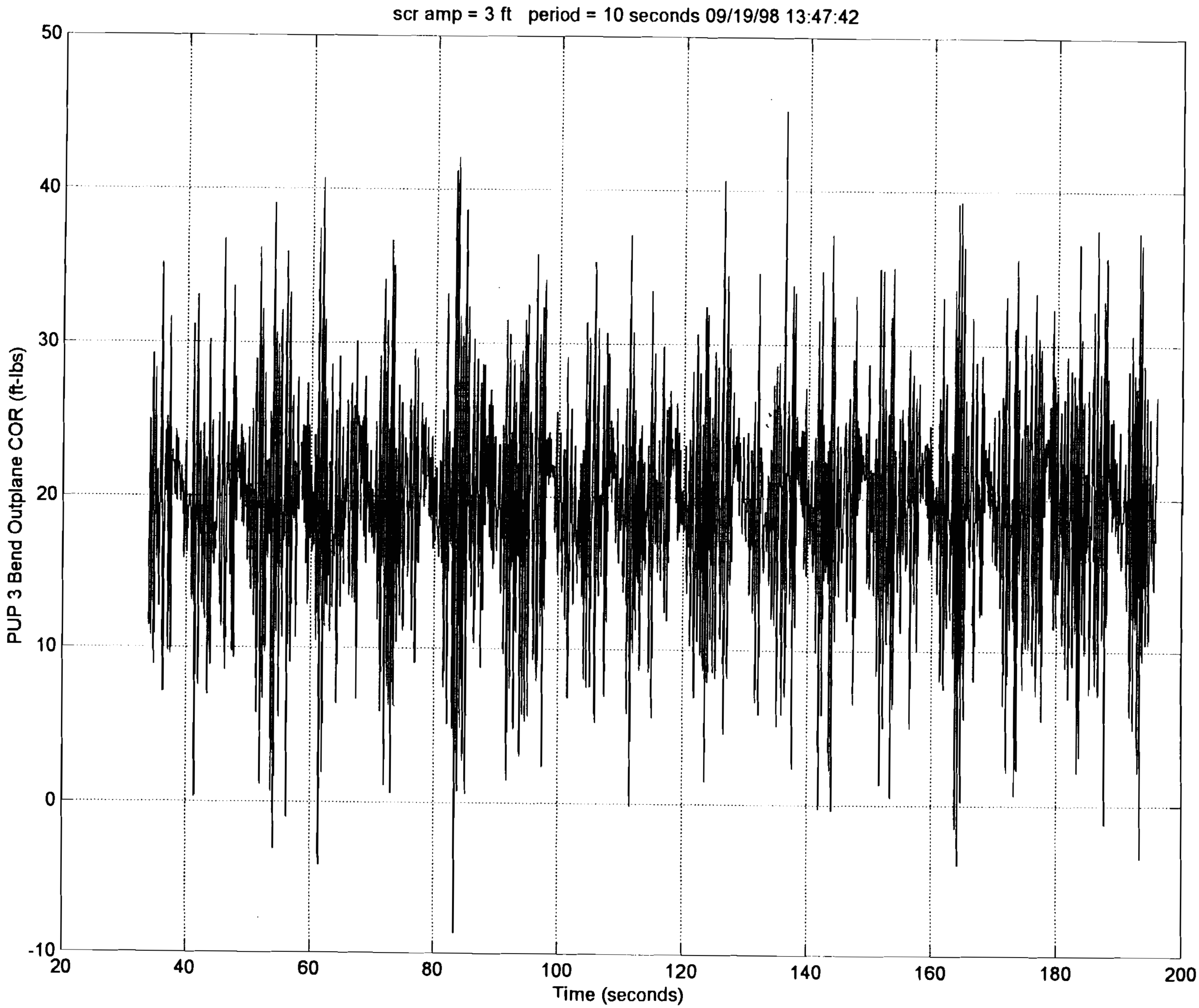
scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 1 Tension COR (lbs)
1650
1600
1550
1500
1450
1400
1350
1300
1250
1200
20
40
60
80
120
140
160
180
(seconds)


scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 2 Bend Inplane COR (ft-lbs)
Time (seconds)
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
20
40
60
80
100
120
140
160
180
200

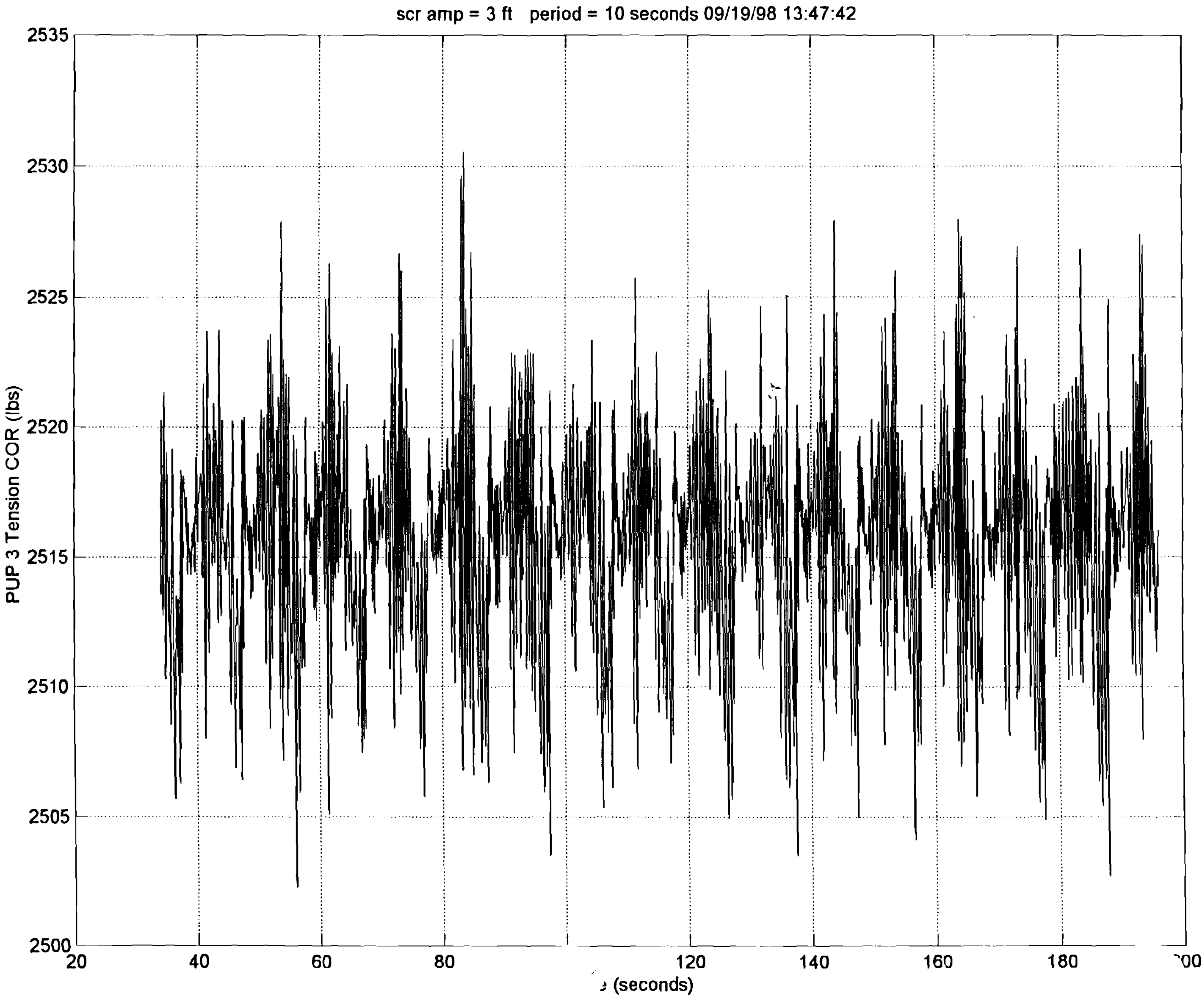

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 2 Bend Outplane COR (ft-lbs)
ιe (seconds)
30
20
10
0
-10
-20
-30
-40
20
40
60
80
120
140
160
180
200

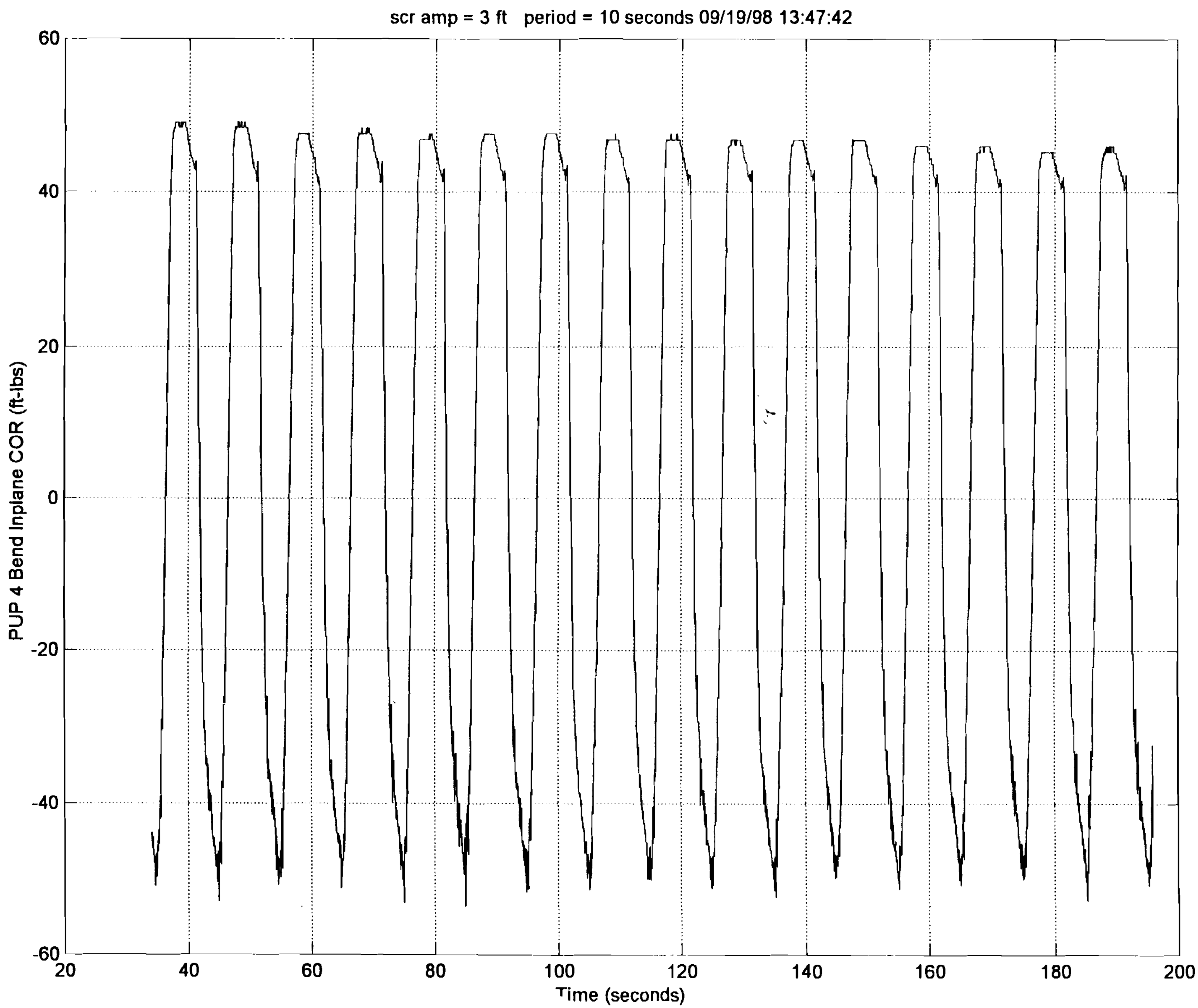

scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
PUP 2 Tension COR (lbs)
350
300
250
200
150
100
50
0
-50
20
40
60
80
100
120
140
160
180
200
Time (seconds)

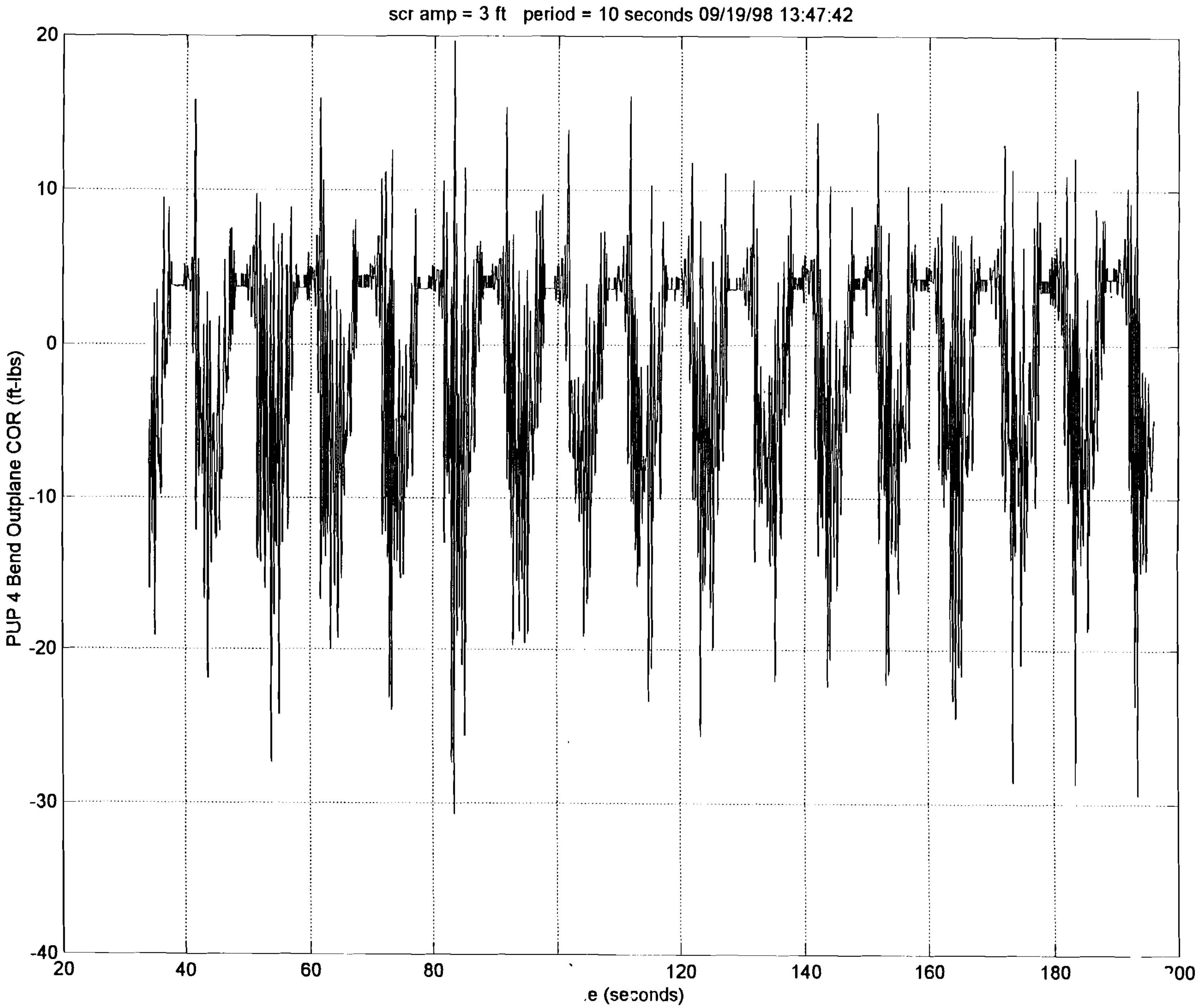

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 3 Bend Inplane COR (ft-lbs)
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
20
40
60
80
120
140
160
180
ne (seconds)

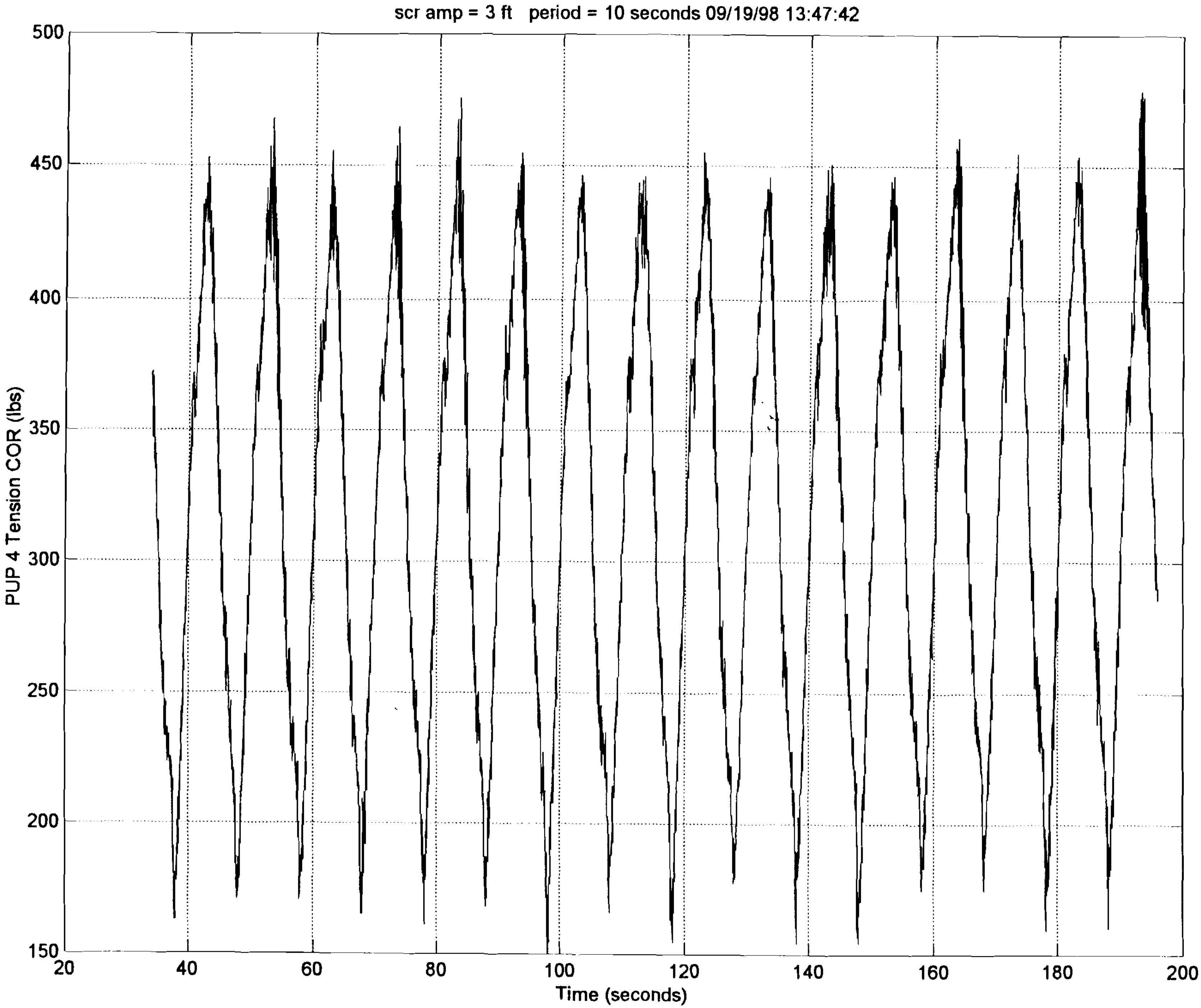


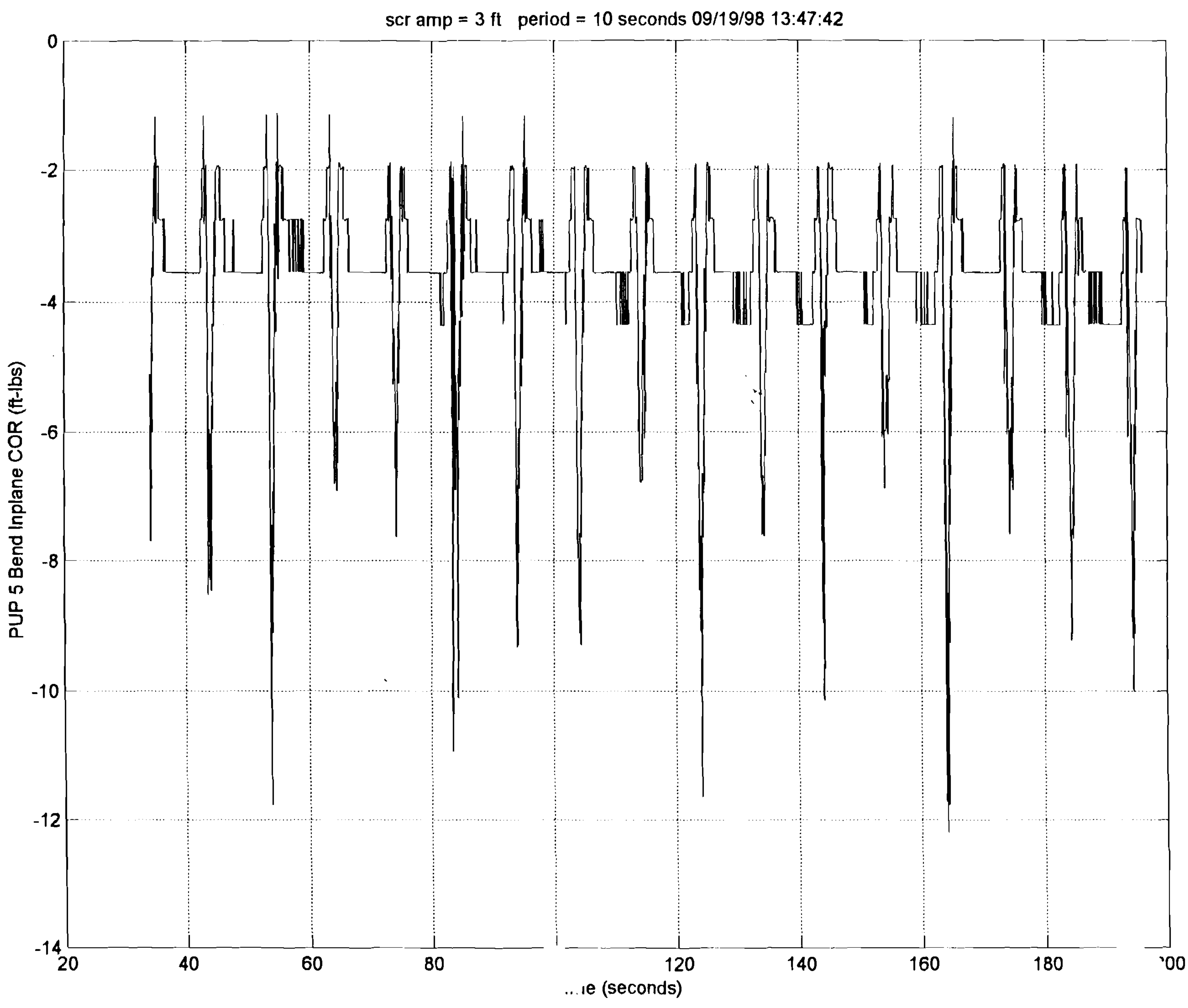
scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 3 Bend Outplane COR (ft-lbs)
50
40
30
20
10
0
-10
20
40
60
80
100
120
140
160
180
200
Time (seconds)


scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 3 Tension COR (lbs)
2535
2530
2525
2520
2515
2510
2505
2500
20
40
60
80
120
140
160
180
(seconds)

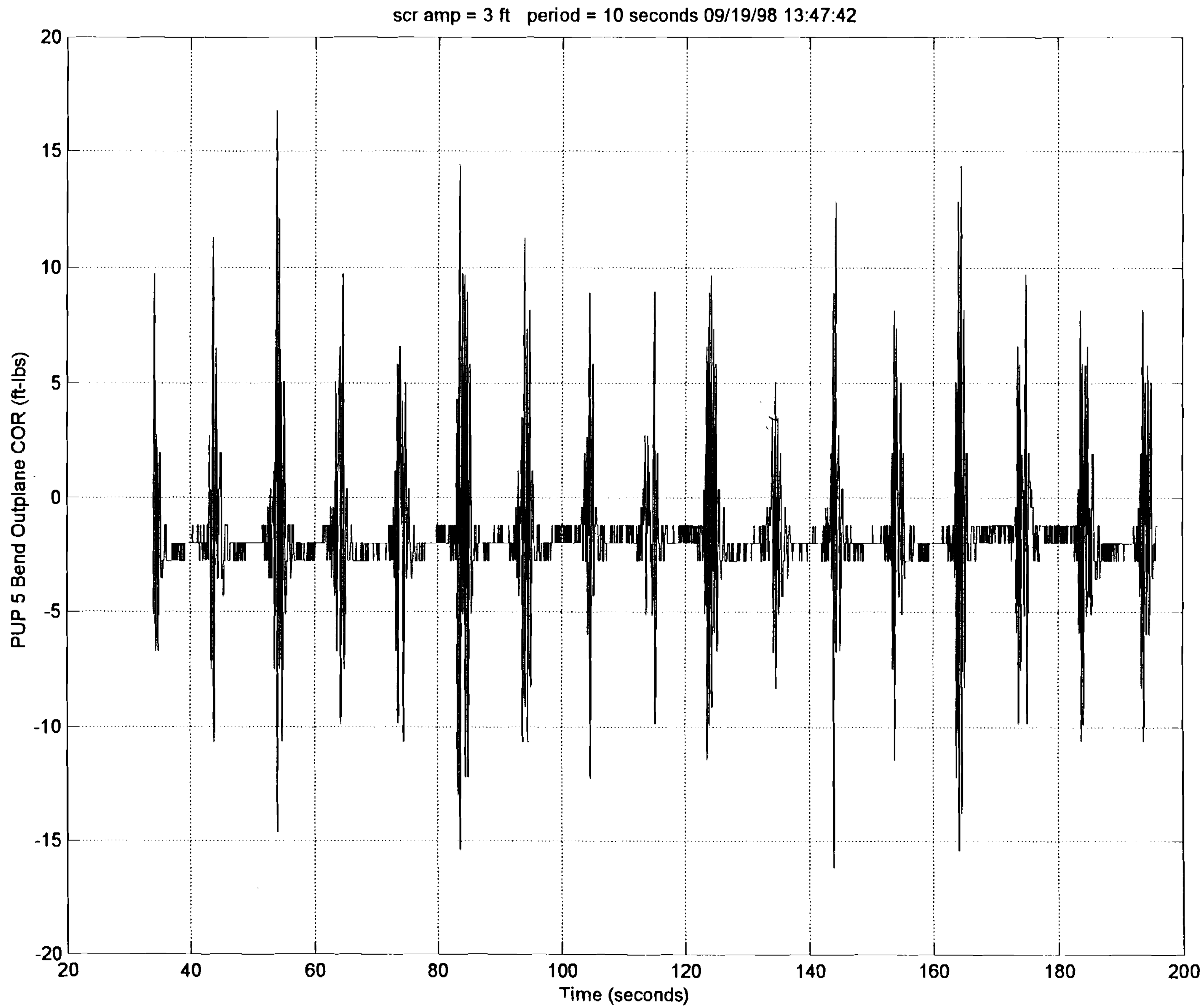

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 4 Bend Inplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
20
40
60
80
100
120
140
160
180
200
Time (seconds)

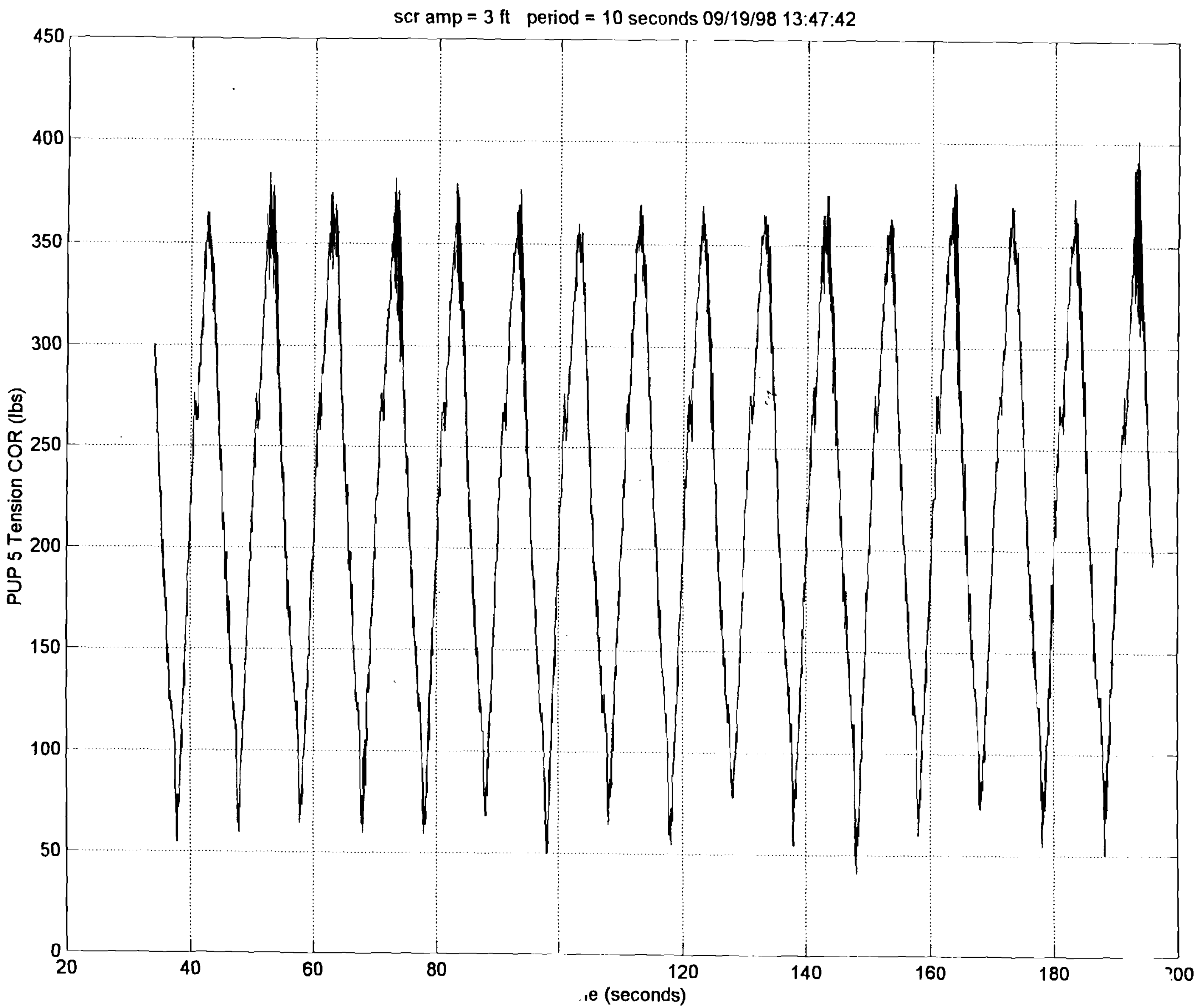

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 4 Bend Outplane COR (ft-lbs)
20
10
0
-10
-20
-30
-40
20
40
60
80
120
140
160
180
.e (seconds)

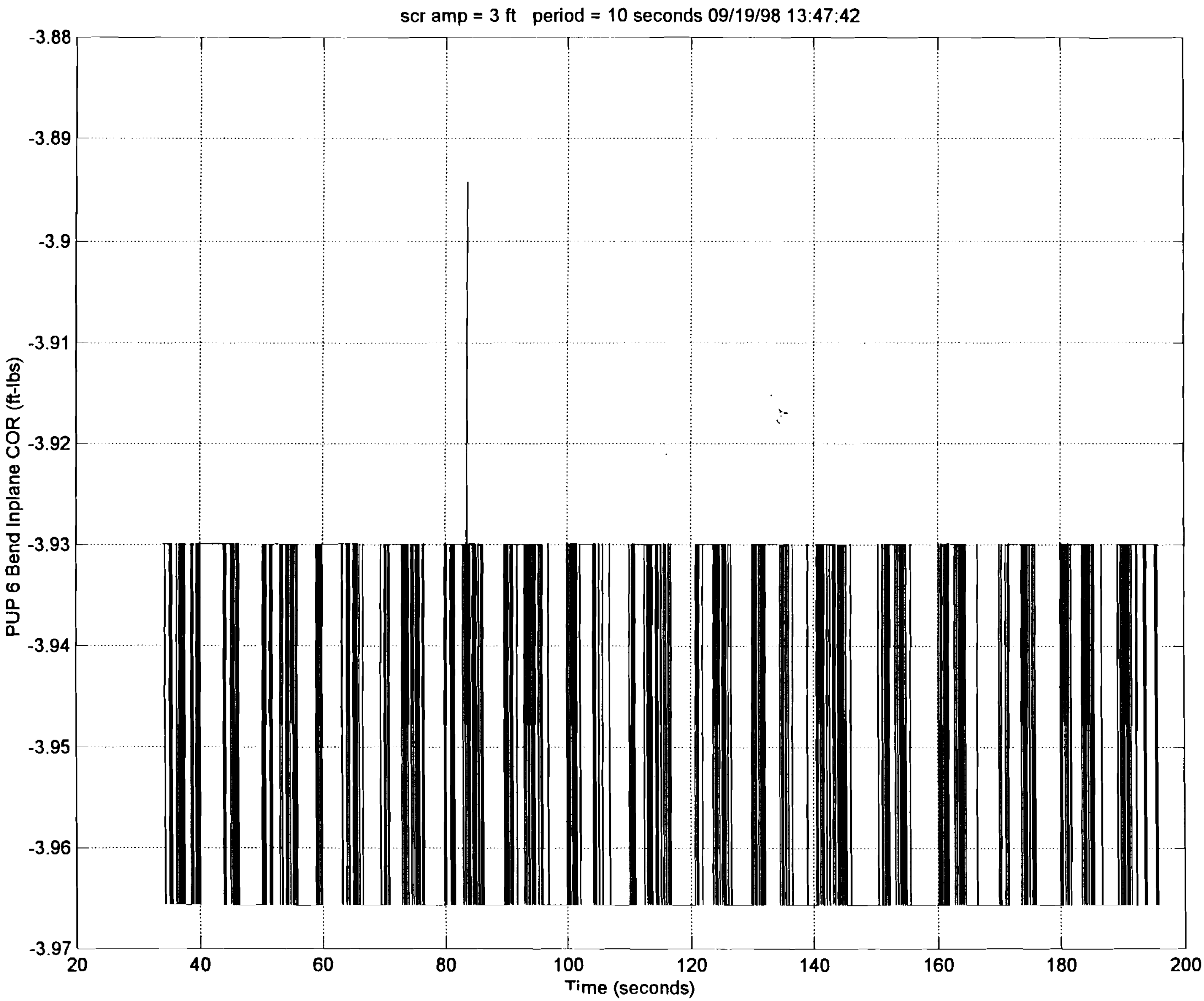

scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
PUP 4 Tension COR (lbs)
Time (seconds)
500
450
400
350
300
250
200
150
20
40
60
80
100
120
140
160
180
200

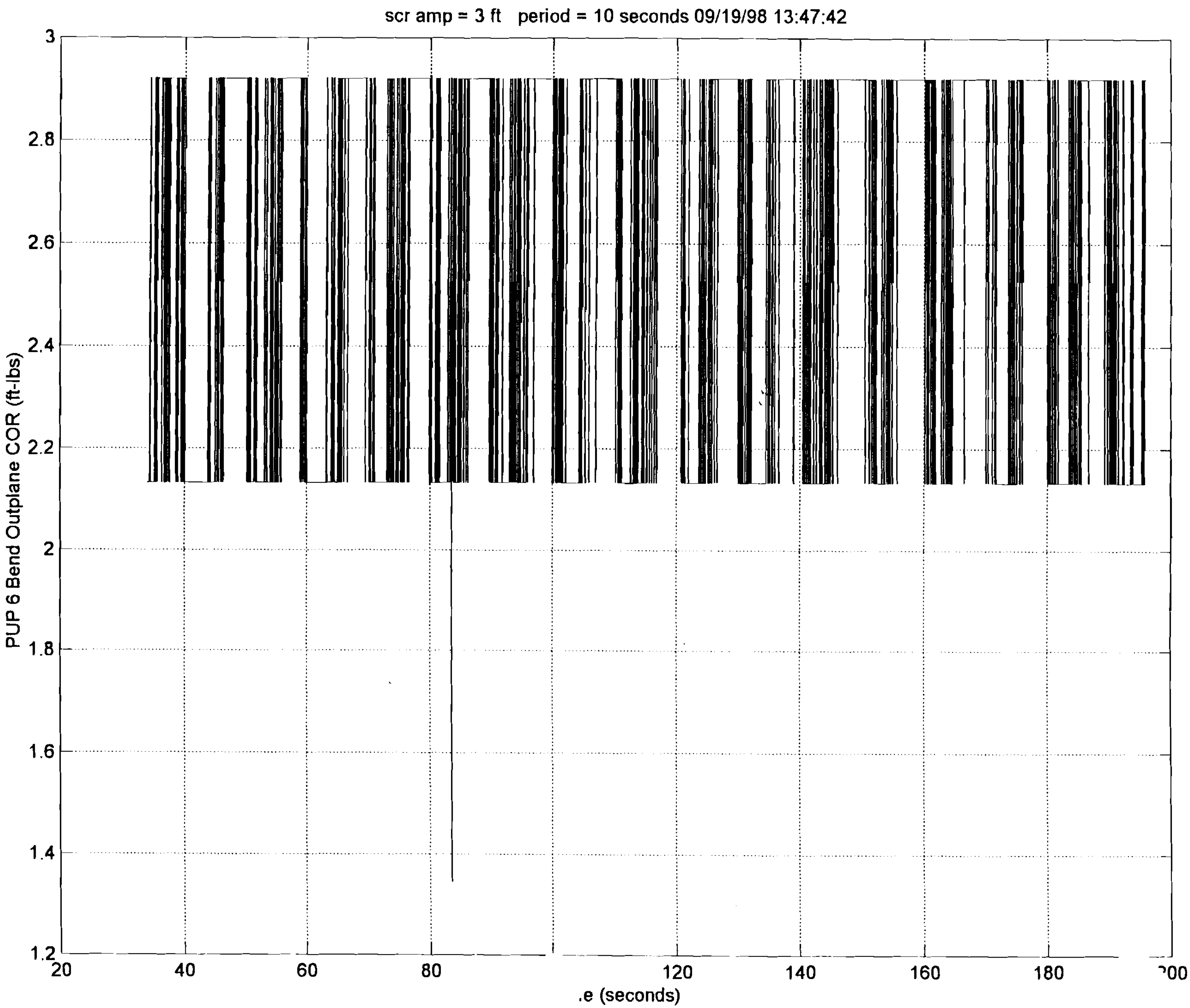


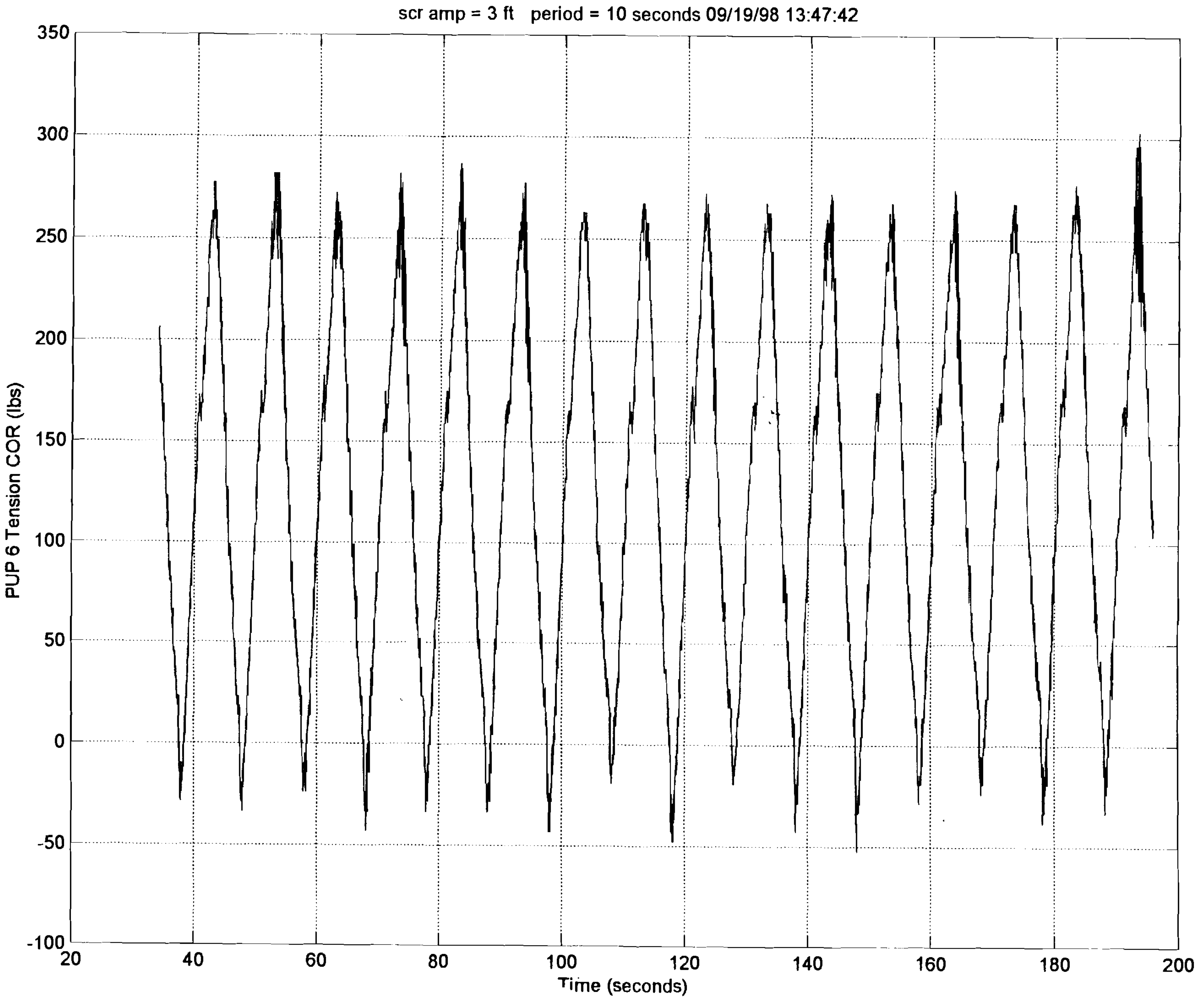
scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 5 Bend Inplane COR (ft-lbs)
0
-2
-4
-6
-8
-10
-12
-14
20
40
60
80
120
140
160
180
...ie (seconds)

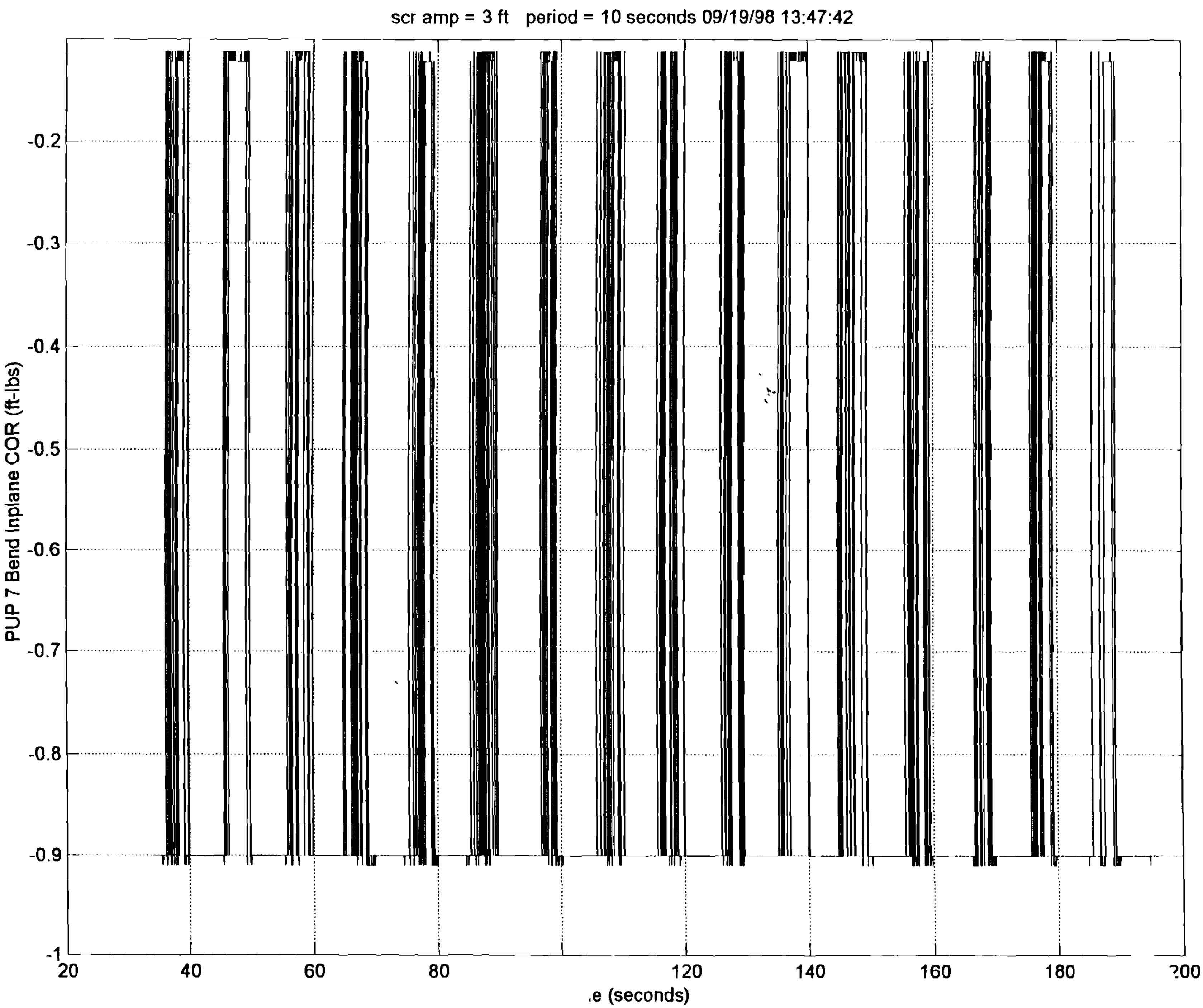

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 5 Bend Outplane COR (ft-lbs)
Time (seconds)
20
15
10
5
0
-5
-10
-15
-20
20
40
60
80
100
120
140
160
180
200

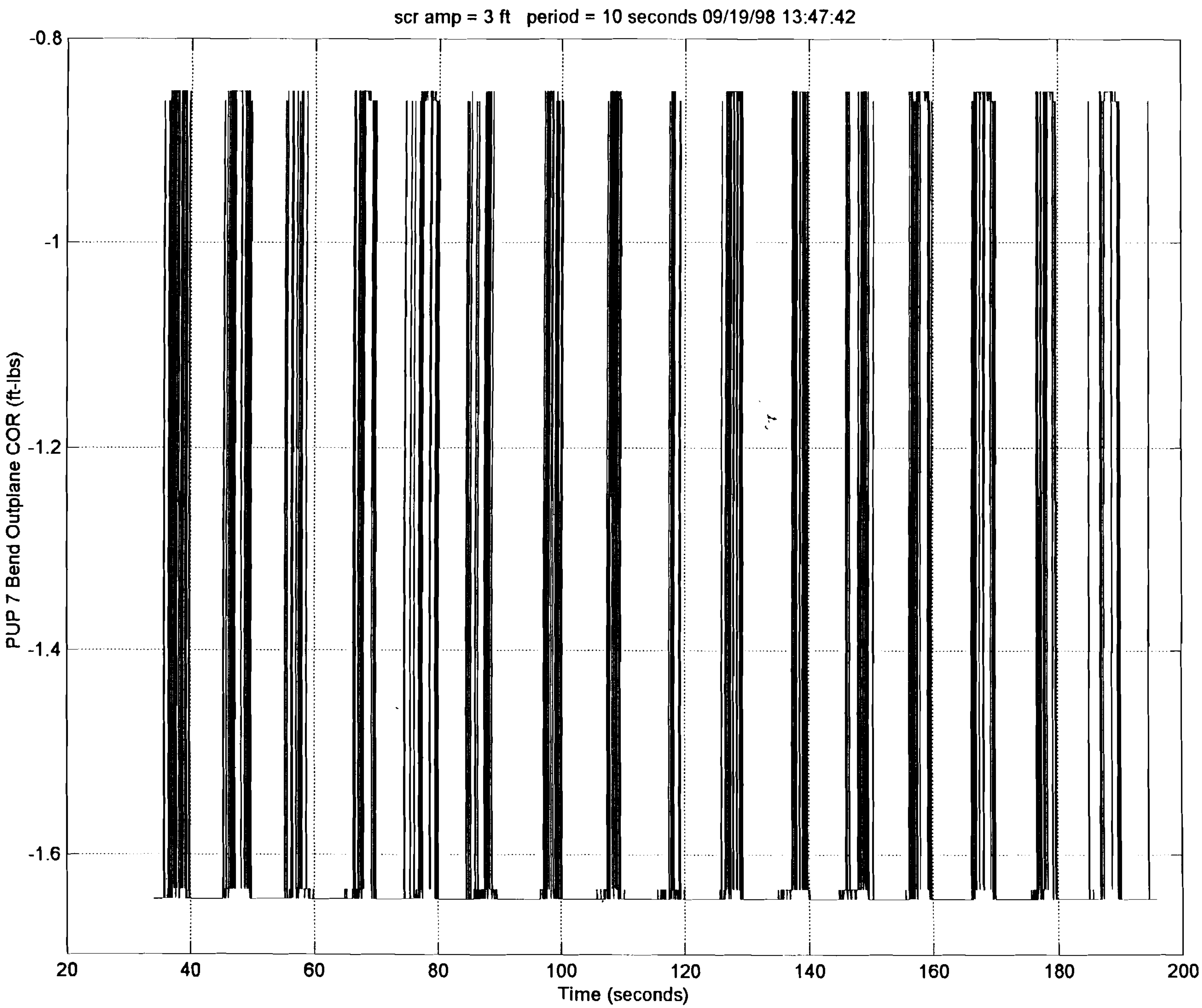

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 5 Tension COR (lbs)
0
50
100
150
200
250
300
350
400
450
20
40
60
80
120
140
160
180
?00
.ie (seconds)

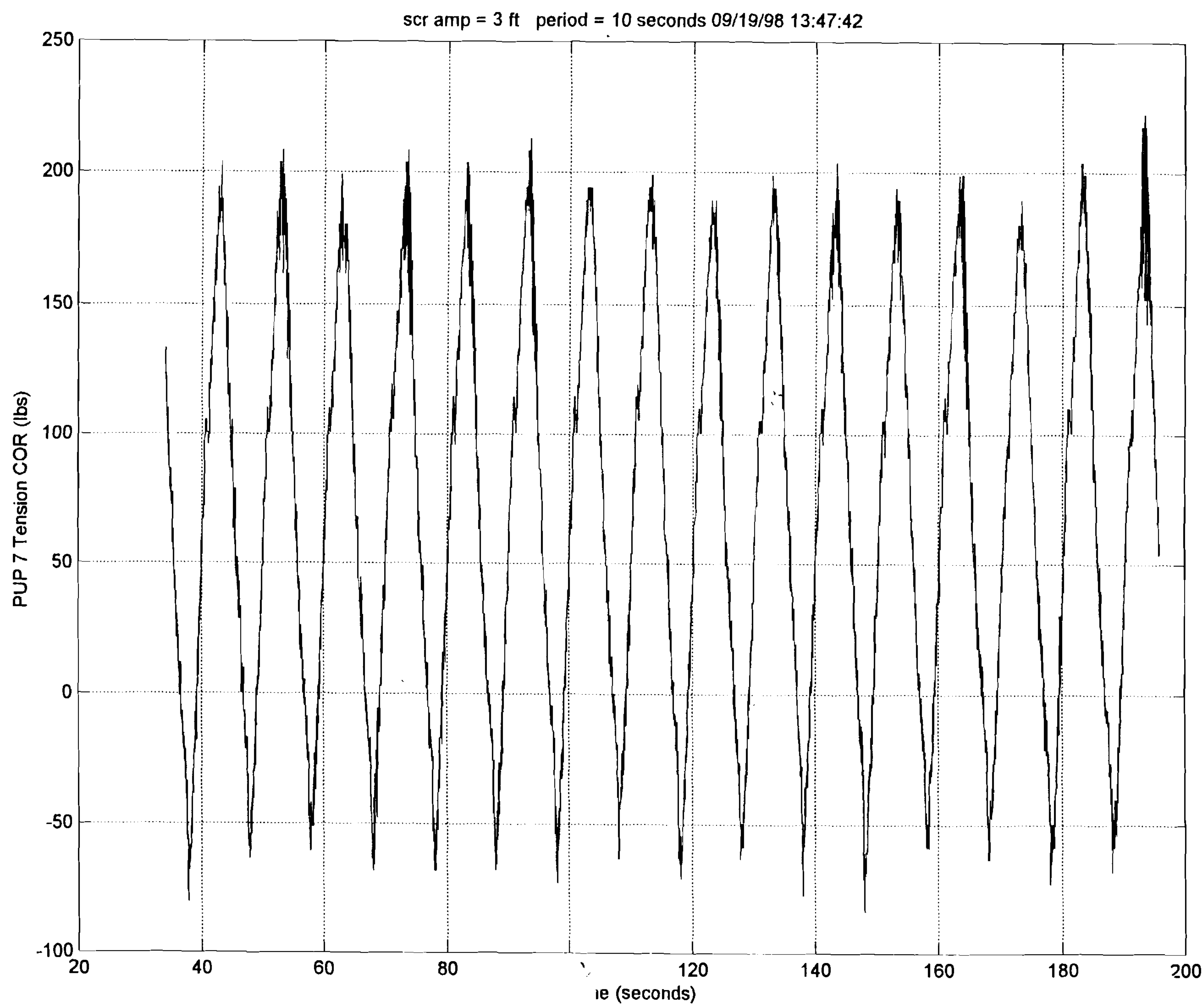

scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
-3.88
-3.89
-3.9
-3.91
-3.92
-3.93
-3.94
-3.95
-3.96
-3.97
PUP 6 Bend Inplane COR (ft-lbs)
20
40
60
80
100
120
140
160
180
200
Time (seconds)

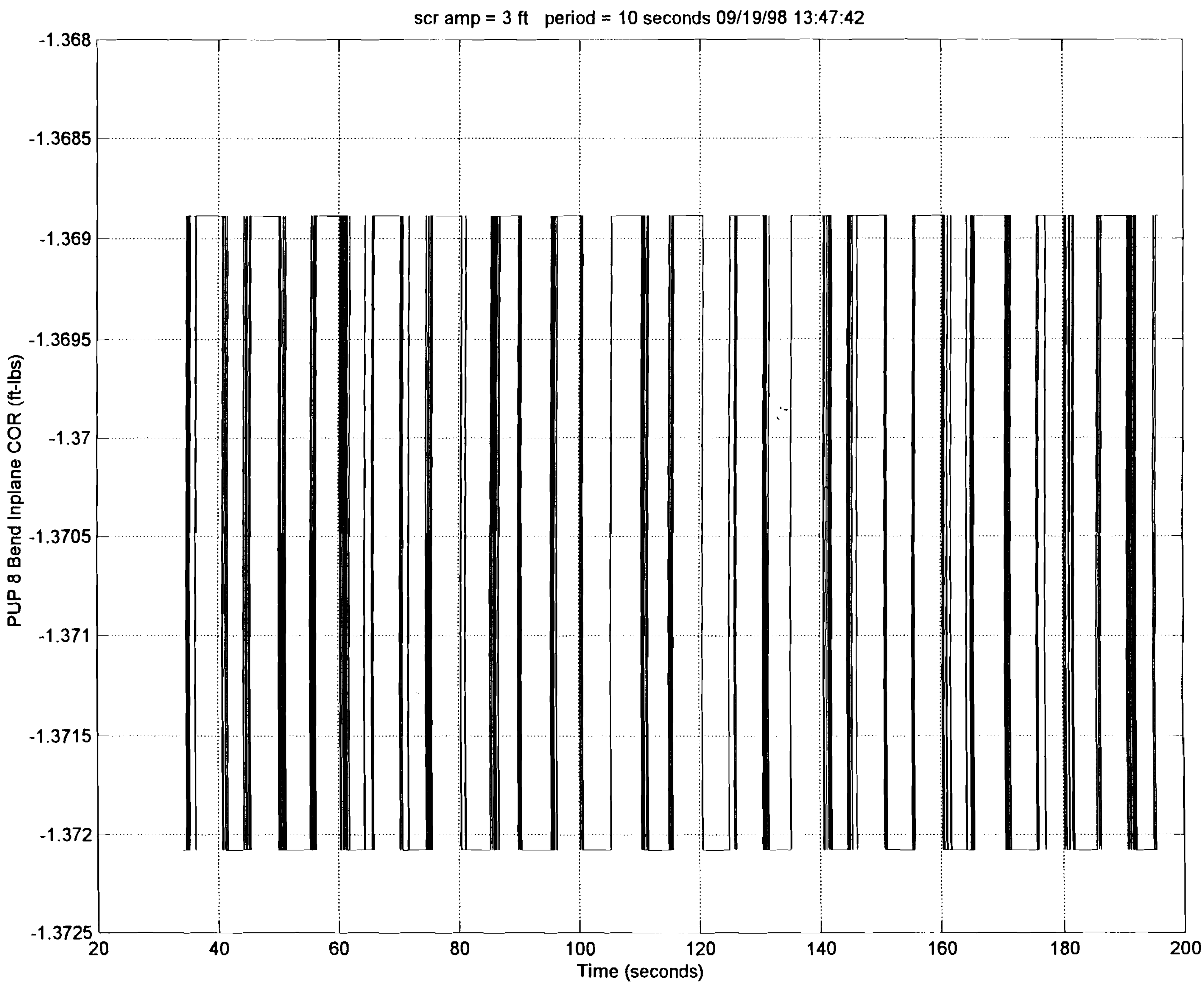

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 6 Bend Outplane COR (ft-lbs)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
20
40
60
80
120
140
160
180
.e (seconds)

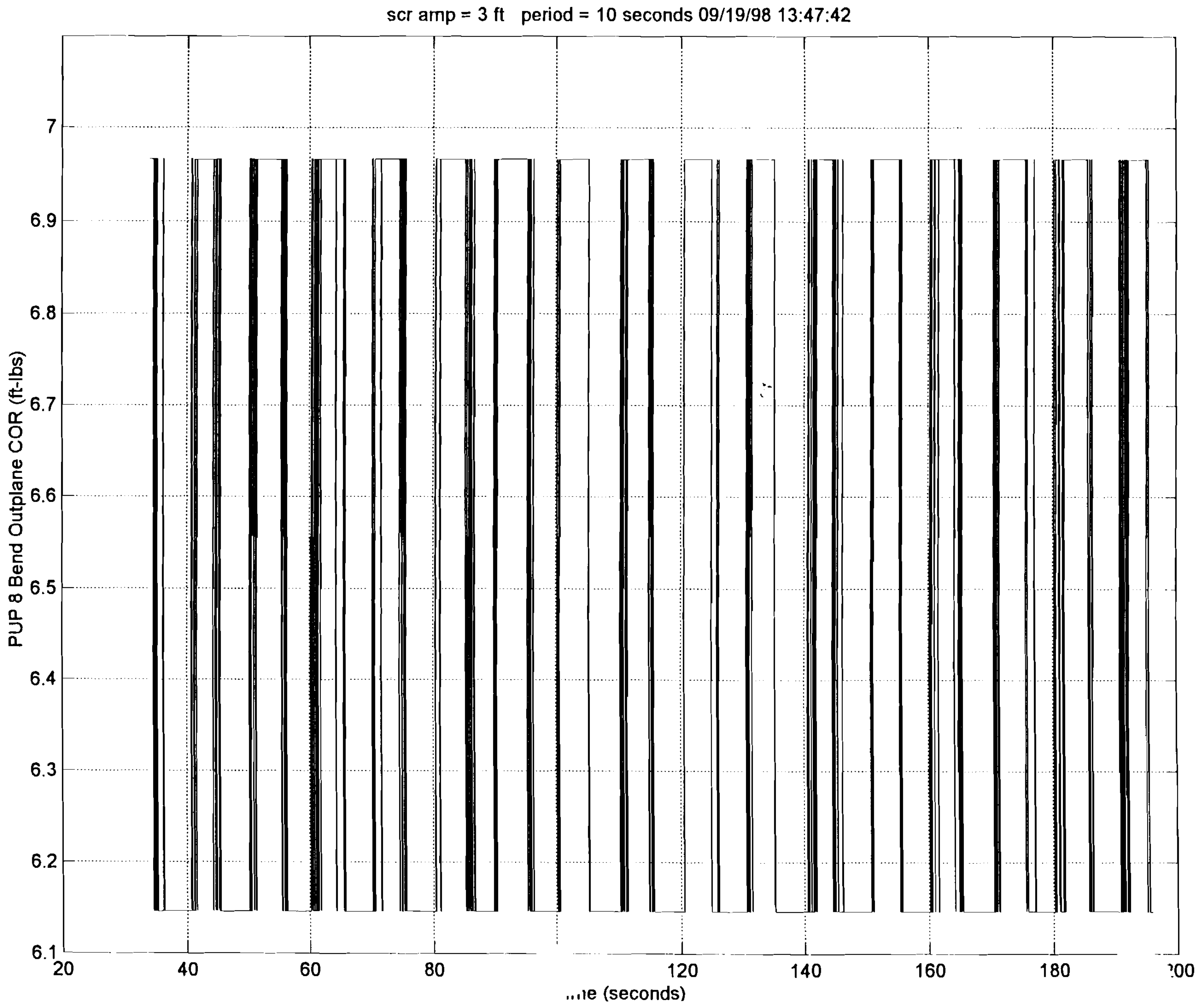

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 6 Tension COR (lbs)
350
300
250
200
150
100
50
0
-50
-100
20
40
60
80
100
120
140
160
180
200
Time (seconds)


scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
PUP 7 Bend Inplane COR (ft-lbs)
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
20
40
60
80
120
140
160
180
?00
.e (seconds)

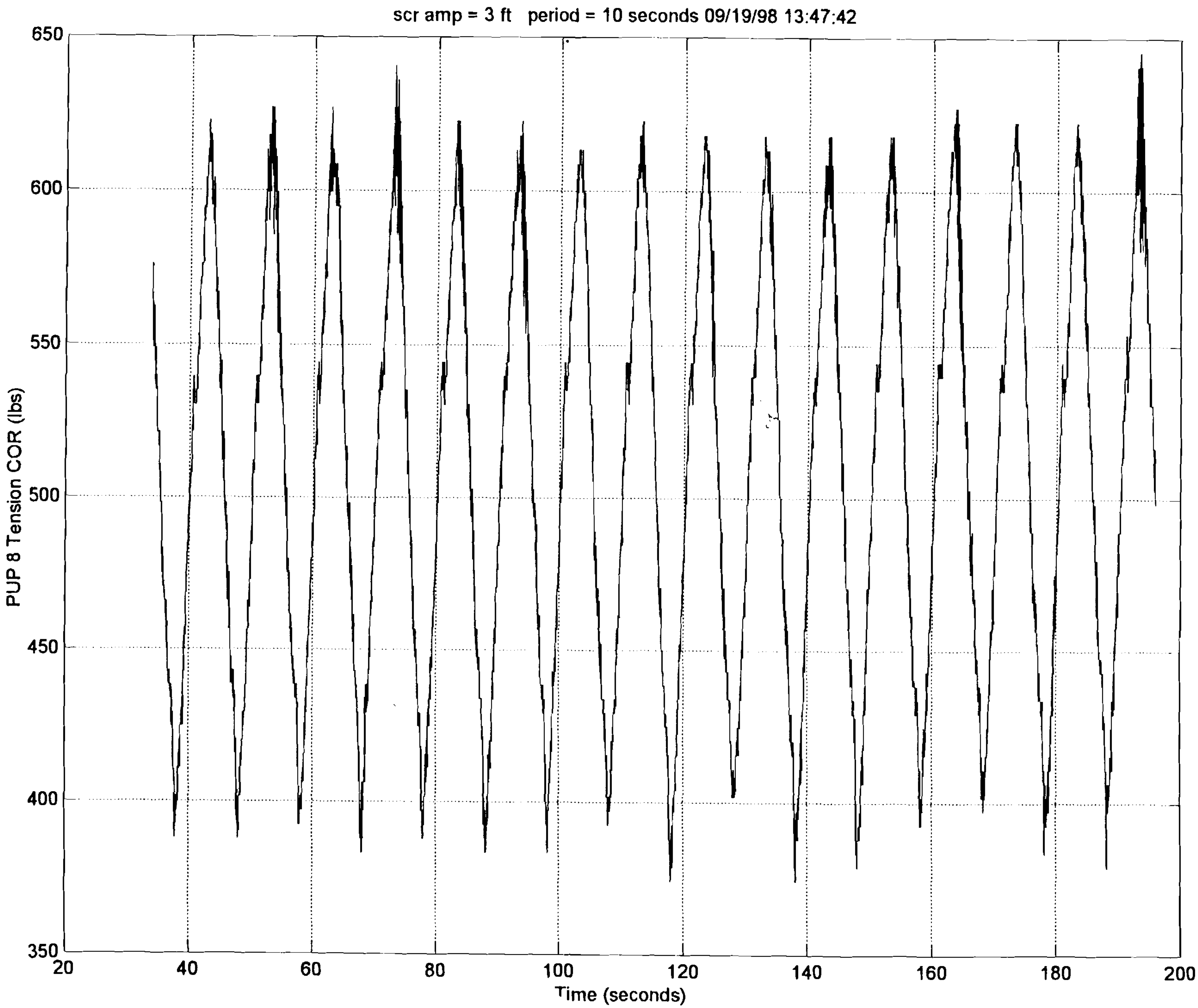

scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
PUP 7 Bend Outplane COR (ft-lbs)
-0.8
-1
-1.2
-1.4
-1.6
20
40
60
80
100
120
140
160
180
200
Time (seconds)

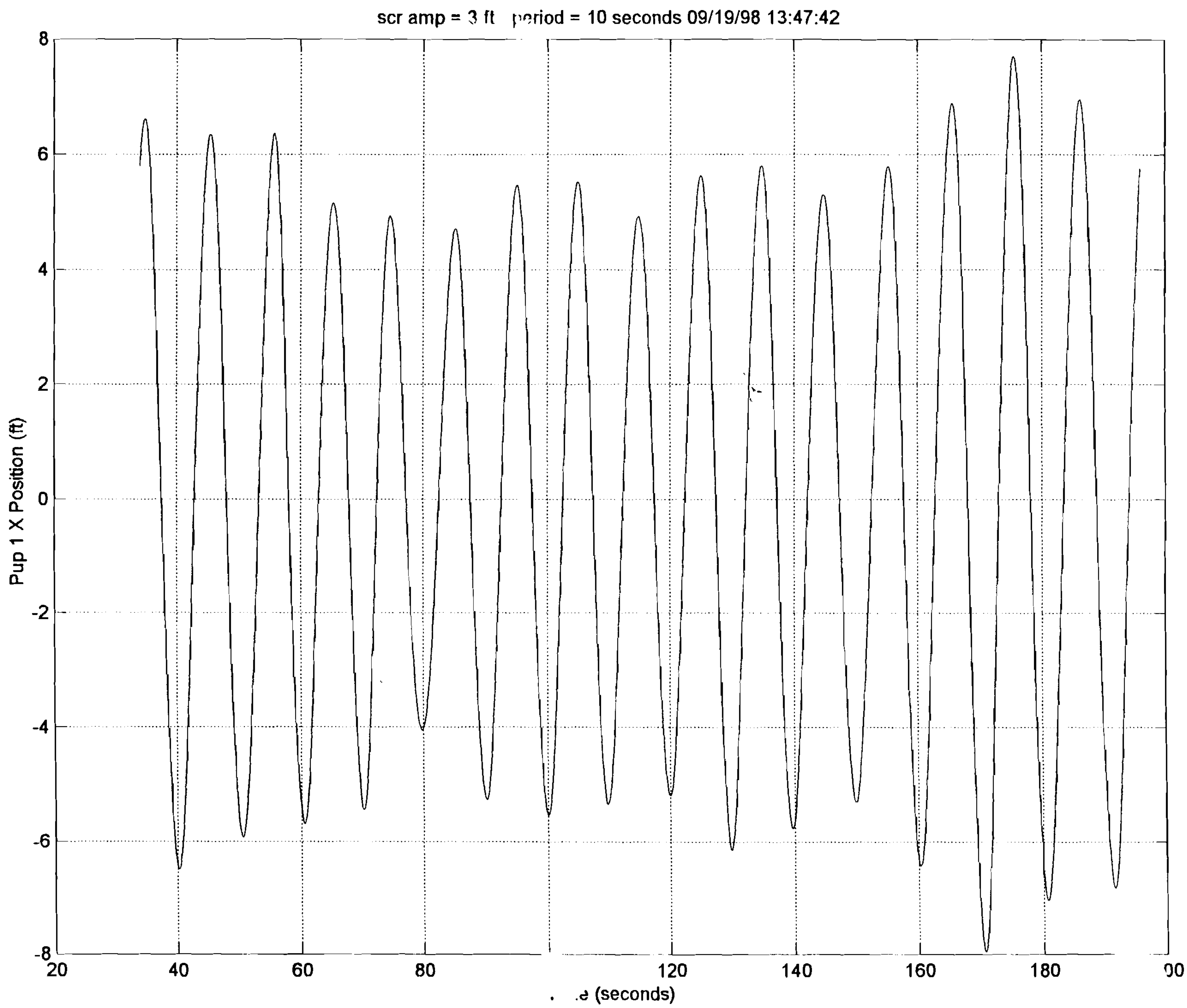

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 7 Tension COR (lbs)
250
200
150
100
50
0
-50
-100
20
40
60
80
120
140
160
180
200
ıe (seconds)

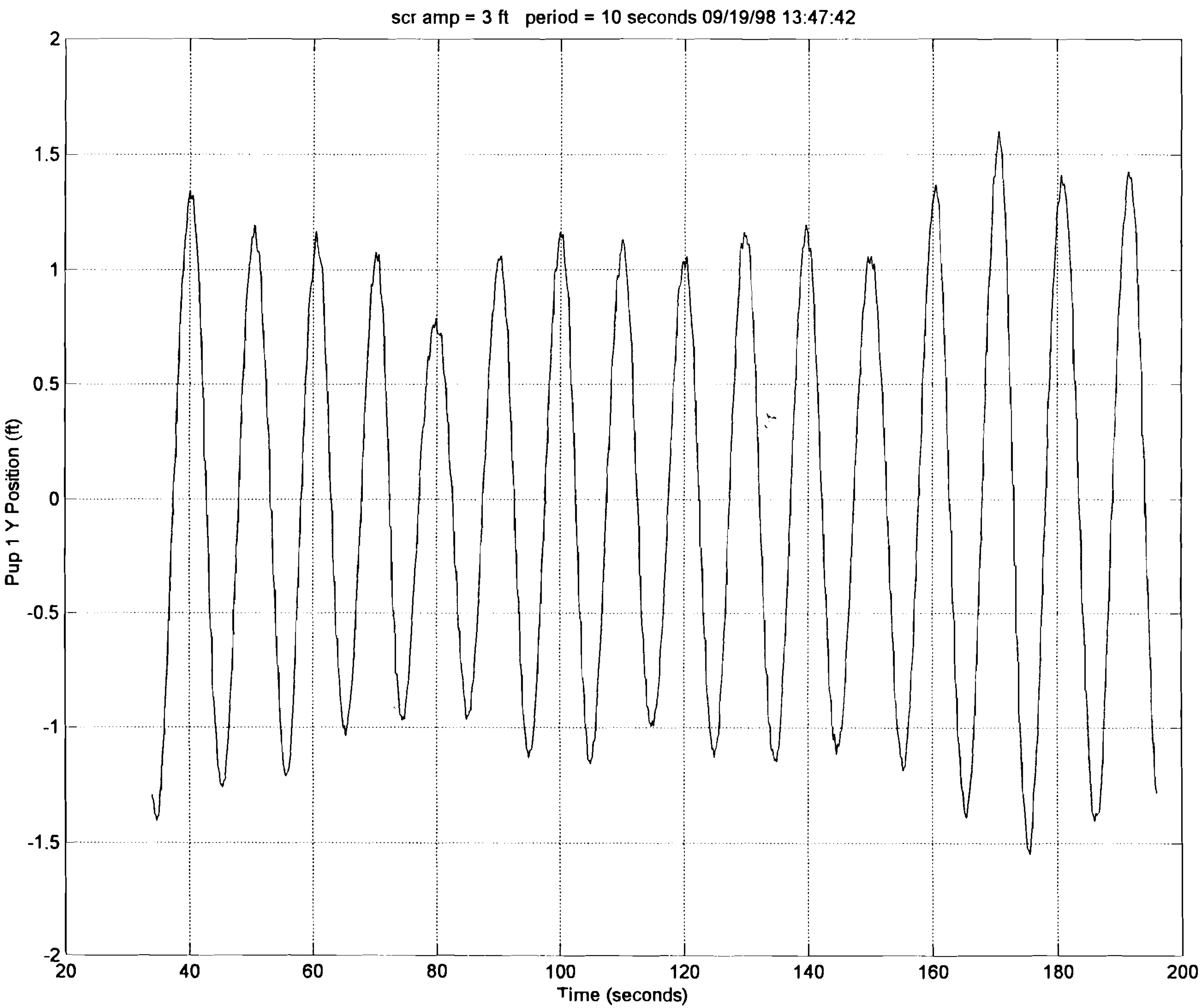

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
-1.368
-1.3685
-1.369
-1.3695
-1.37
-1.3705
-1.371
-1.3715
-1.372
-1.3725
PUP 8 Bend Inplane COR (ft-lbs)
20
40
60
80
100
120
140
160
180
200
Time (seconds)

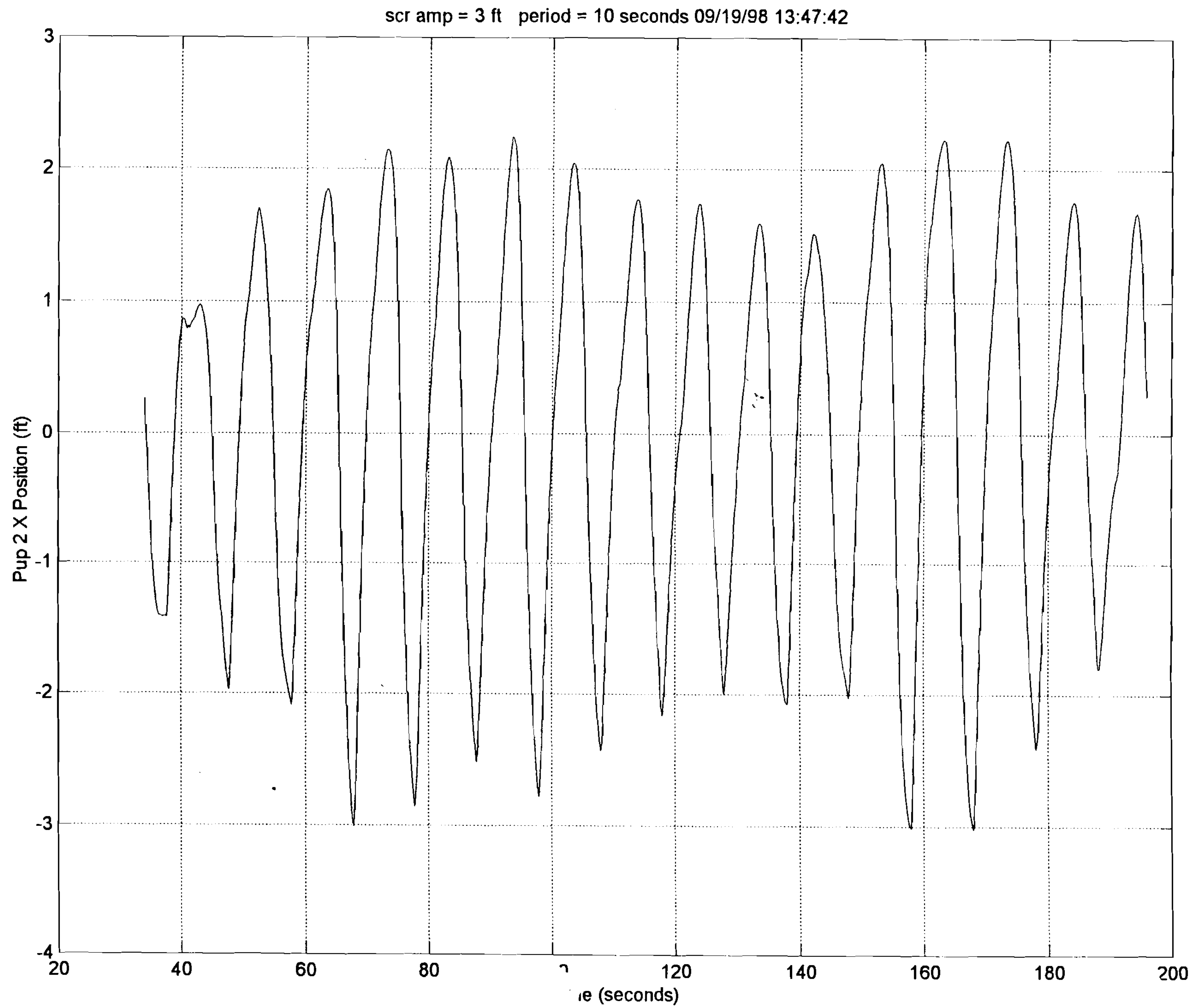


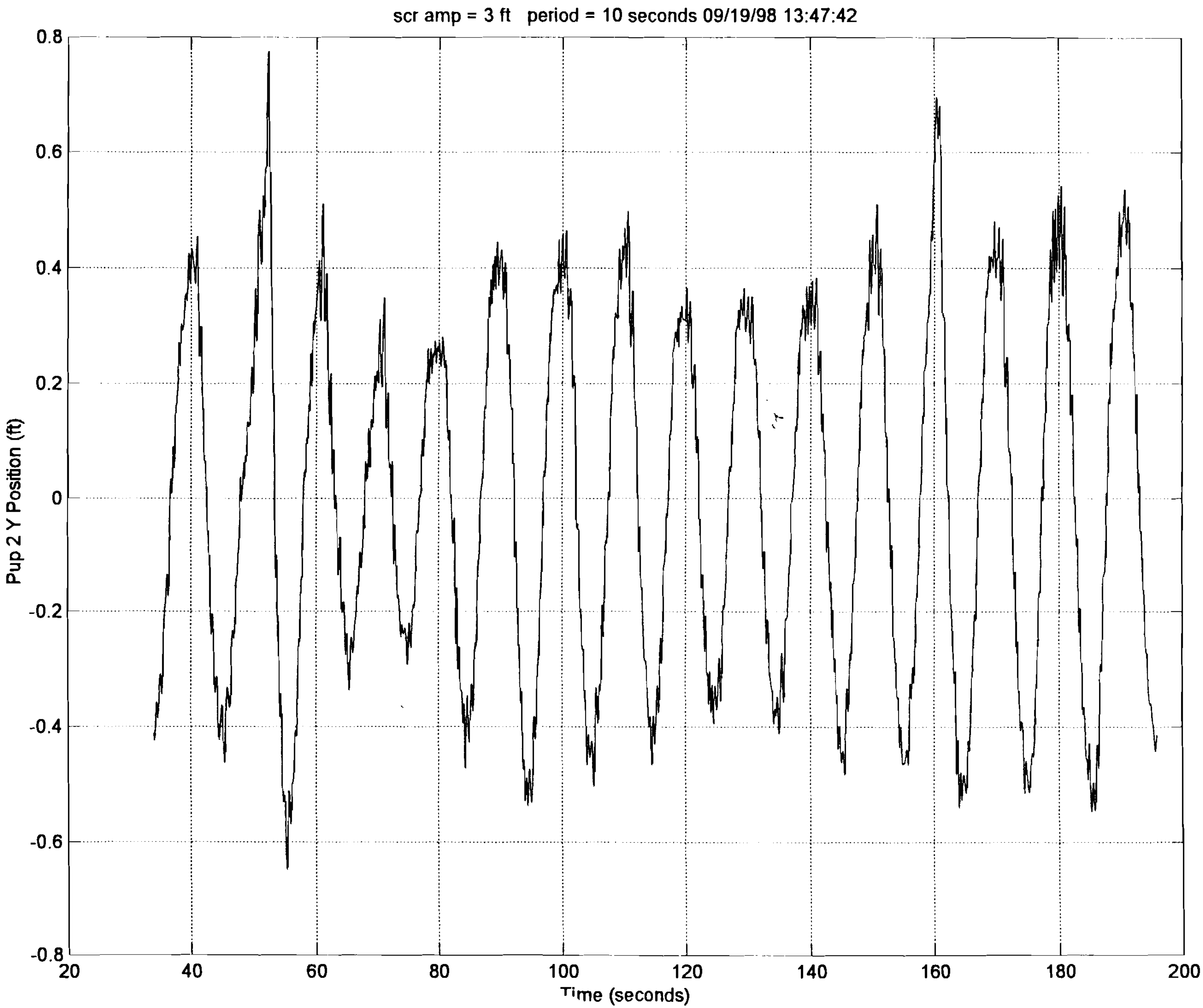
scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
PUP 8 Bend Outplane COR (ft-lbs)
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
20
40
60
80
120
140
160
180
ne (seconds)

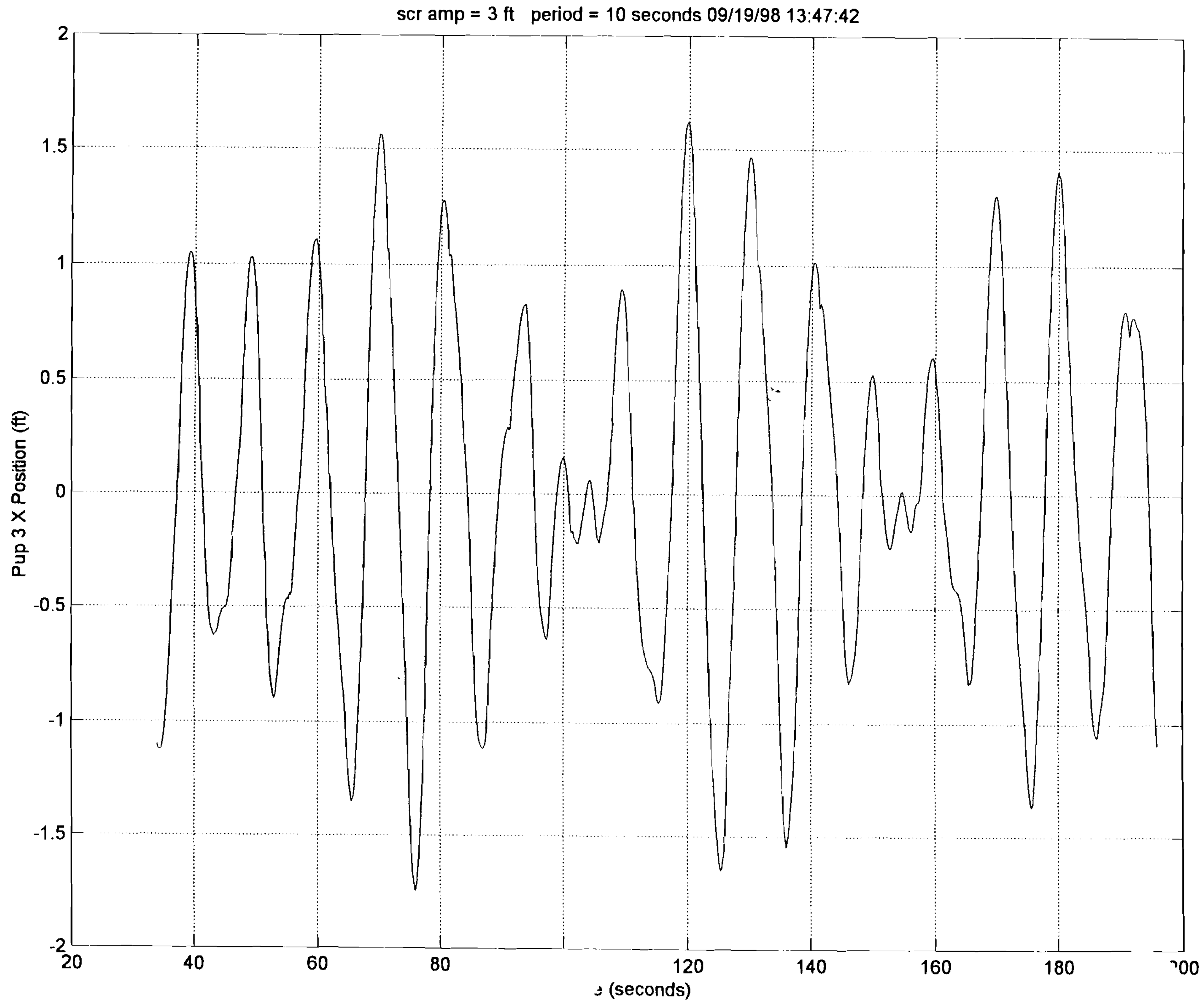

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
PUP 8 Tension COR (lbs)
Time (seconds)
650
600
550
500
450
400
350
20
40
60
80
100
120
140
160
180
200

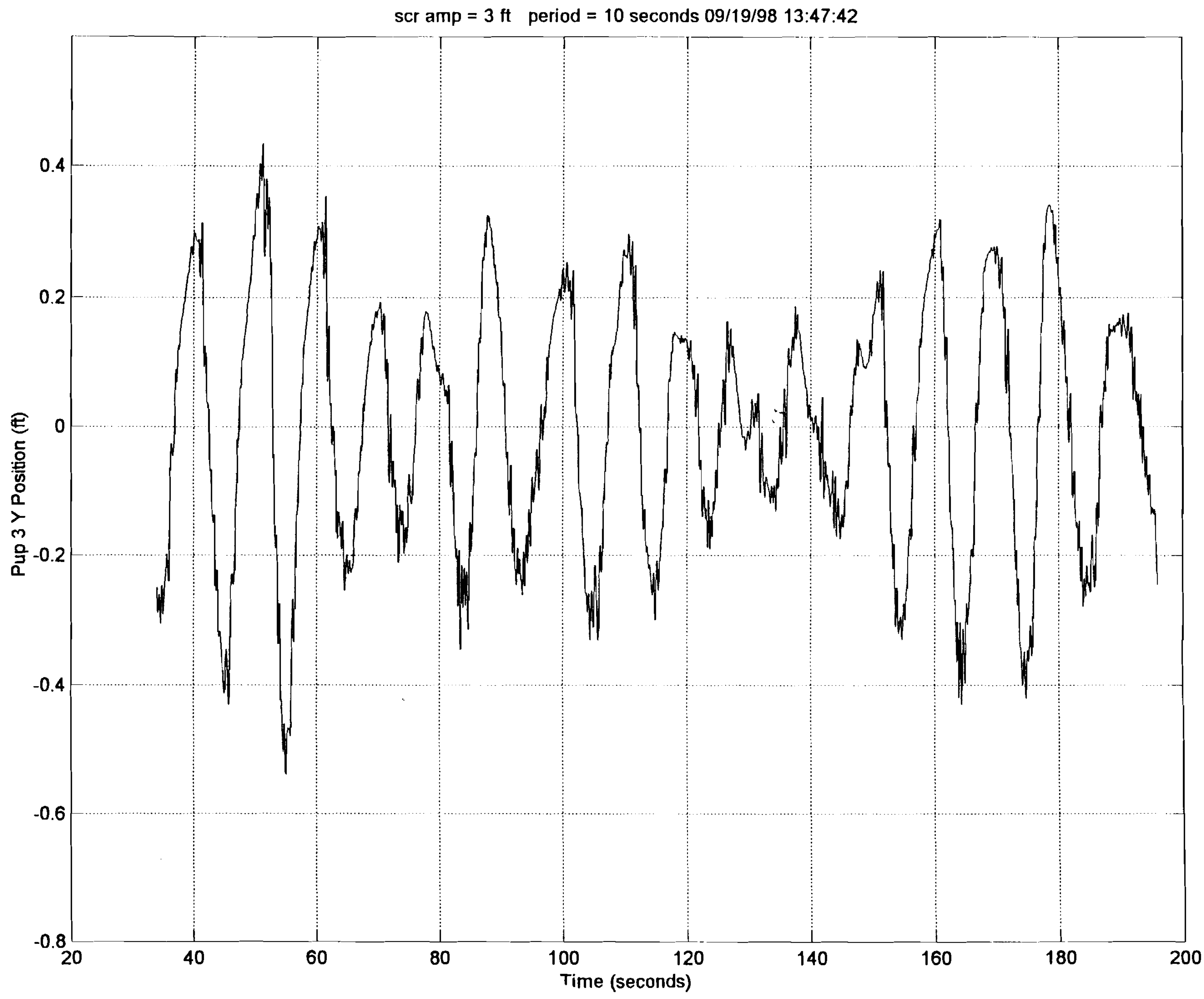

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 1 X Position (ft)
8
6
4
2
0
-2
-4
-6
-8
20
40
60
80
120
140
160
180
00
e (seconds)

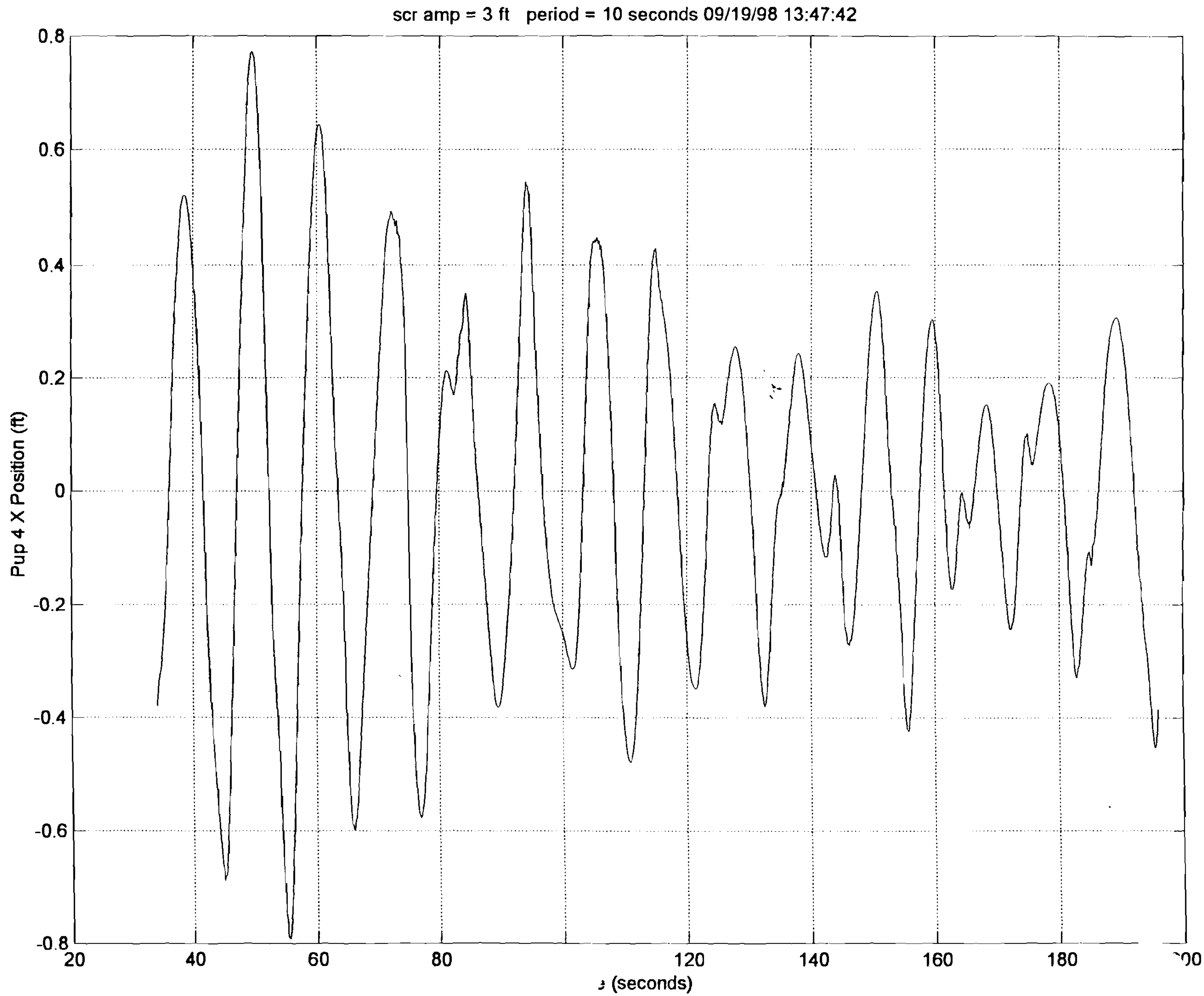

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 1 Y Position (ft)
Time (seconds)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
20
40
60
80
100
120
140
160
180
200

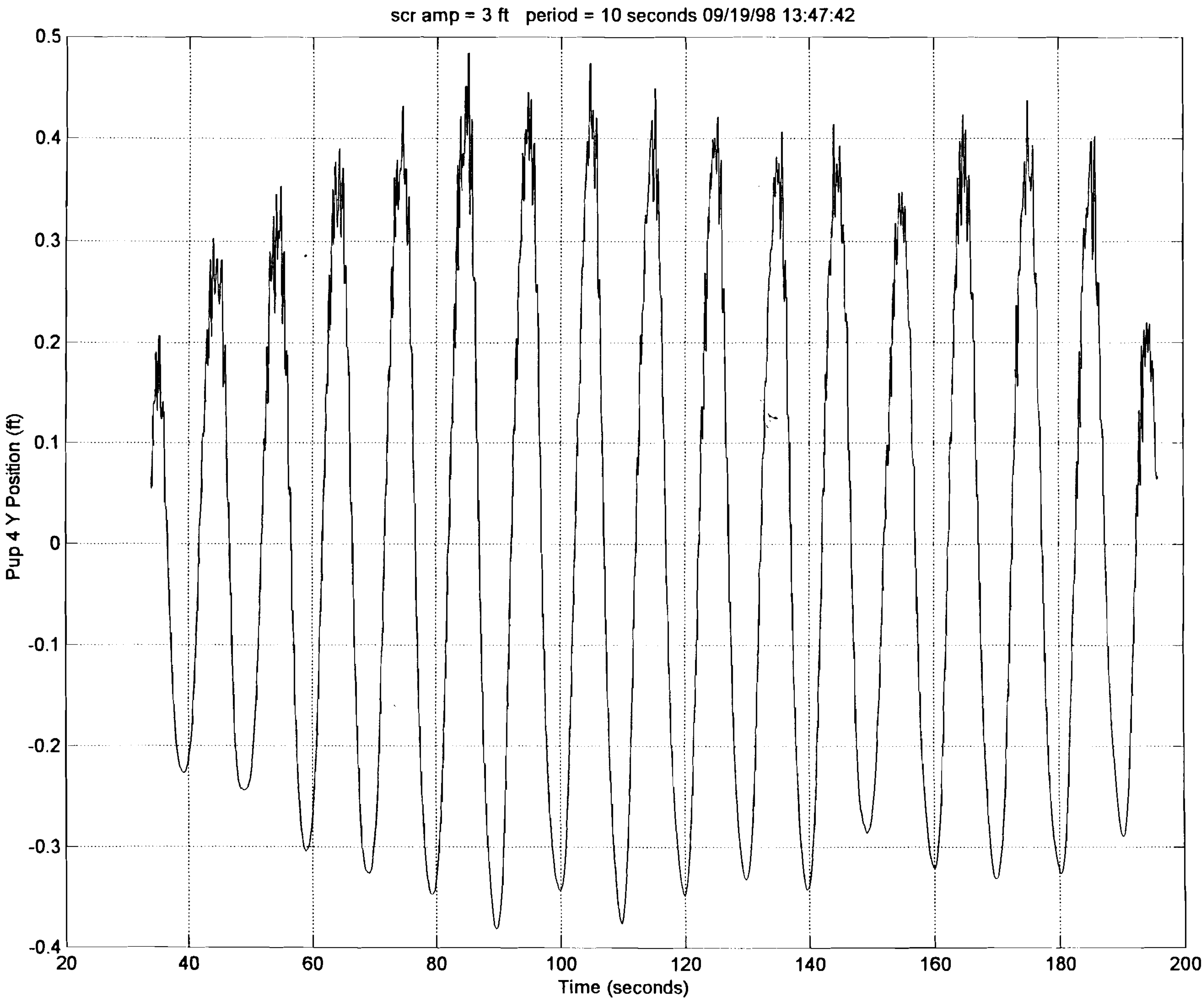

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 2 X Position (ft)
3
2
1
0
-1
-2
-3
-4
20
40
60
80
120
140
160
180
200
ıe (seconds)

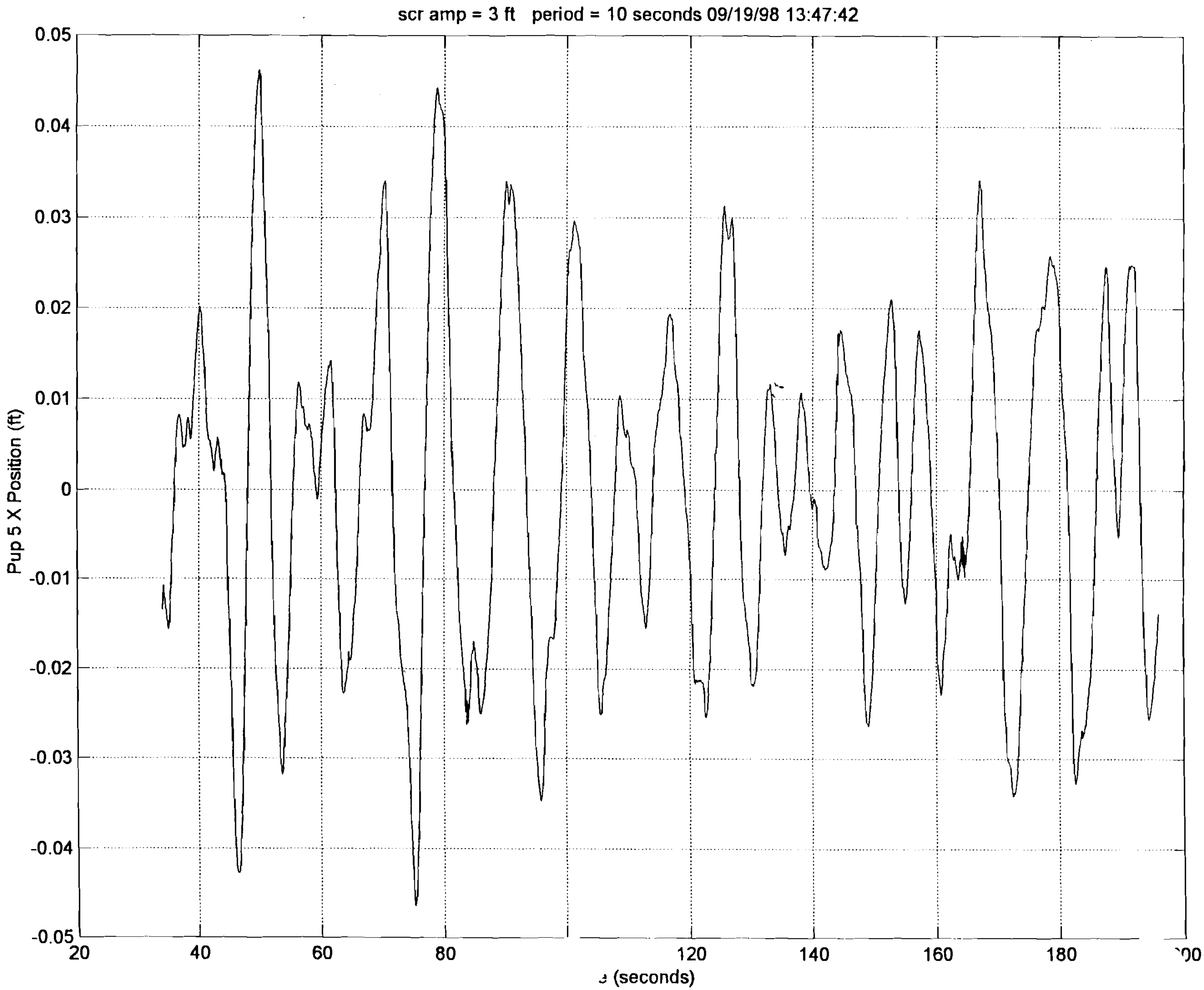

scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
Pup 2 Y Position (ft)
Time (seconds)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
20
40
60
80
100
120
140
160
180
200

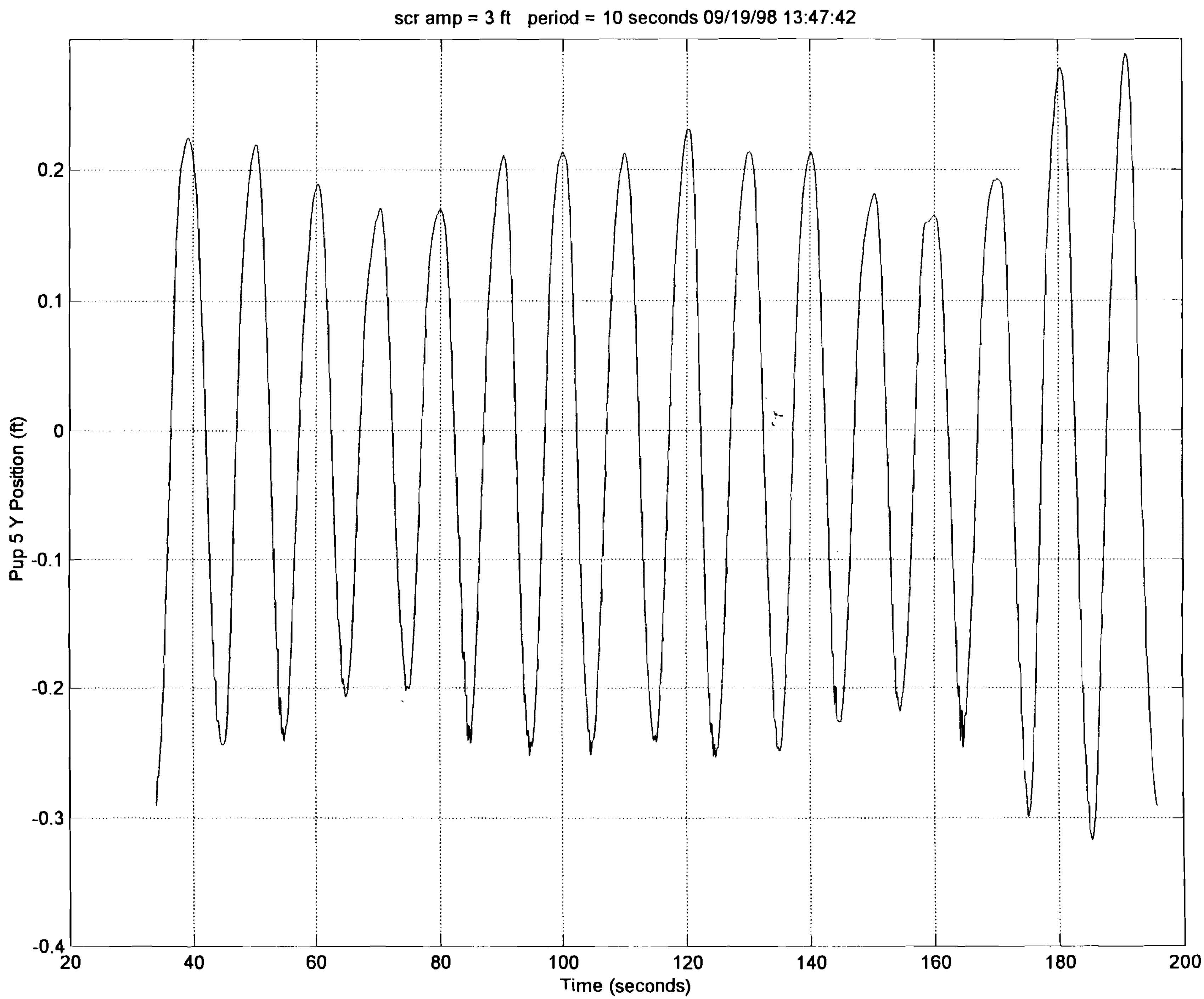

scr amp = 3 ft   period = 10 seconds 09/19/98 13:47:42
Pup 3 X Position (ft)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
20
40
60
80
120
140
160
180
(seconds)

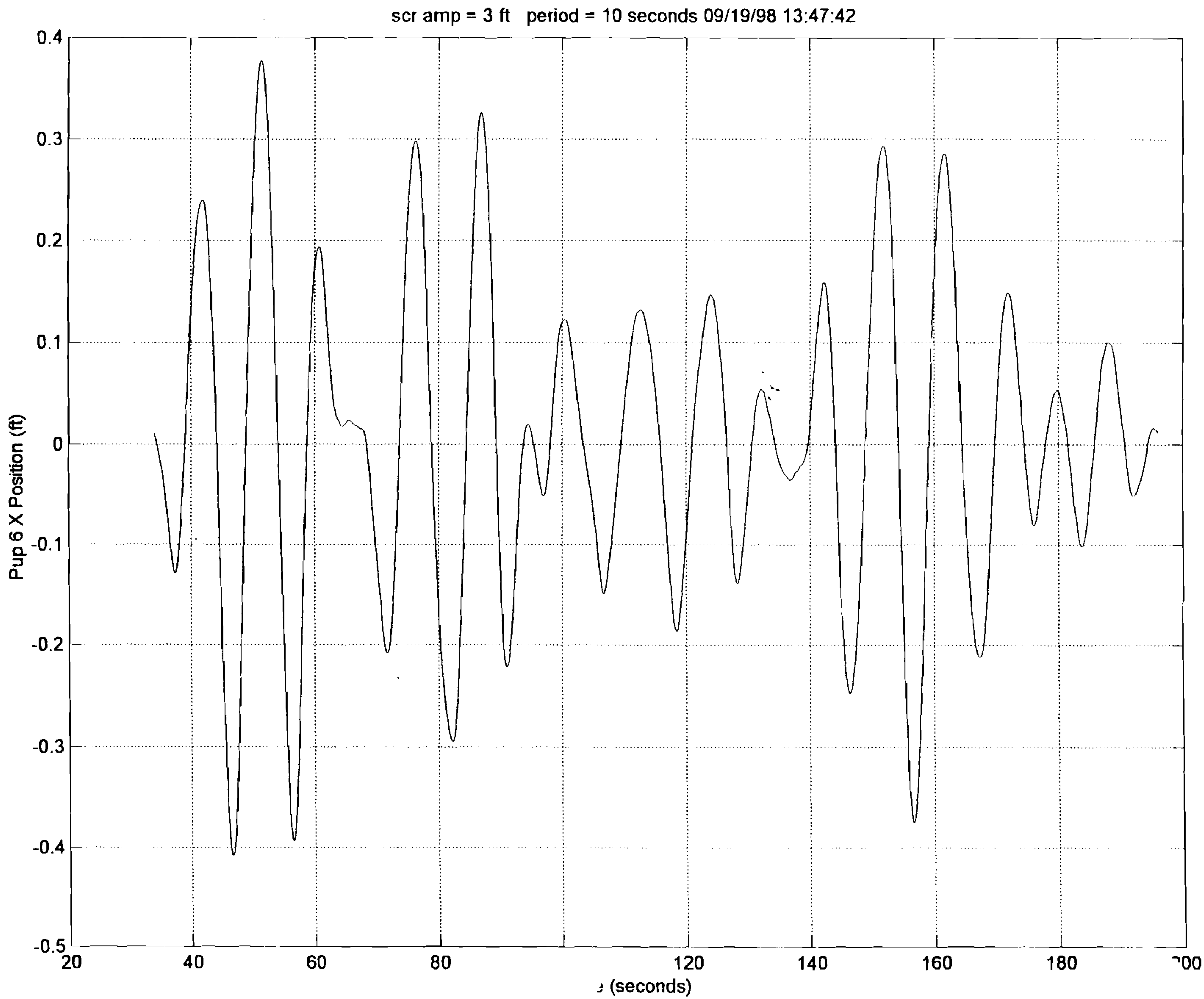

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 3 Y Position (ft)
Time (seconds)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
20
40
60
80
100
120
140
160
180
200


scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 4 X Position (ft)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
20
40
60
80
120
140
160
180
(seconds)

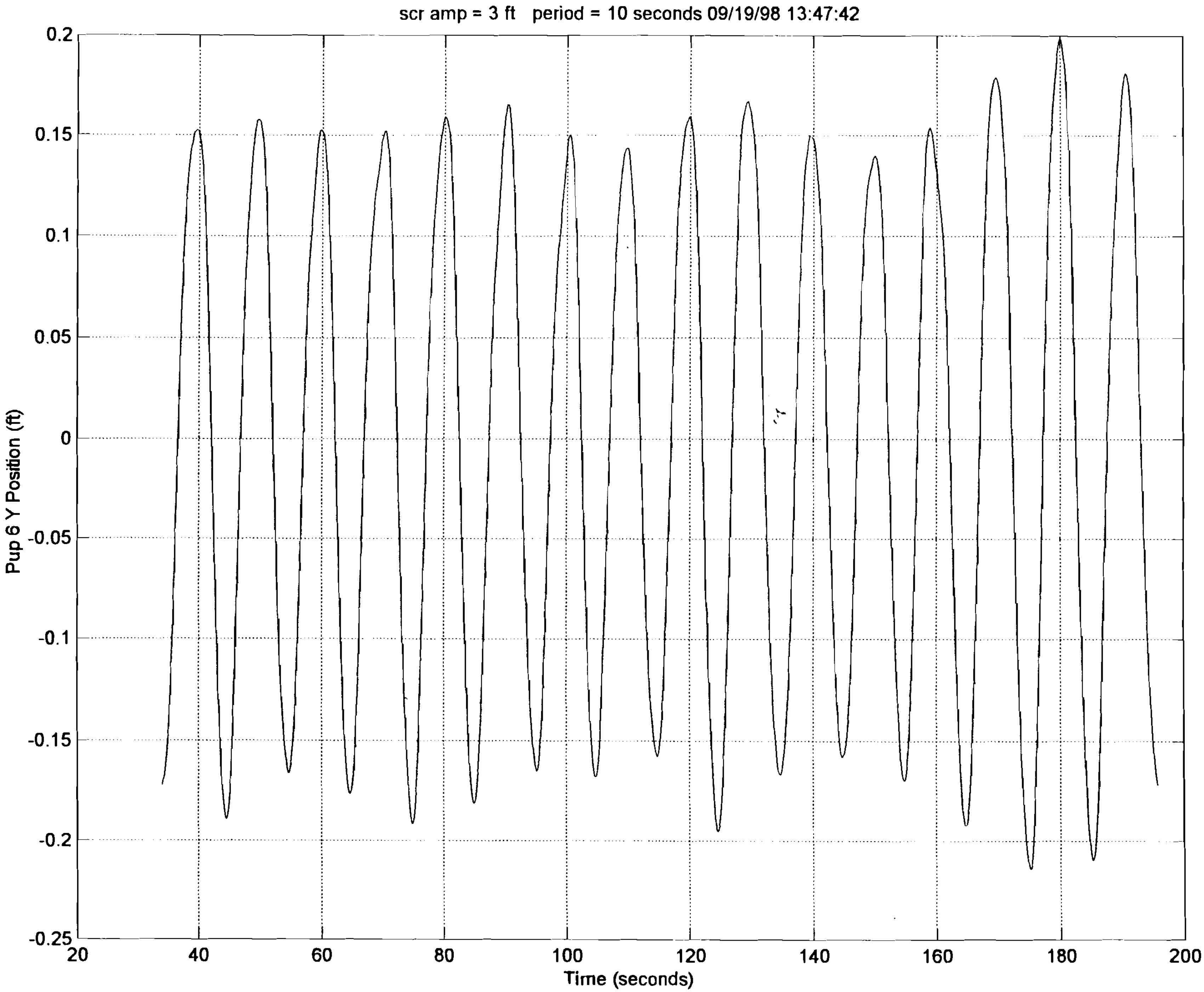

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 4 Y Position (ft)
Time (seconds)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
20
40
60
80
100
120
140
160
180
200

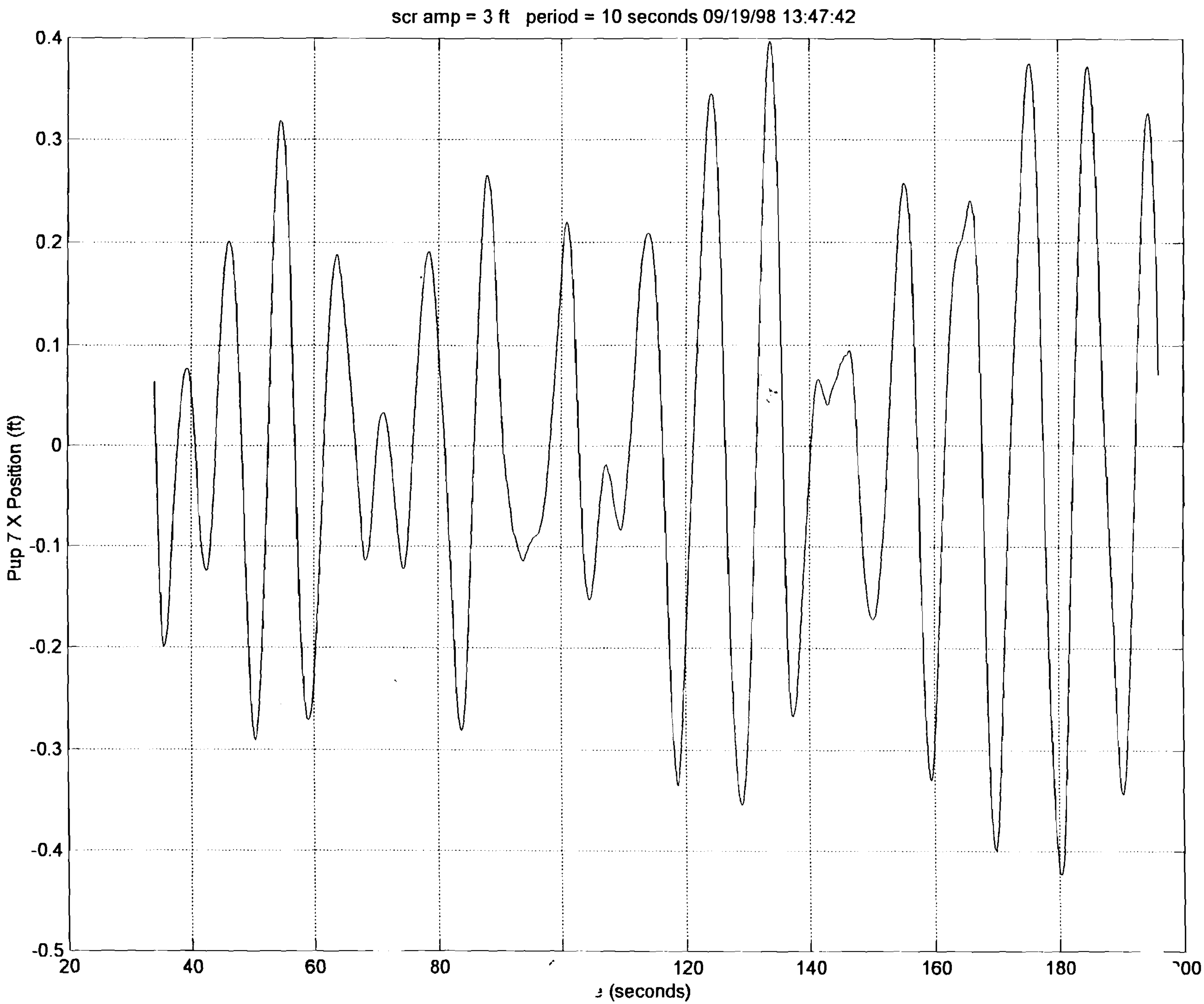

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 5 X Position (ft)
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
20
40
60
80
120
140
160
180
(seconds)

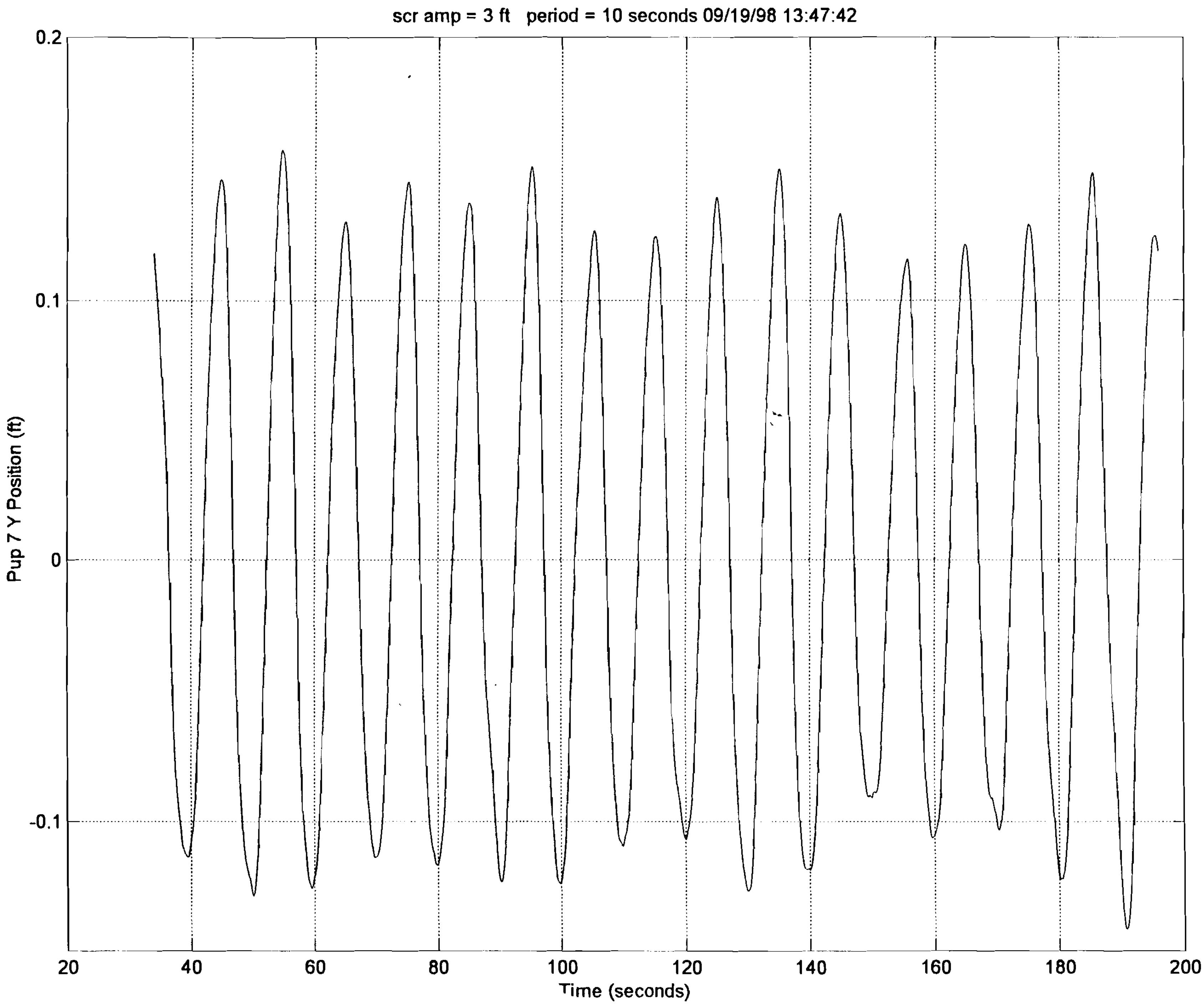

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 5 Y Position (ft)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
20
40
60
80
100
120
140
160
180
200
Time (seconds)

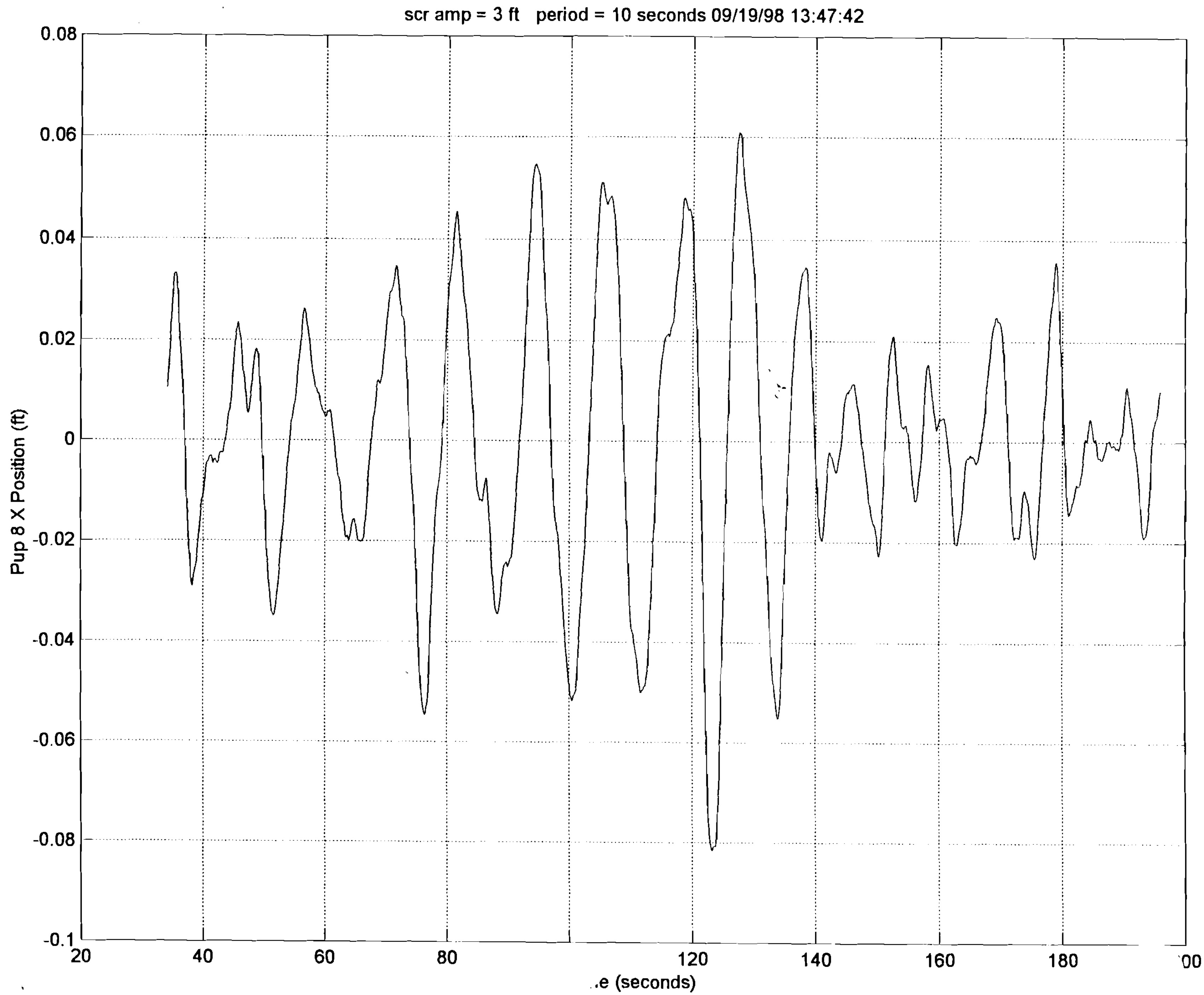


scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 6 X Position (ft)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
20
40
60
80
120
140
160
180
(seconds)

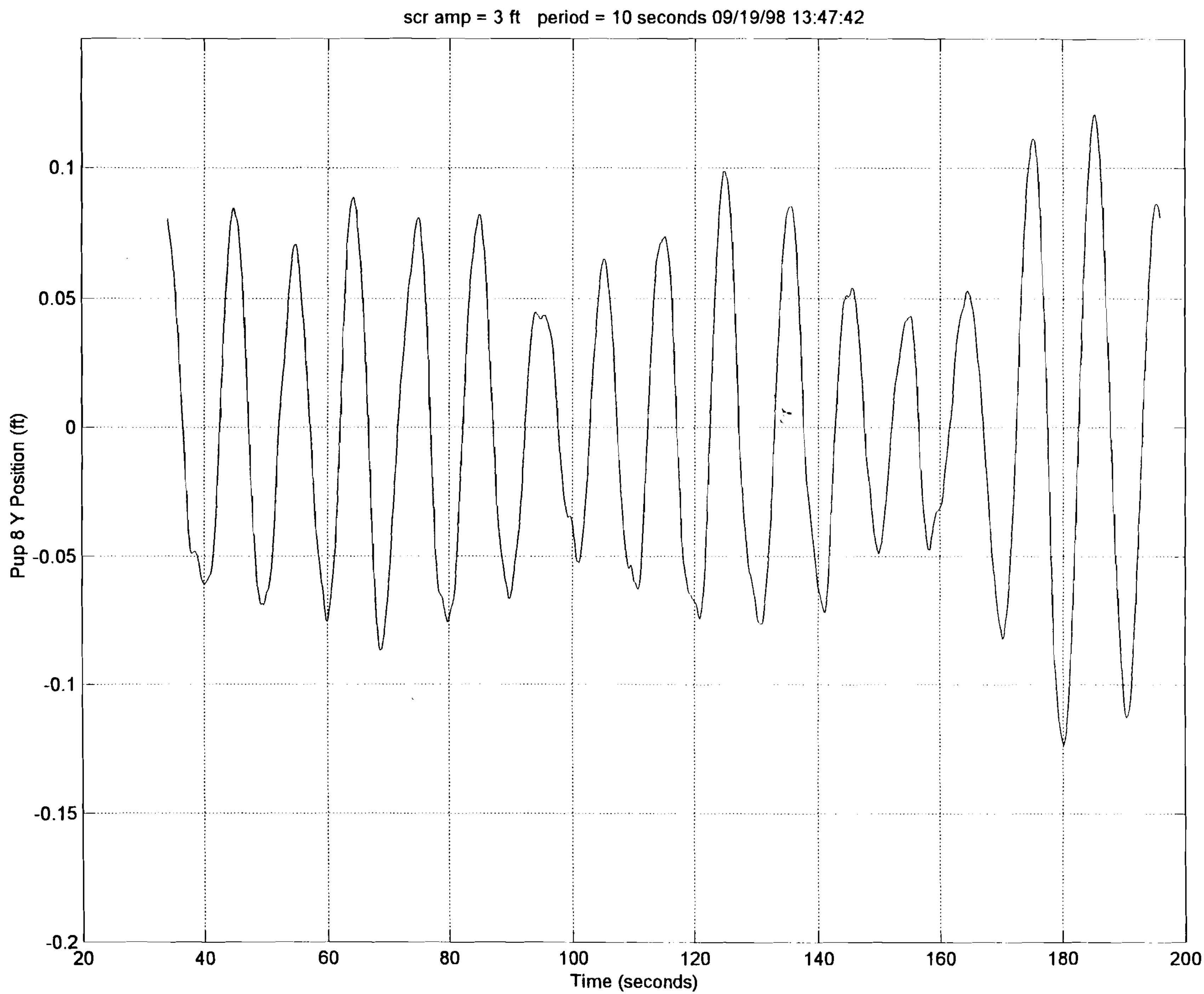

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 6 Y Position (ft)
Time (seconds)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
20
40
60
80
100
120
140
160
180
200

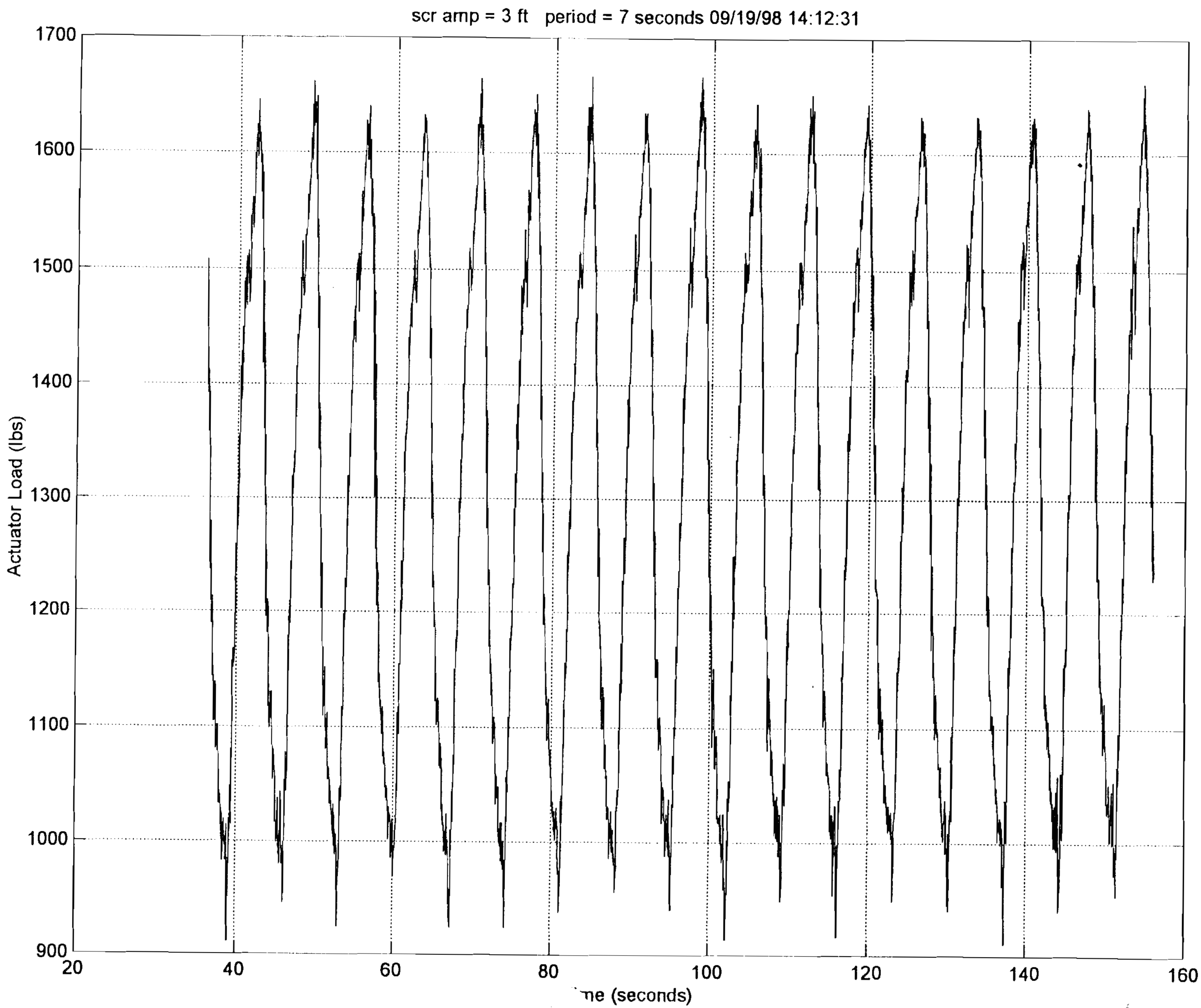

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 7 X Position (ft)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
20
40
60
80
120
140
160
180
(seconds)

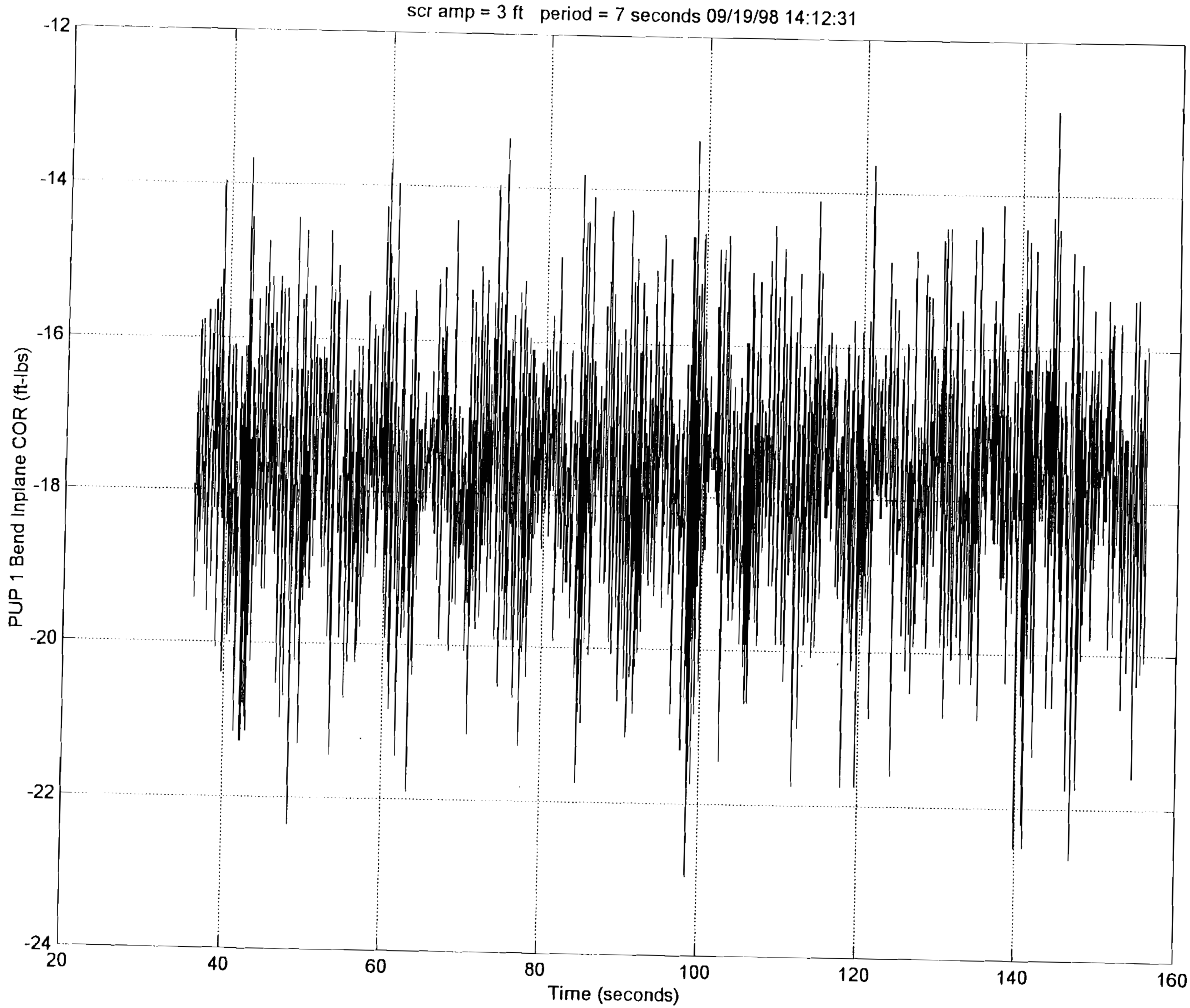

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
0.2
0.1
0
-0.1
Pup 7 Y Position (ft)
20
40
60
80
100
120
140
160
180
200
Time (seconds)



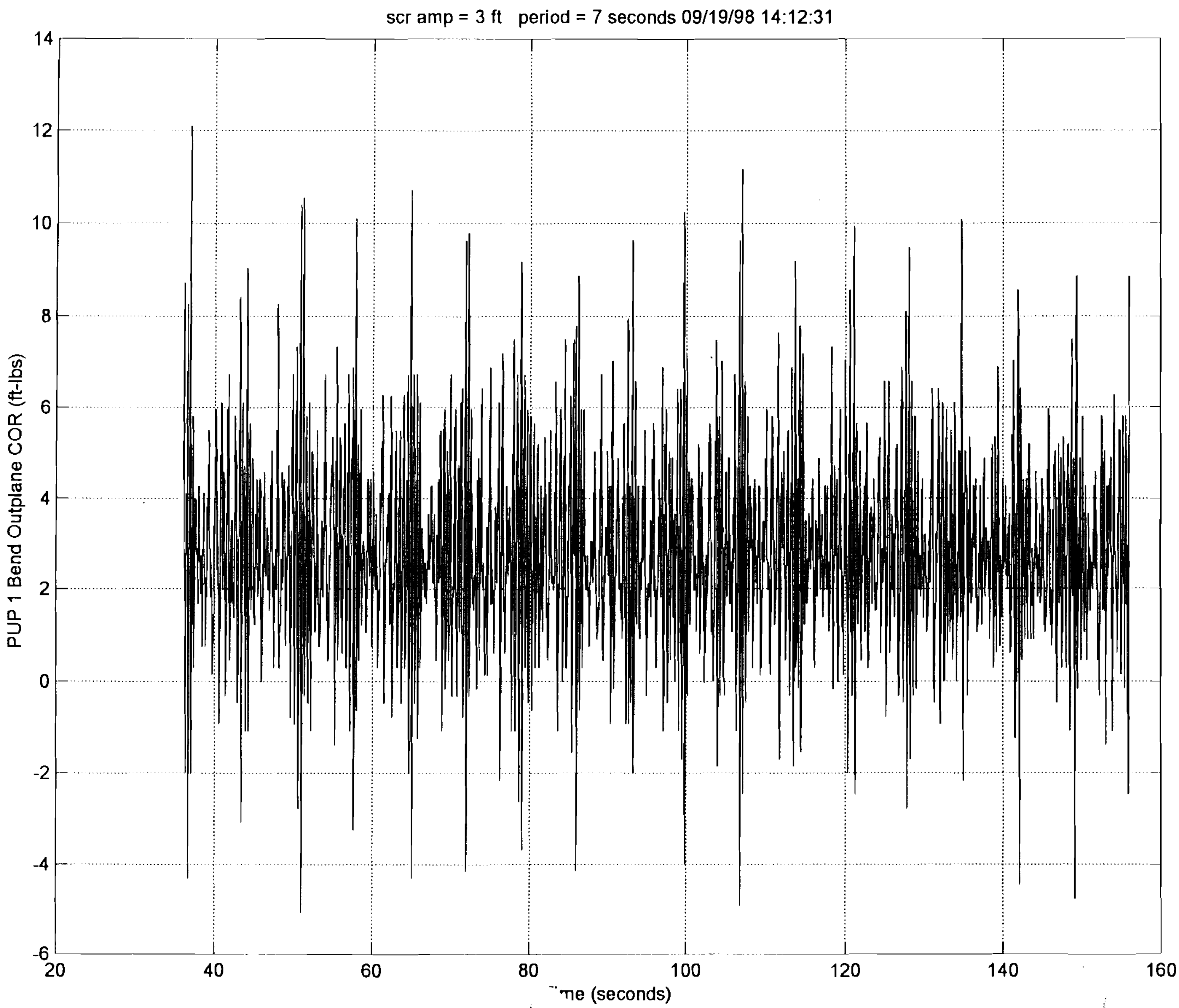
scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 8 X Position (ft)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
20
40
60
80
120
140
160
180
00
.e (seconds)

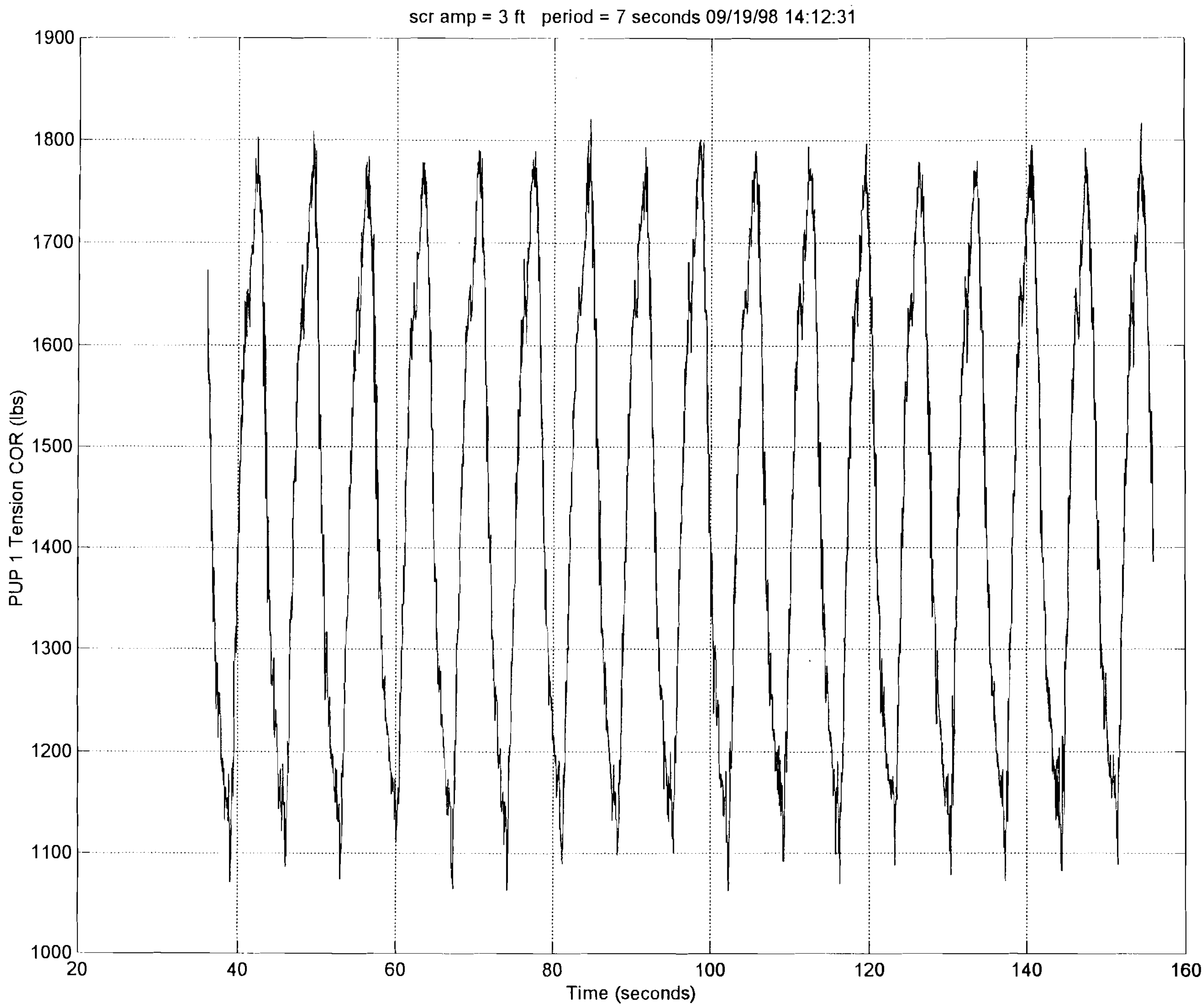

scr amp = 3 ft period = 10 seconds 09/19/98 13:47:42
Pup 8 Y Position (ft)
Time (seconds)
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
20
40
60
80
100
120
140
160
180
200

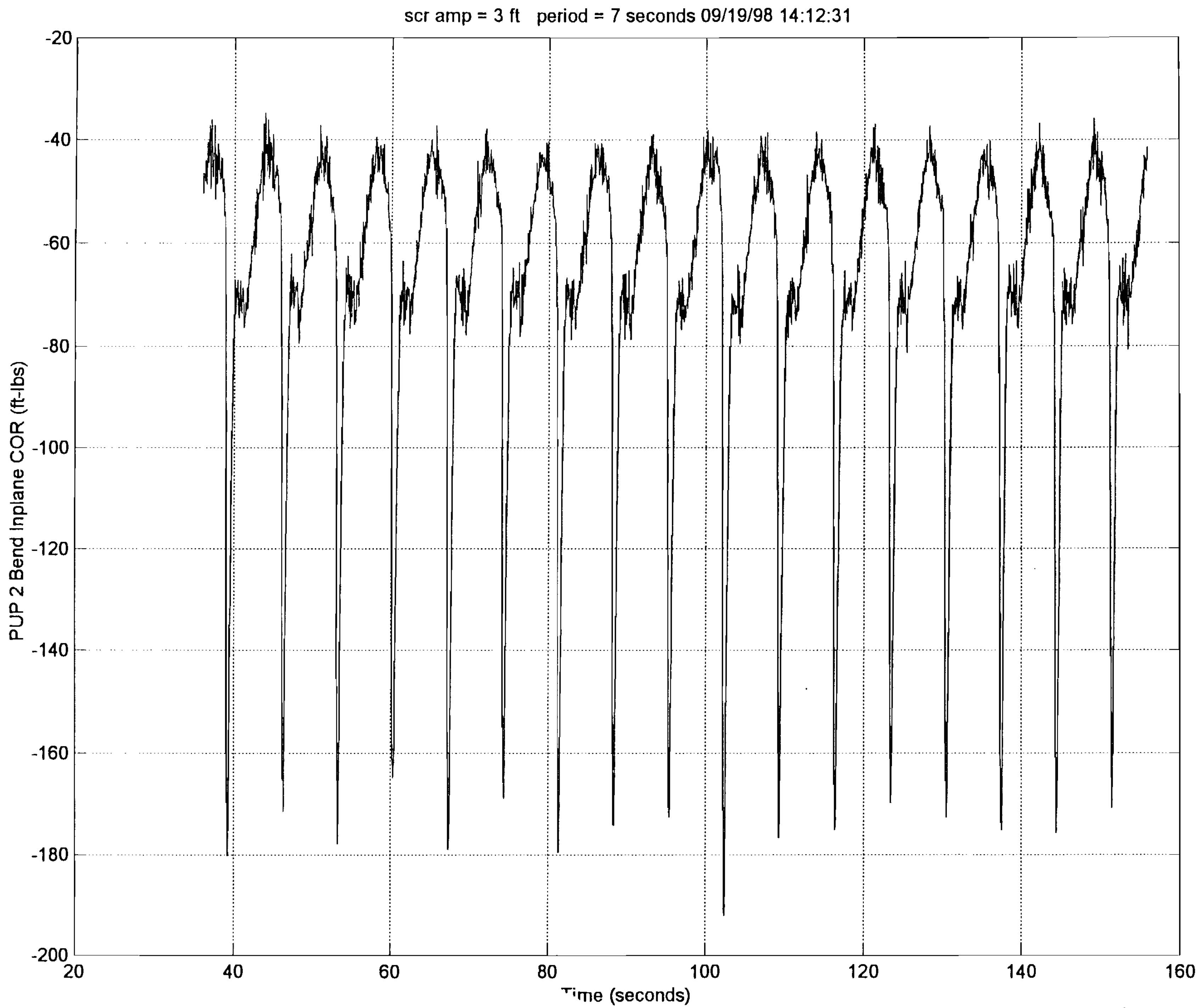

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Actuator Load (lbs)
1700
1600
1500
1400
1300
1200
1100
1000
900
20
40
60
80
100
120
140
160
me (seconds)

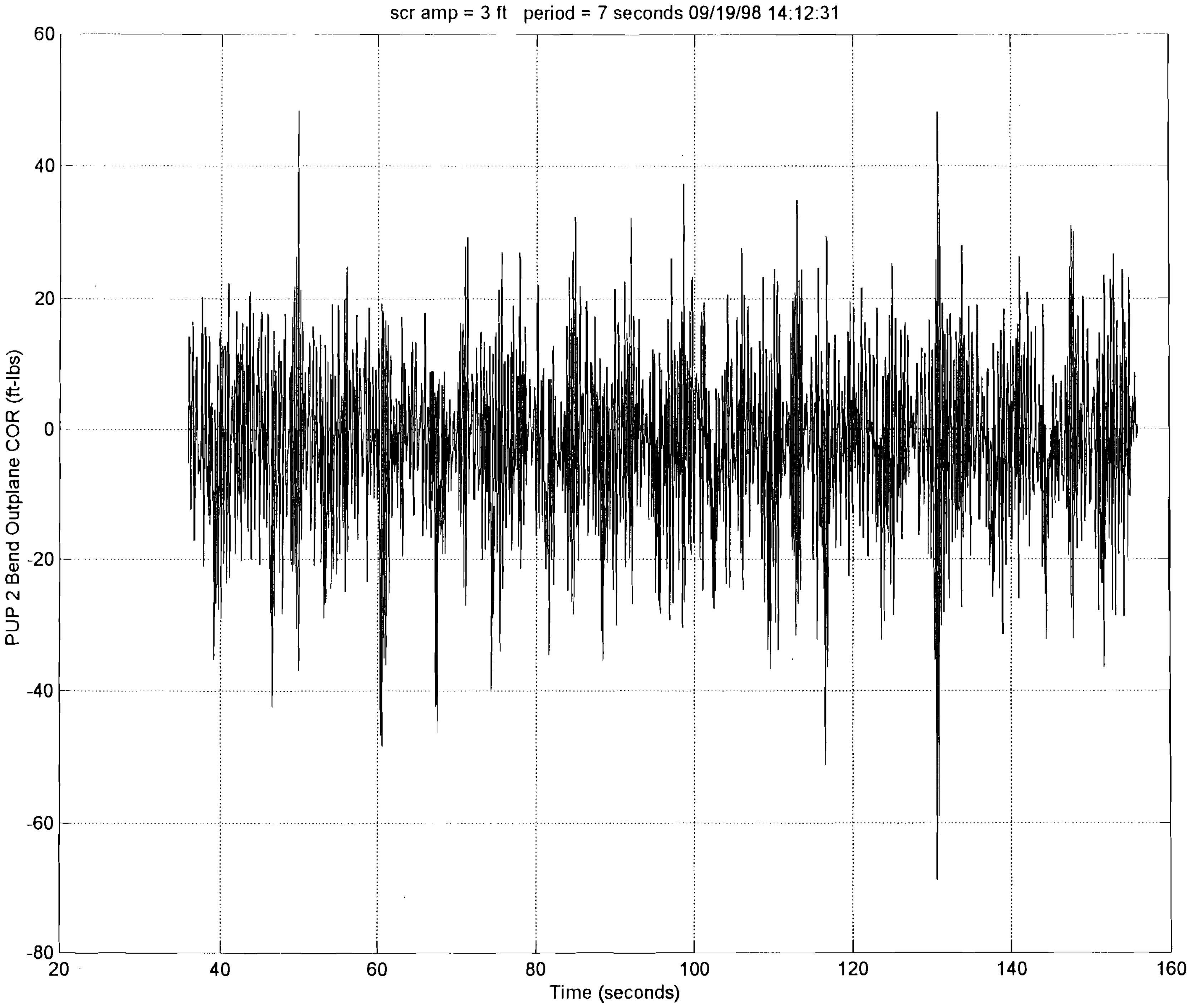


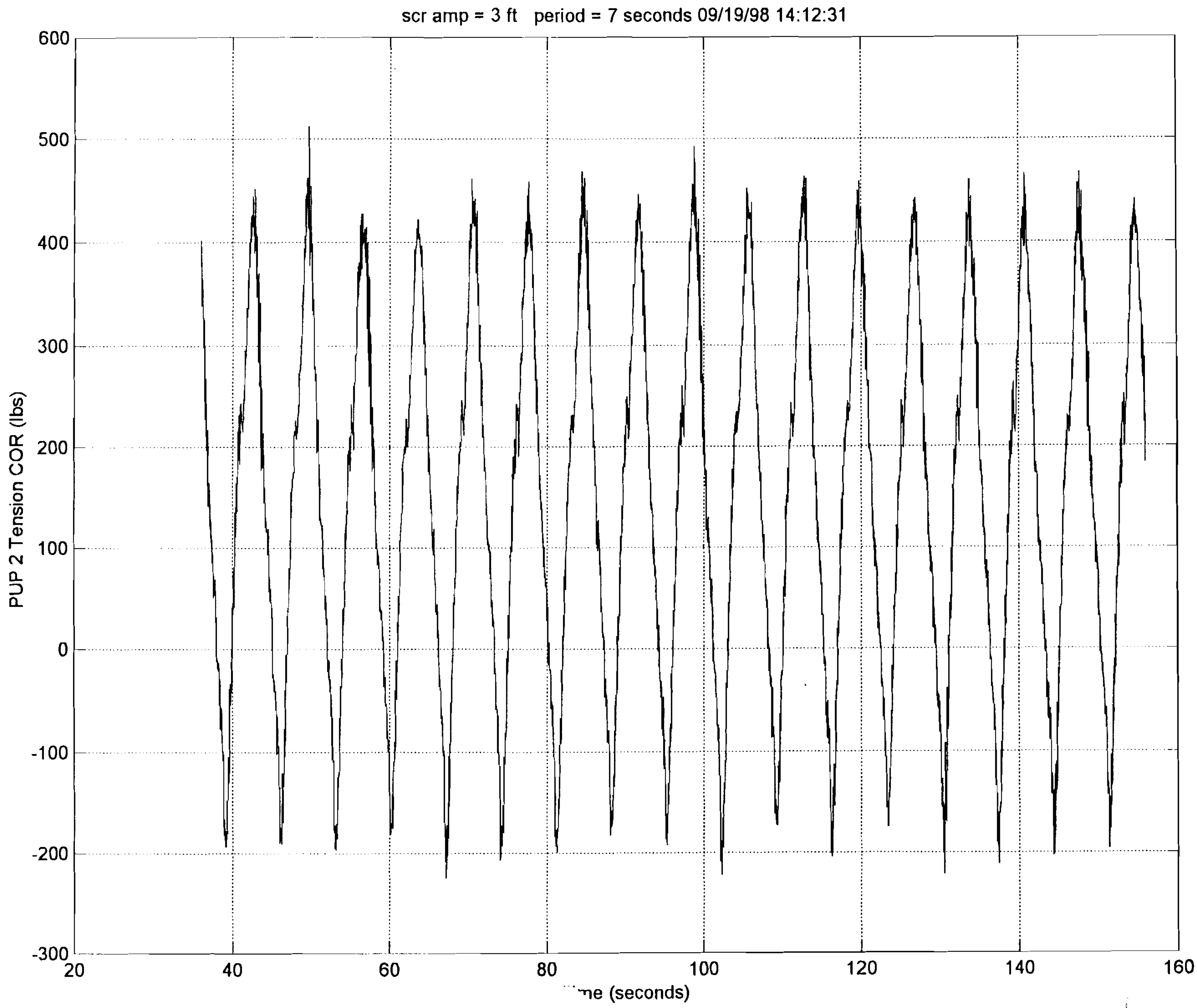
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 1 Bend Inplane COR (ft-lbs)
Time (seconds)
-12
-14
-16
-18
-20
-22
-24
20
40
60
80
100
120
140
160

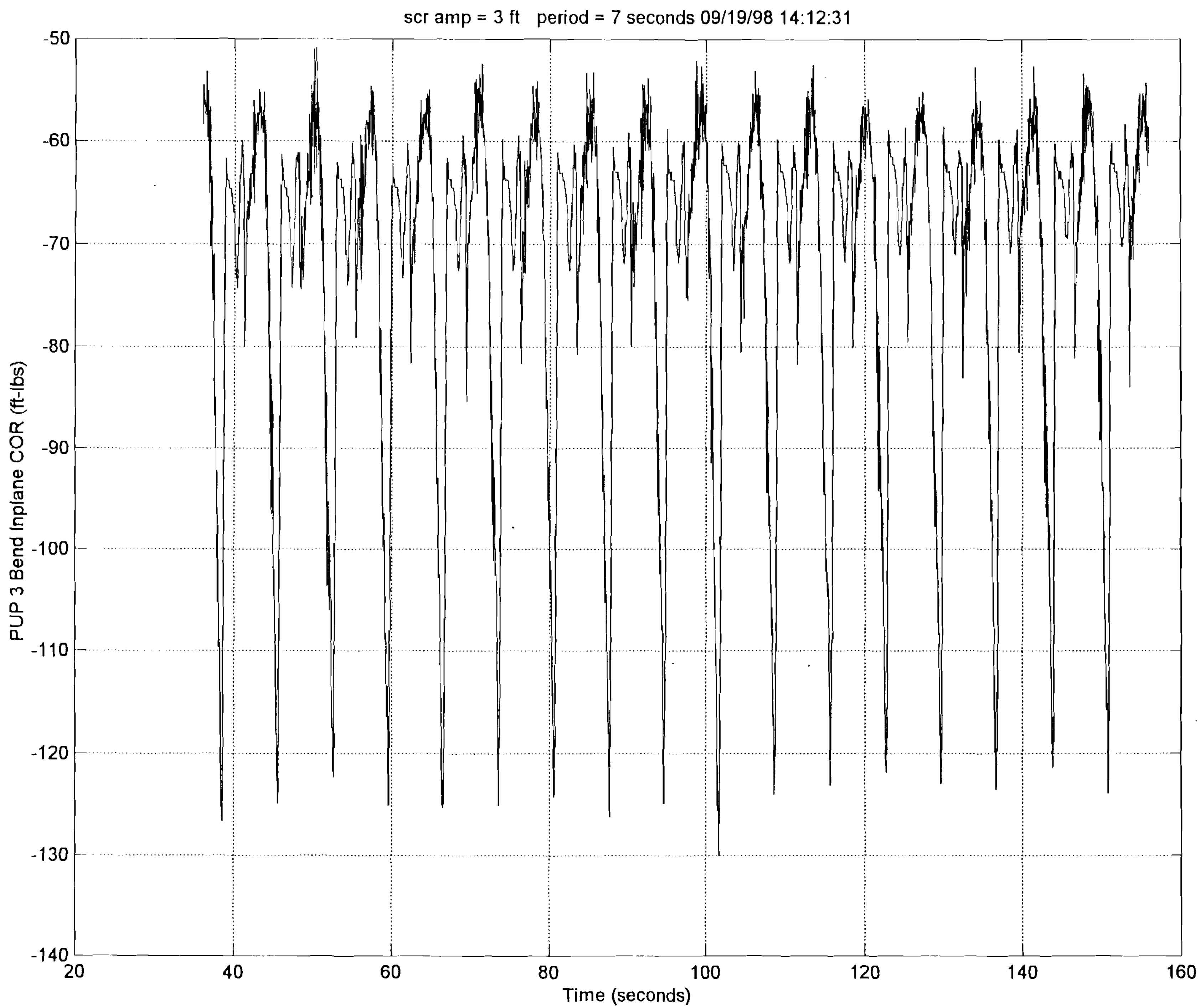

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 1 Bend Outplane COR (ft-lbs)
14
12
10
8
6
4
2
0
-2
-4
-6
20
40
60
80
100
120
140
160
me (seconds)

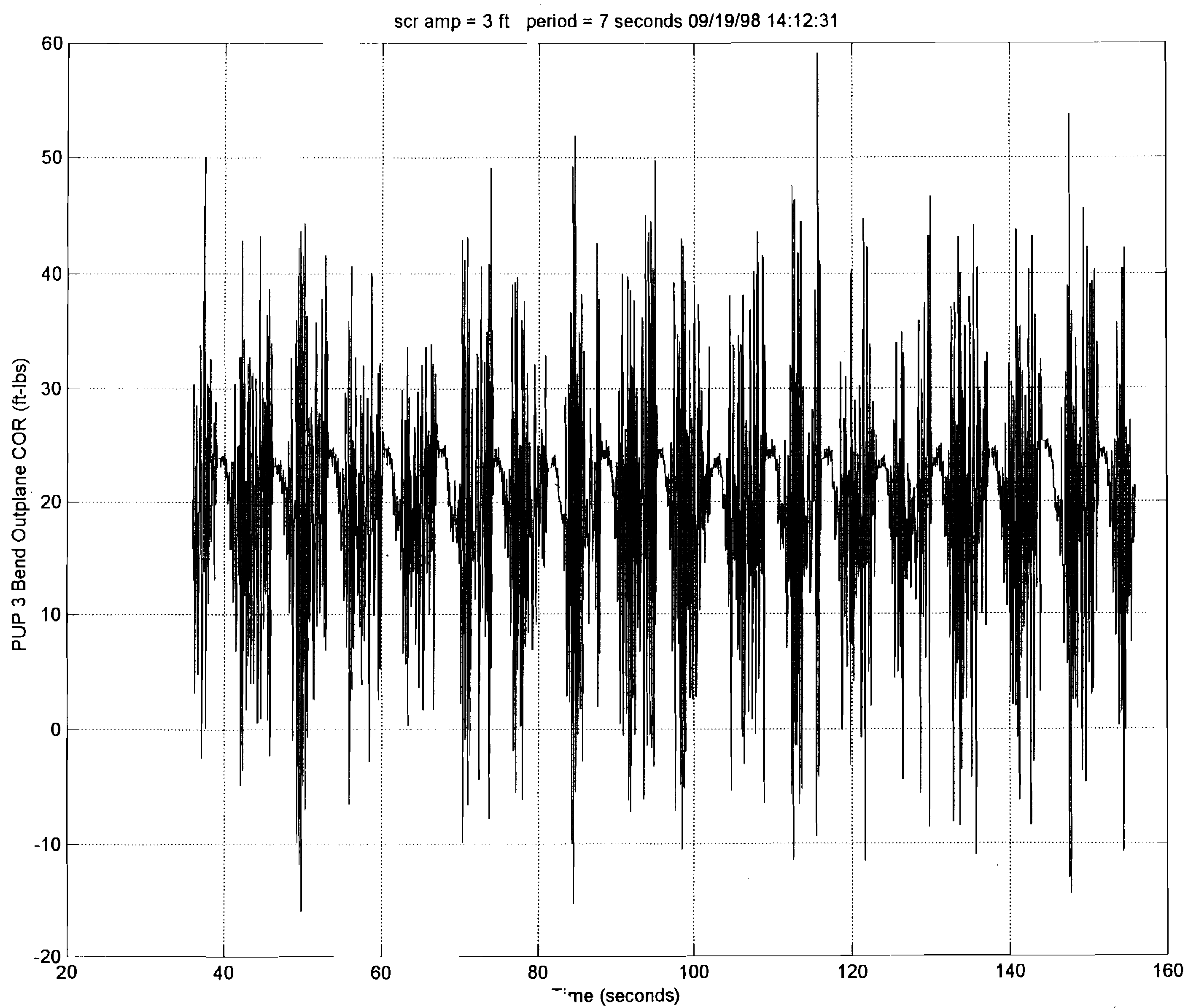

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 1 Tension COR (lbs)
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
20
40
60
80
100
120
140
160
Time (seconds)


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 2 Bend Inplane COR (ft-lbs)
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
20
40
60
80
100
120
140
160
Time (seconds)

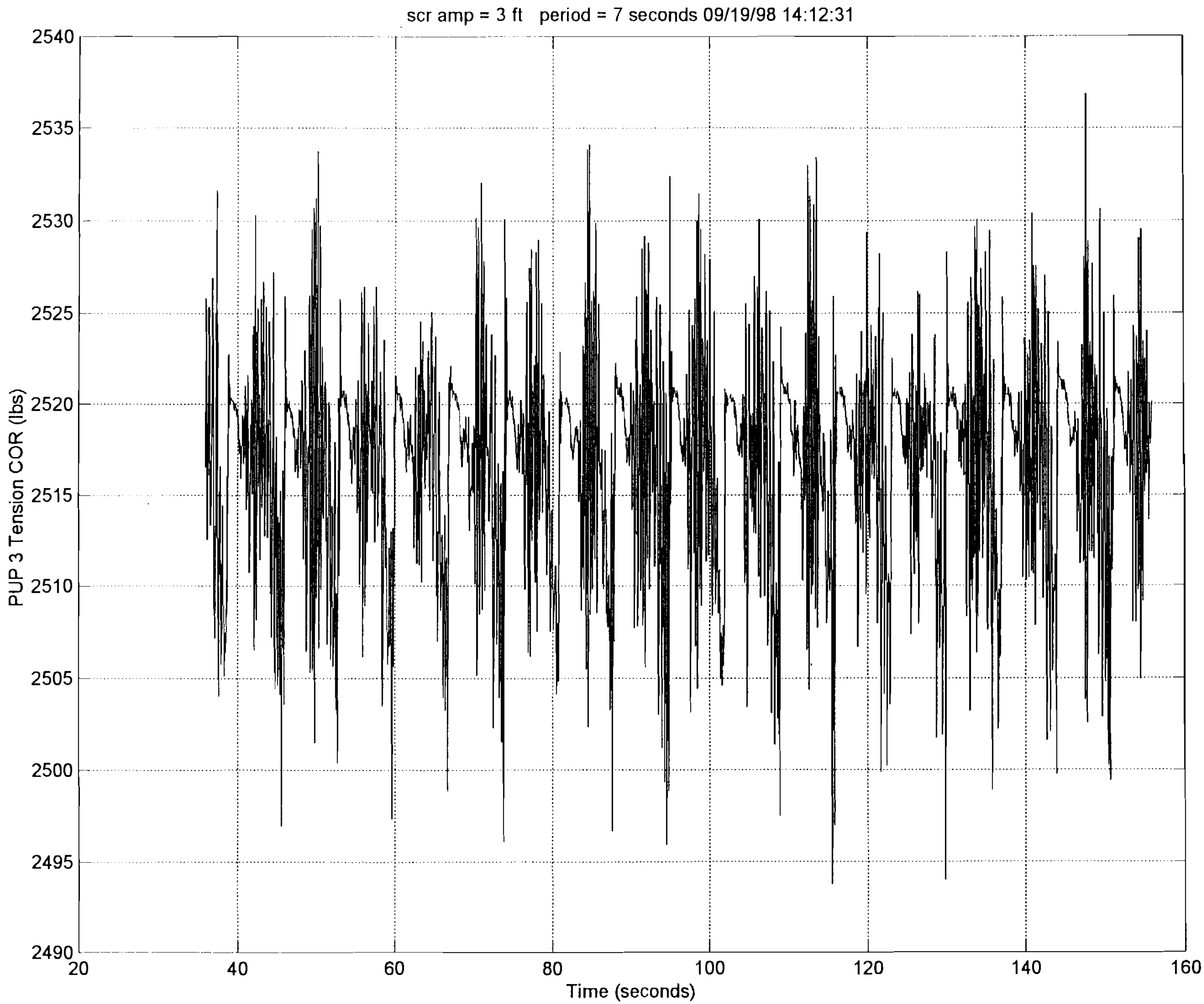

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 2 Bend Outplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
-80
20
40
60
80
100
120
140
160
Time (seconds)

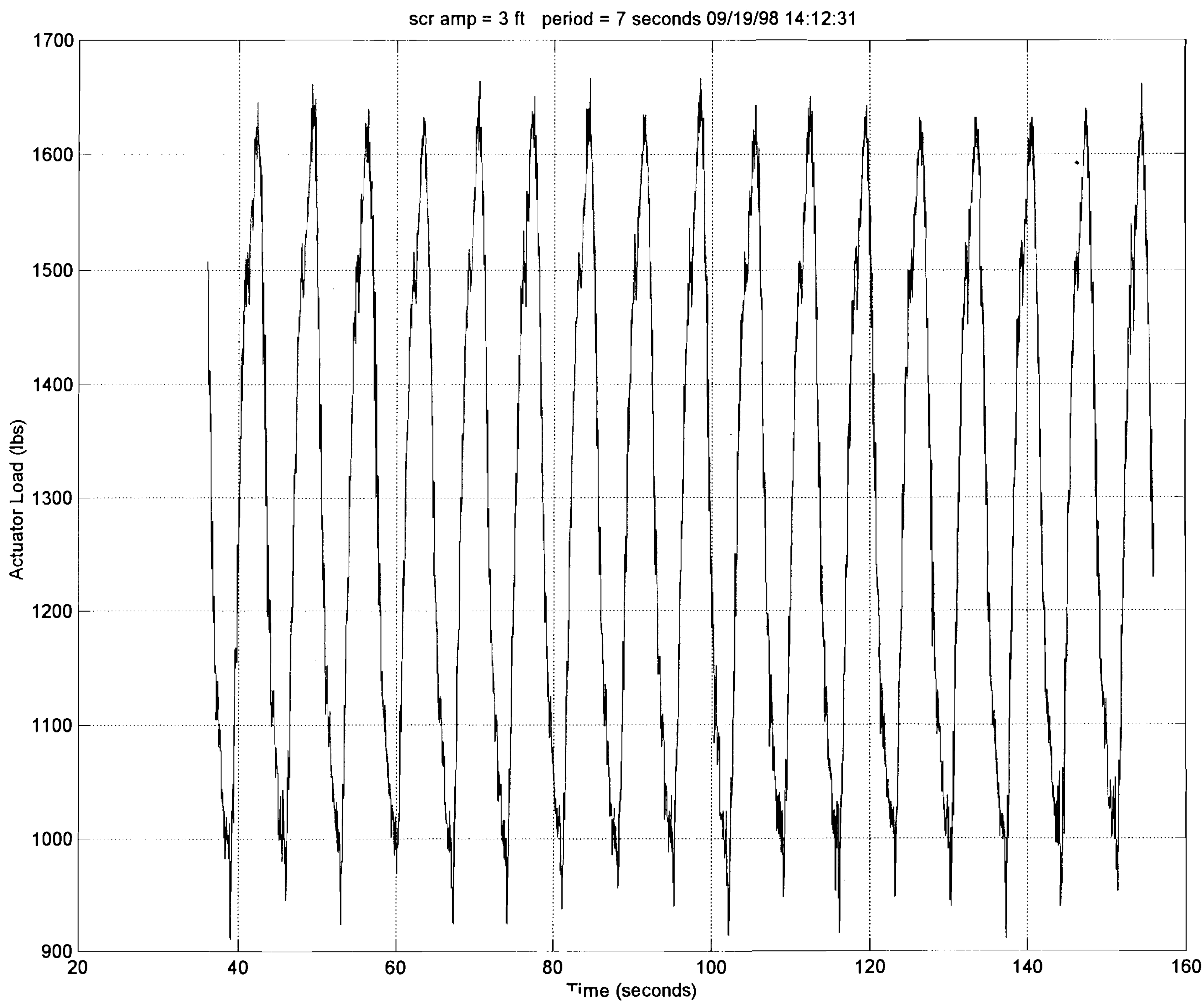

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 2 Tension COR (lbs)
600
500
400
300
200
100
0
-100
-200
-300
20
40
60
80
100
120
140
160
me (seconds)

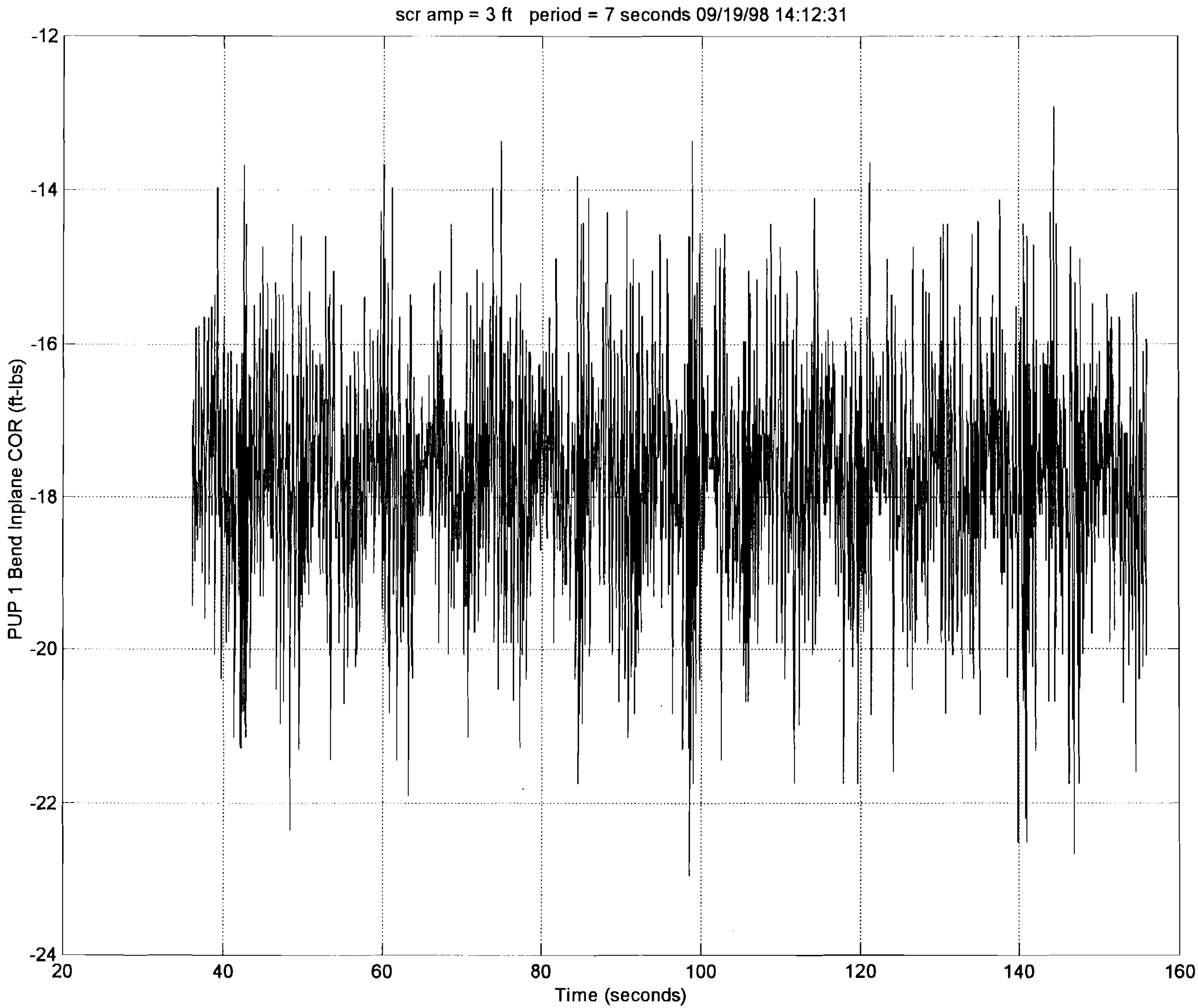

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 3 Bend Inplane COR (ft-lbs)
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
20
40
60
80
100
120
140
160
Time (seconds)



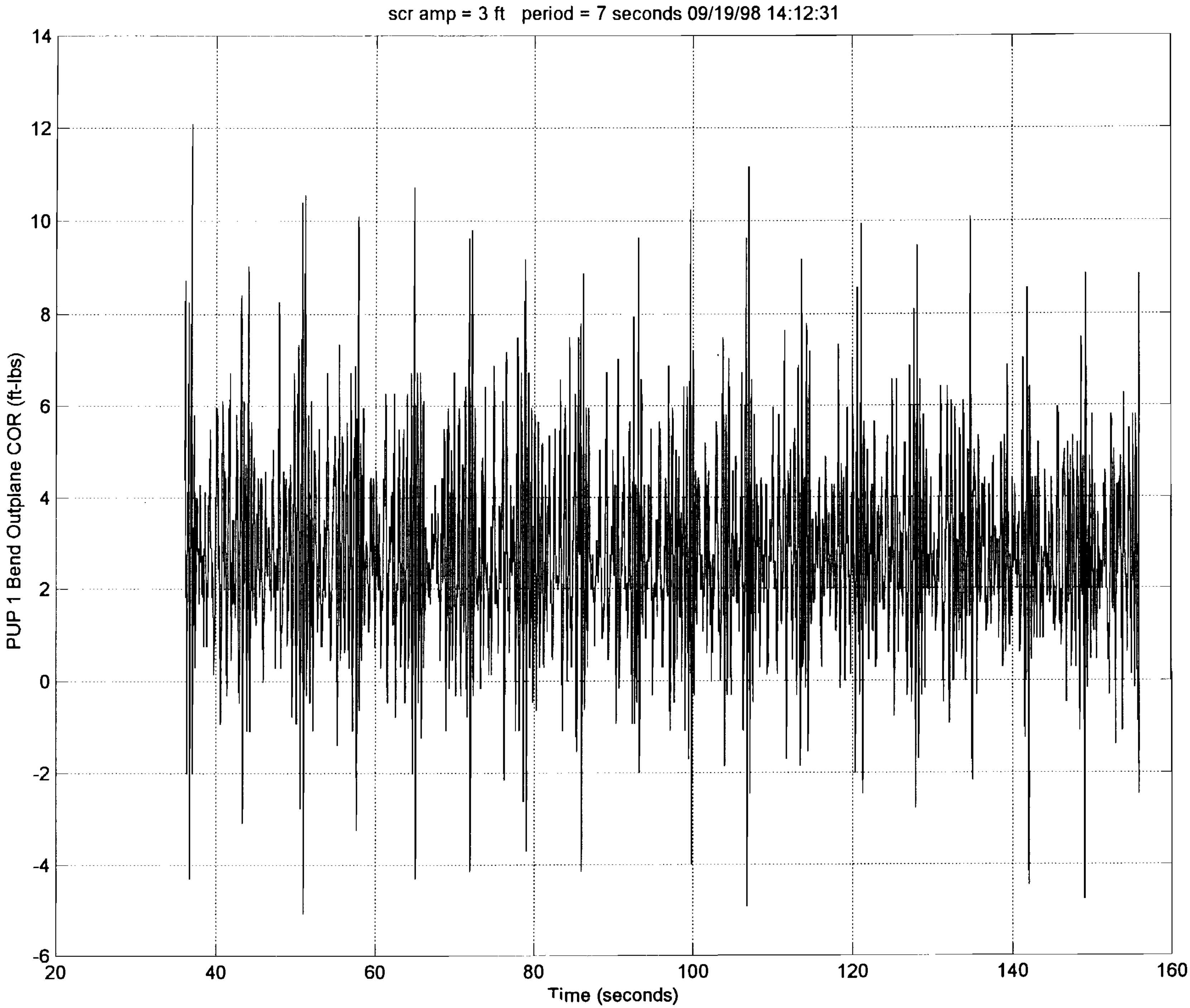
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 3 Bend Outplane COR (ft-lbs)
60
50
40
30
20
10
0
-10
-20
20
40
60
80
100
120
140
160
(seconds)

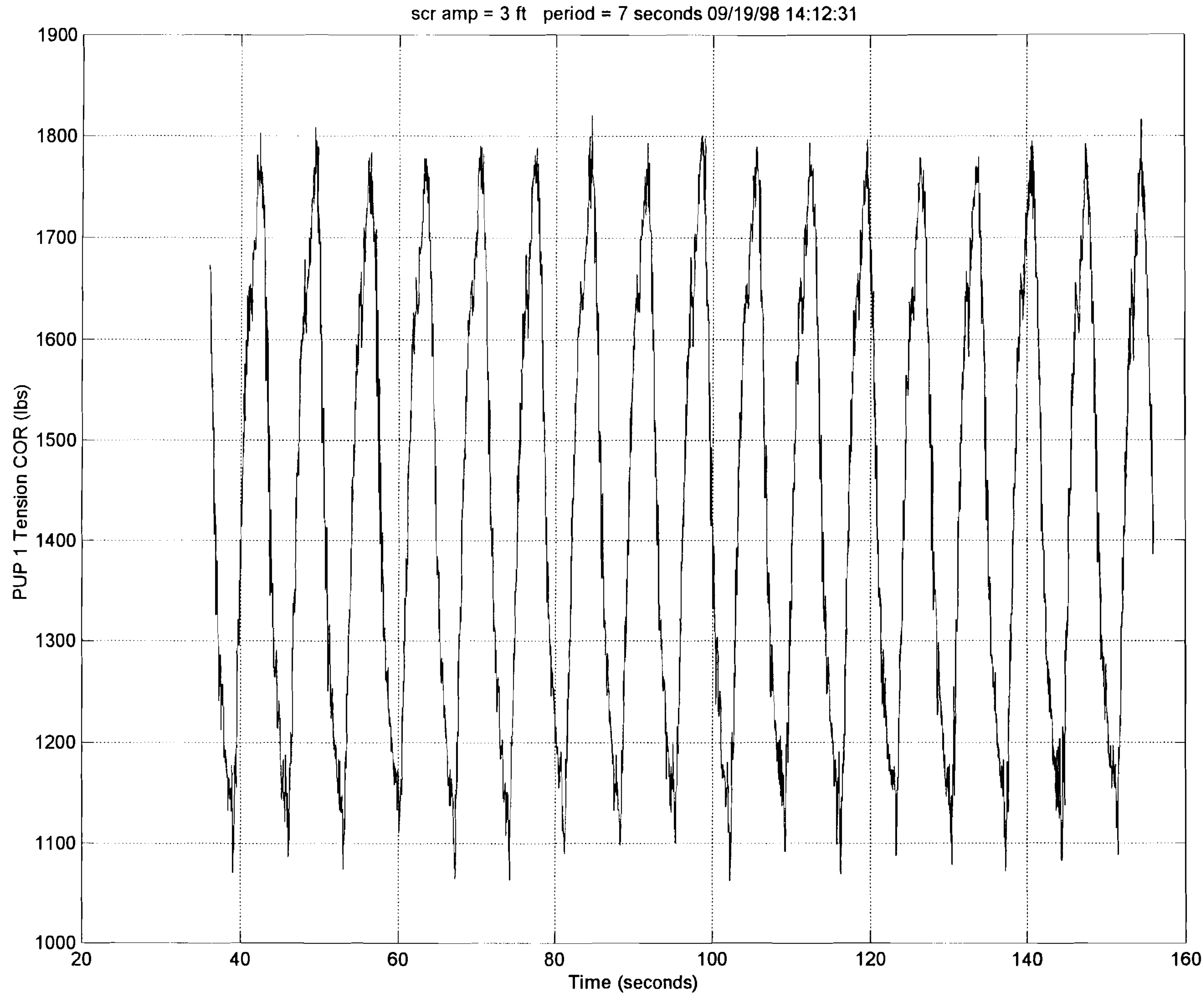

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 3 Tension COR (lbs)
Time (seconds)
2540
2535
2530
2525
2520
2515
2510
2505
2500
2495
2490
20
40
60
80
100
120
140
160

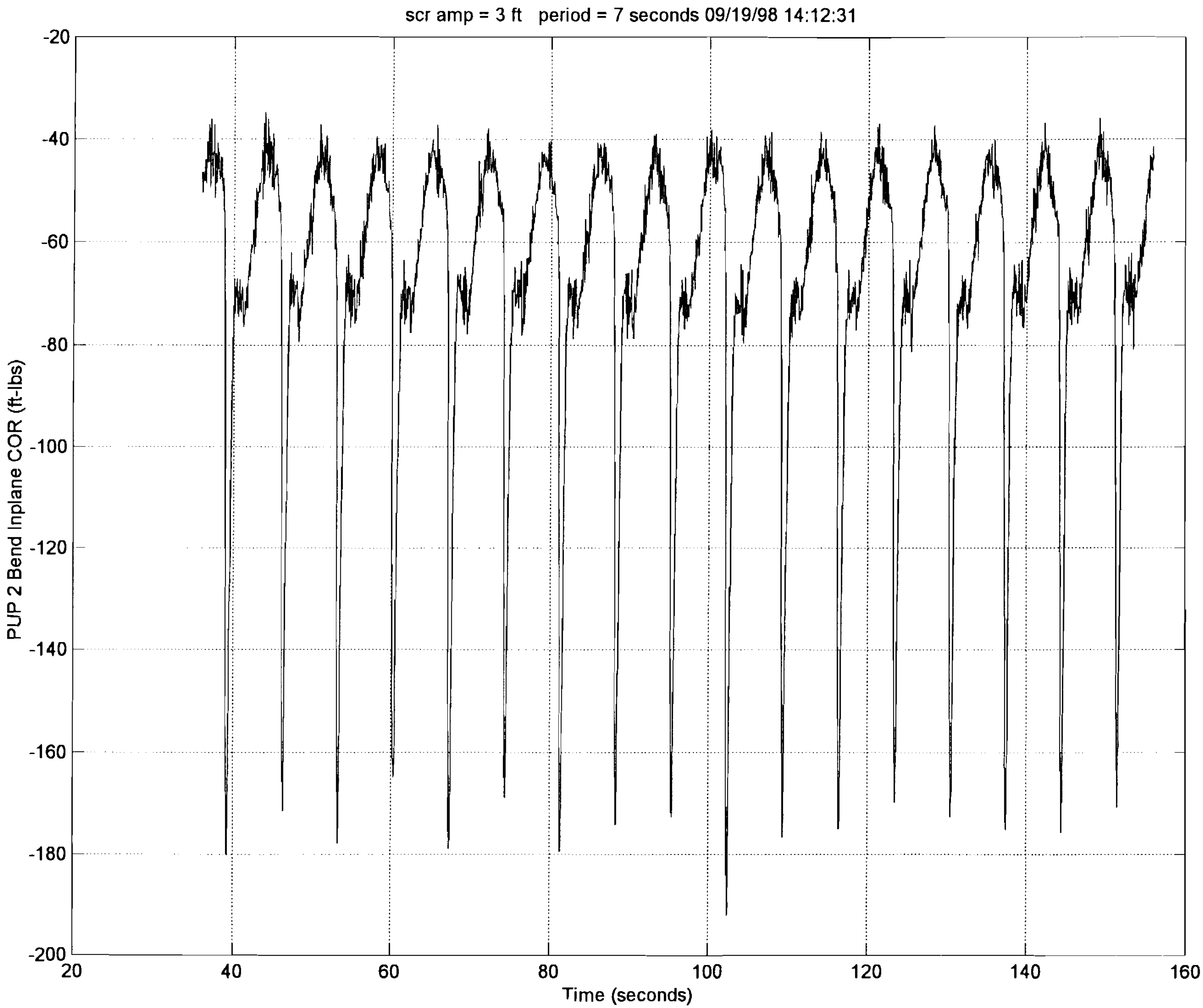

scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
Actuator Load (lbs)
900
1000
1100
1200
1300
1400
1500
1600
1700
20
40
60
80
100
120
140
160
Time (seconds)

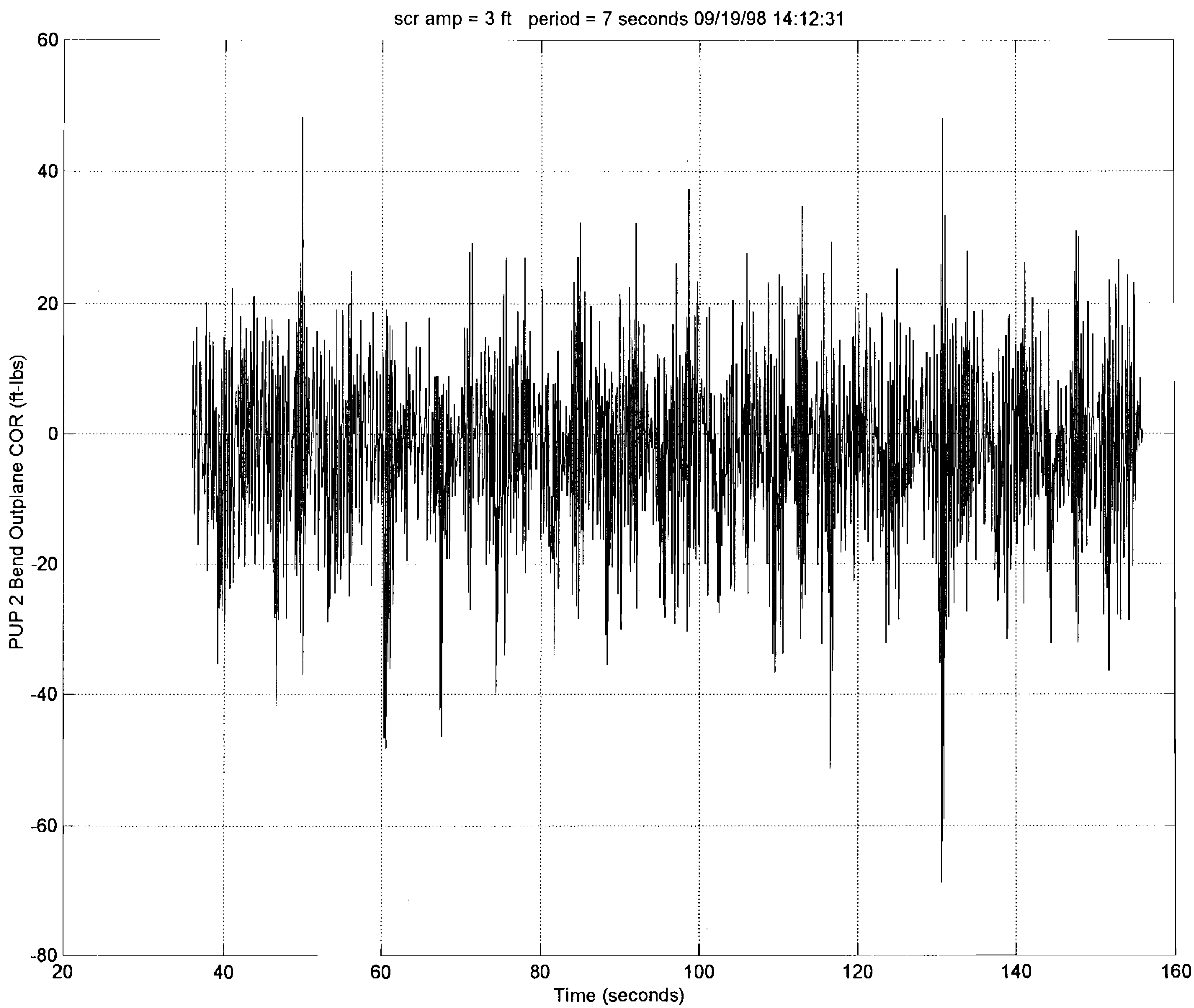


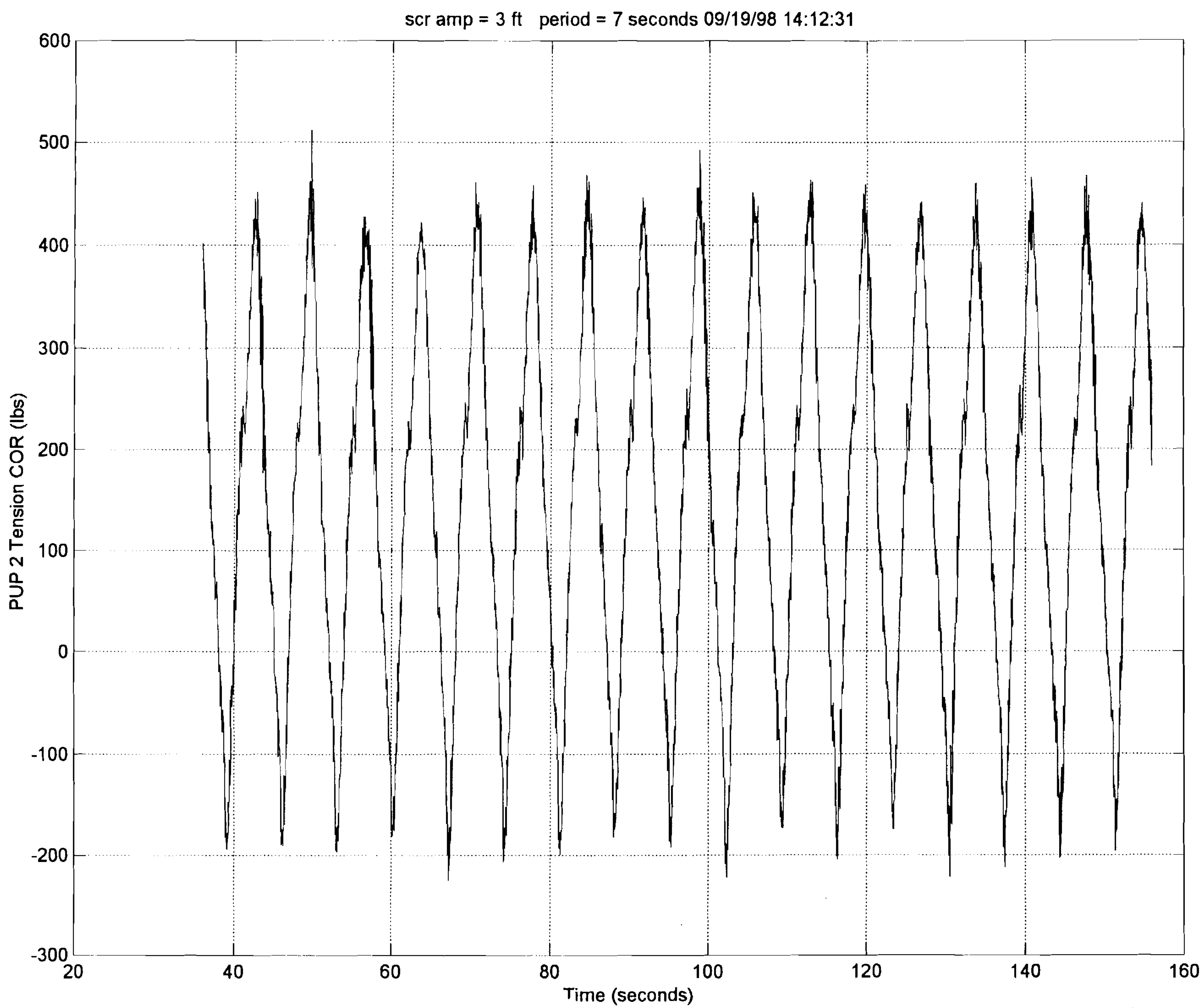
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 1 Bend Inplane COR (ft-lbs)
-12
-14
-16
-18
-20
-22
-24
20
40
60
80
100
120
140
160
Time (seconds)

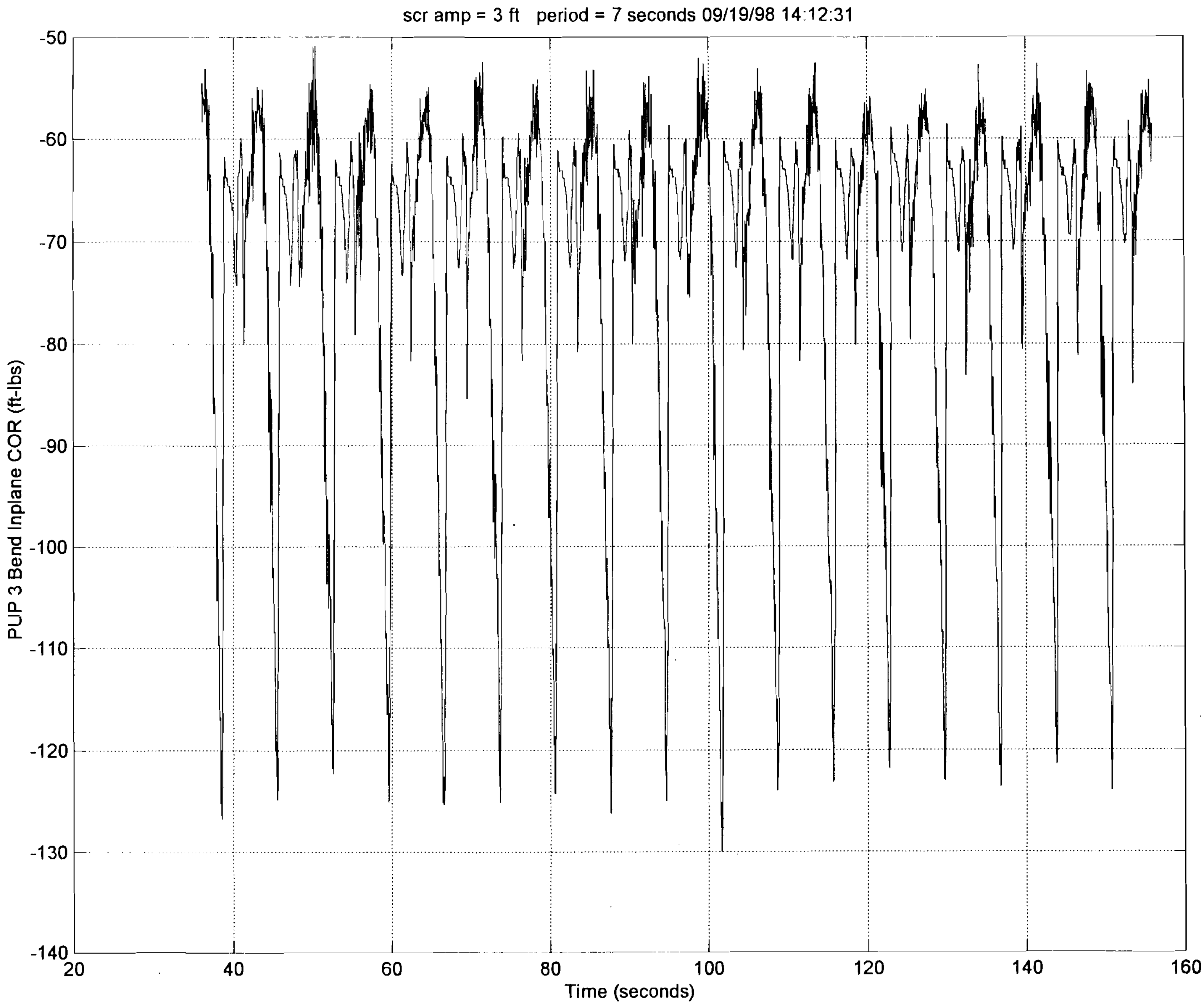

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 1 Bend Outplane COR (ft-lbs)
14
12
10
8
6
4
2
0
-2
-4
-6
20
40
60
80
100
120
140
160
Time (seconds)


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
PUP 1 Tension COR (lbs)
20
40
60
80
100
120
140
160
Time (seconds)

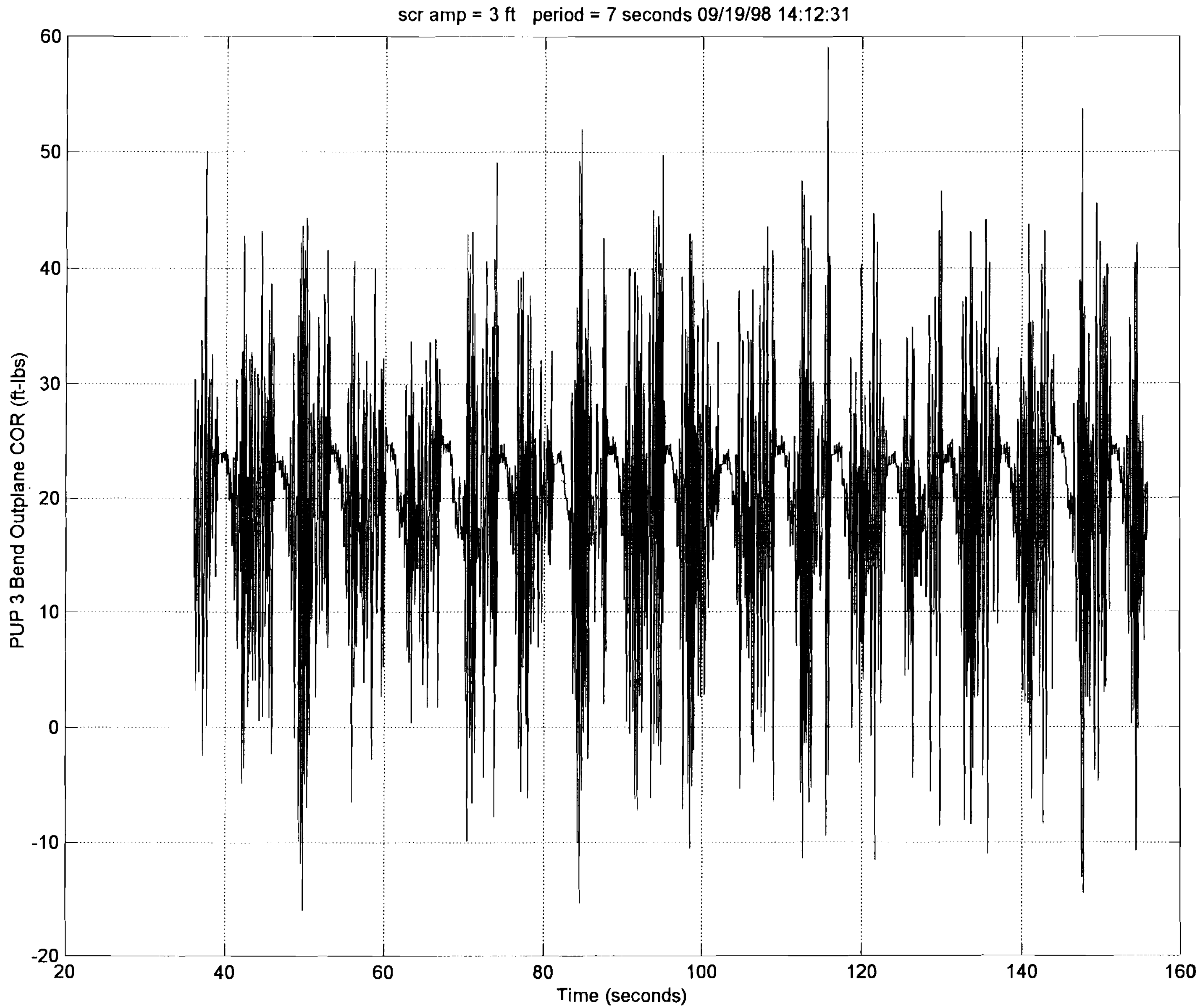

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 2 Bend Inplane COR (ft-lbs)
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
20
40
60
80
100
120
140
160
Time (seconds)

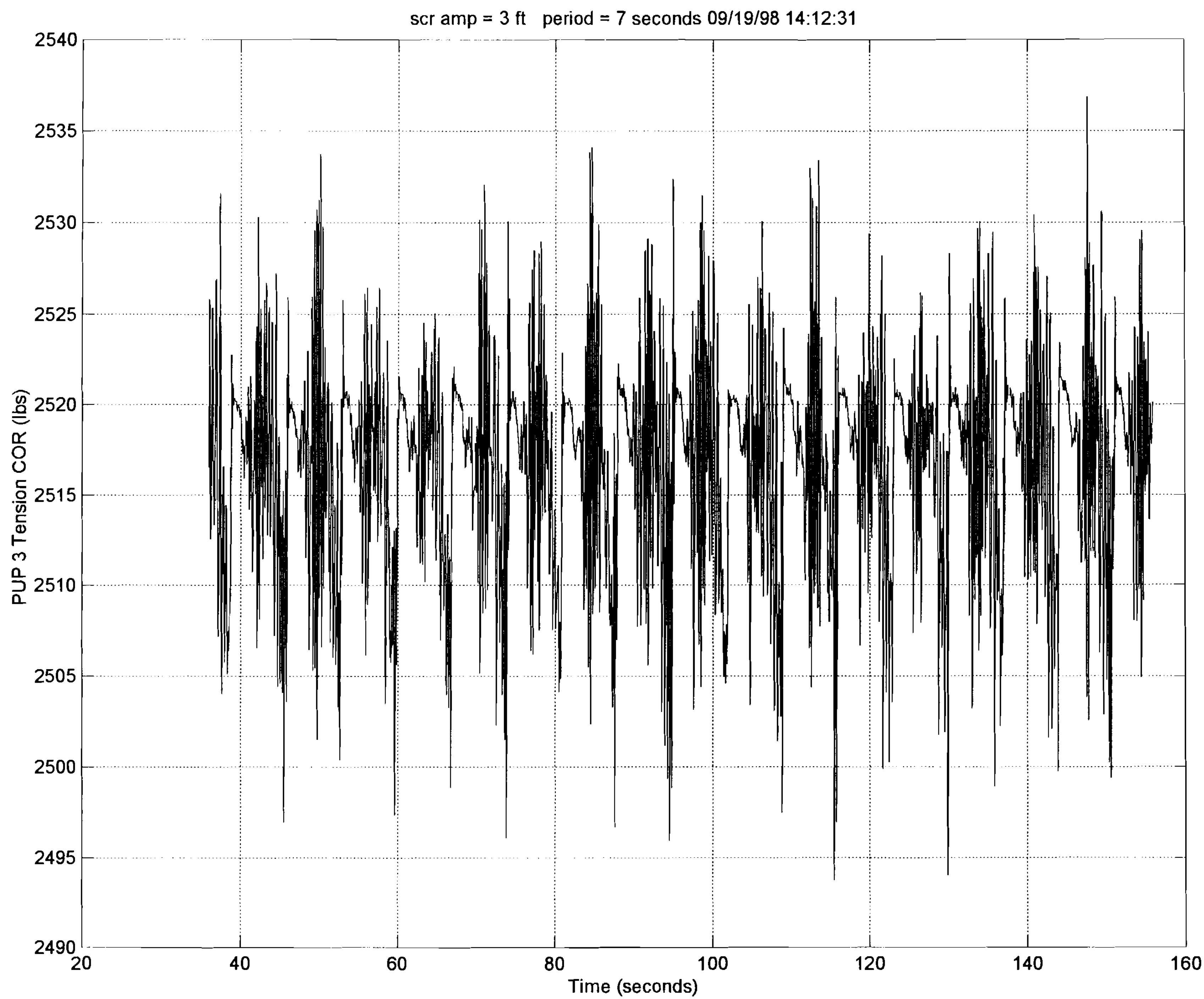

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 2 Bend Outplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
-80
20
40
60
80
100
120
140
160
Time (seconds)

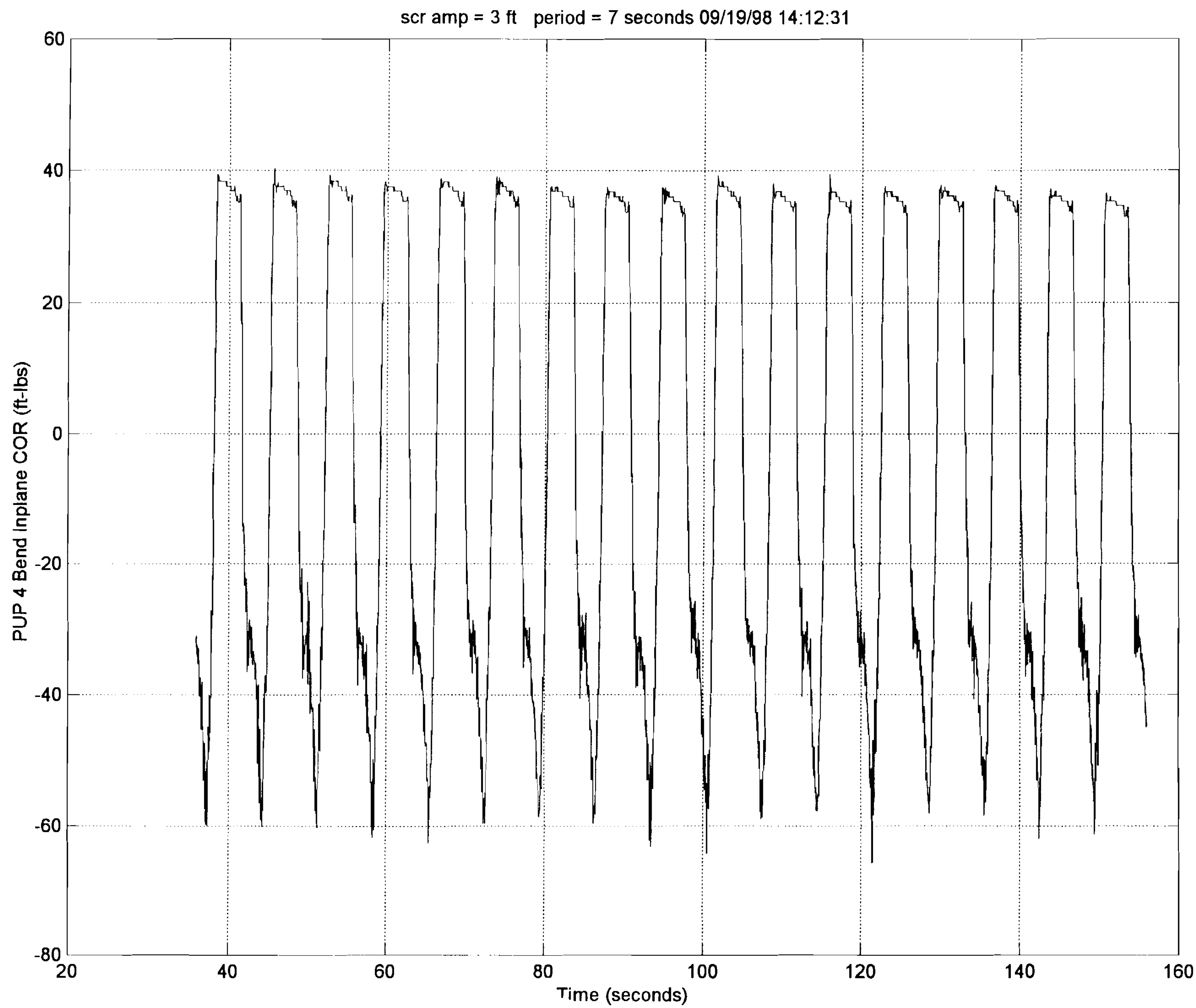

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 2 Tension COR (lbs)
Time (seconds)
600
500
400
300
200
100
0
-100
-200
-300
20
40
60
80
100
120
140
160

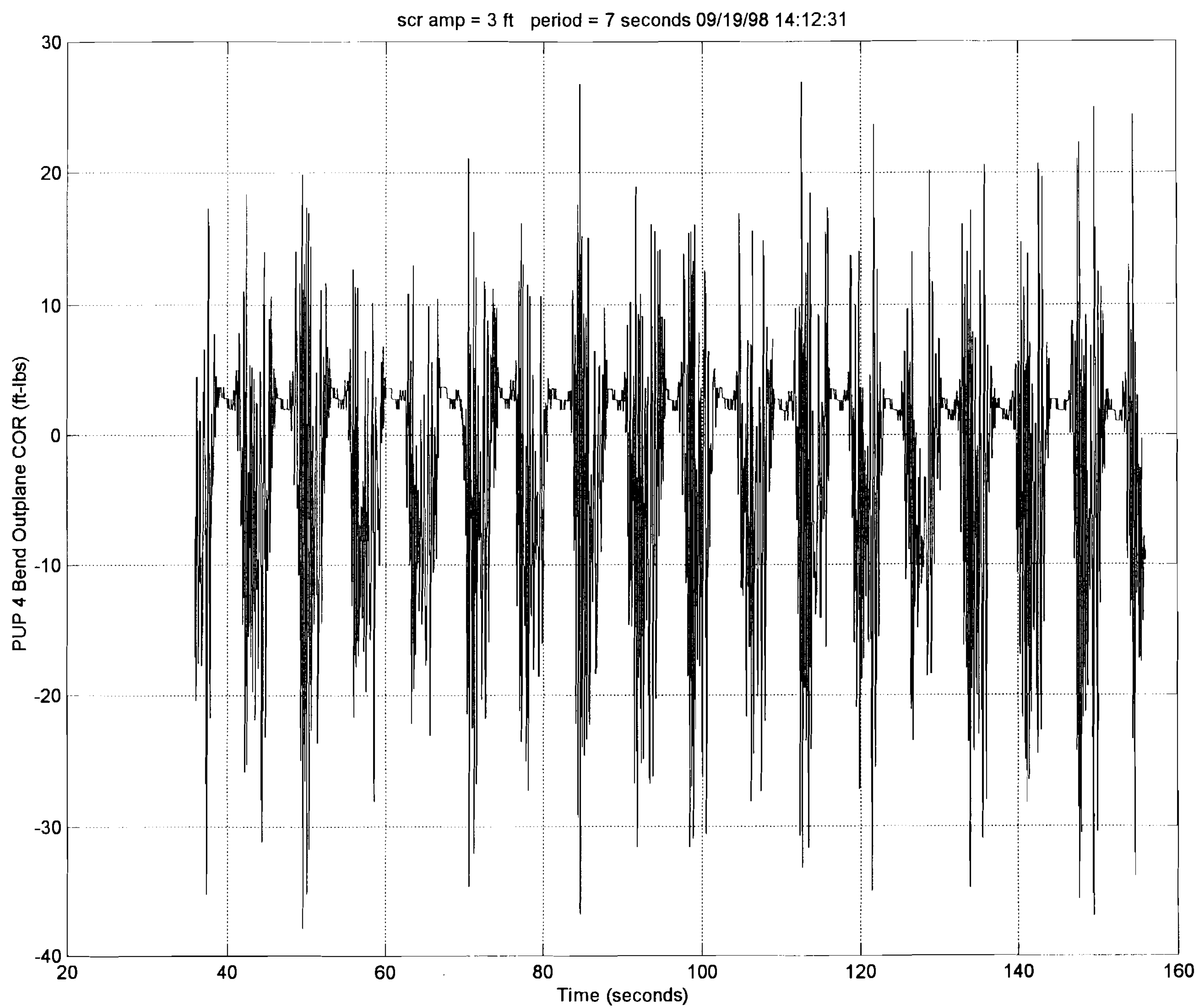


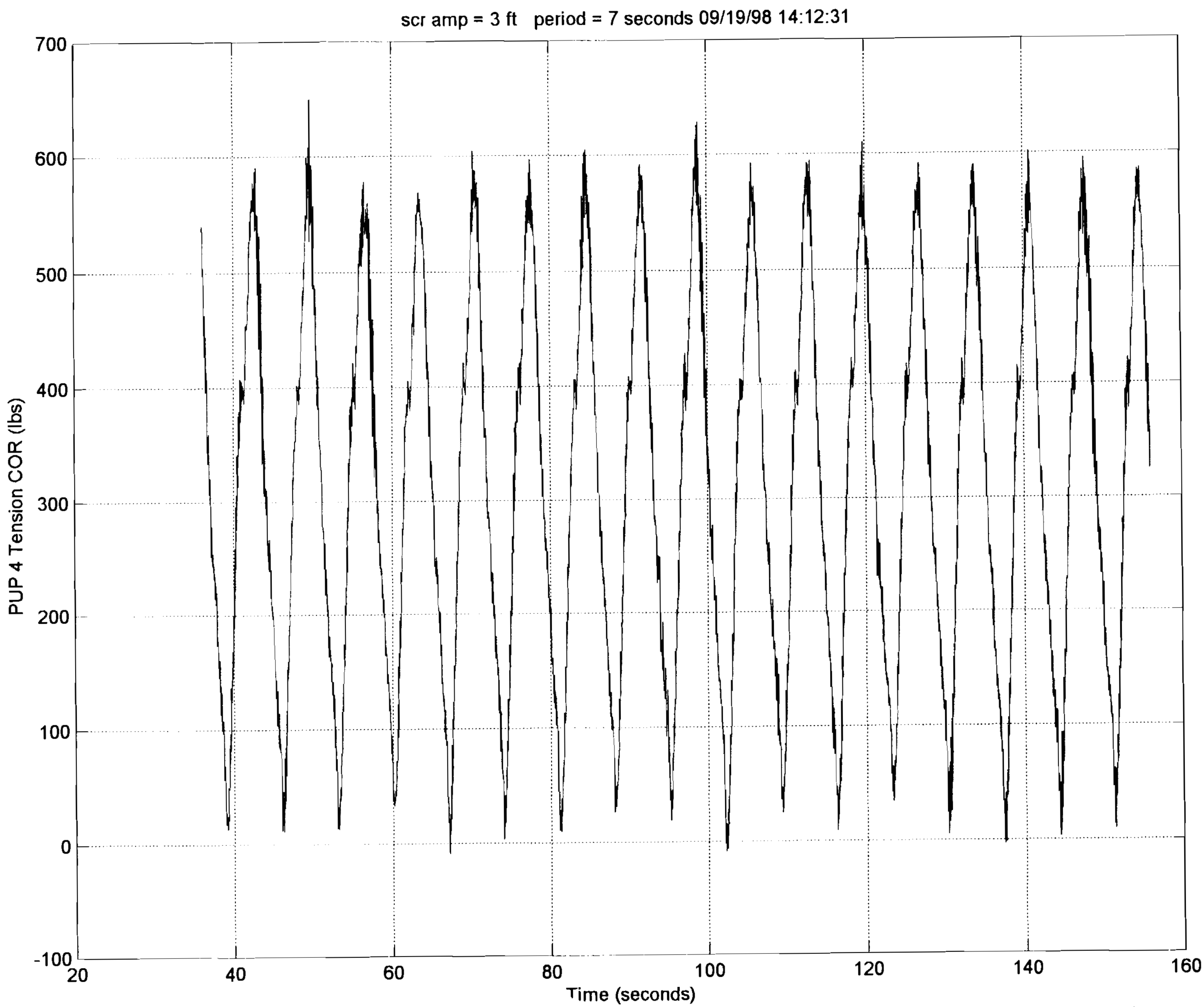
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 3 Bend Inplane COR (ft-lbs)
Time (seconds)
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
20
40
60
80
100
120
140
160


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 3 Bend Outplane COR (ft-lbs)
Time (seconds)
60
50
40
30
20
10
0
-10
-20
20
40
60
80
100
120
140
160

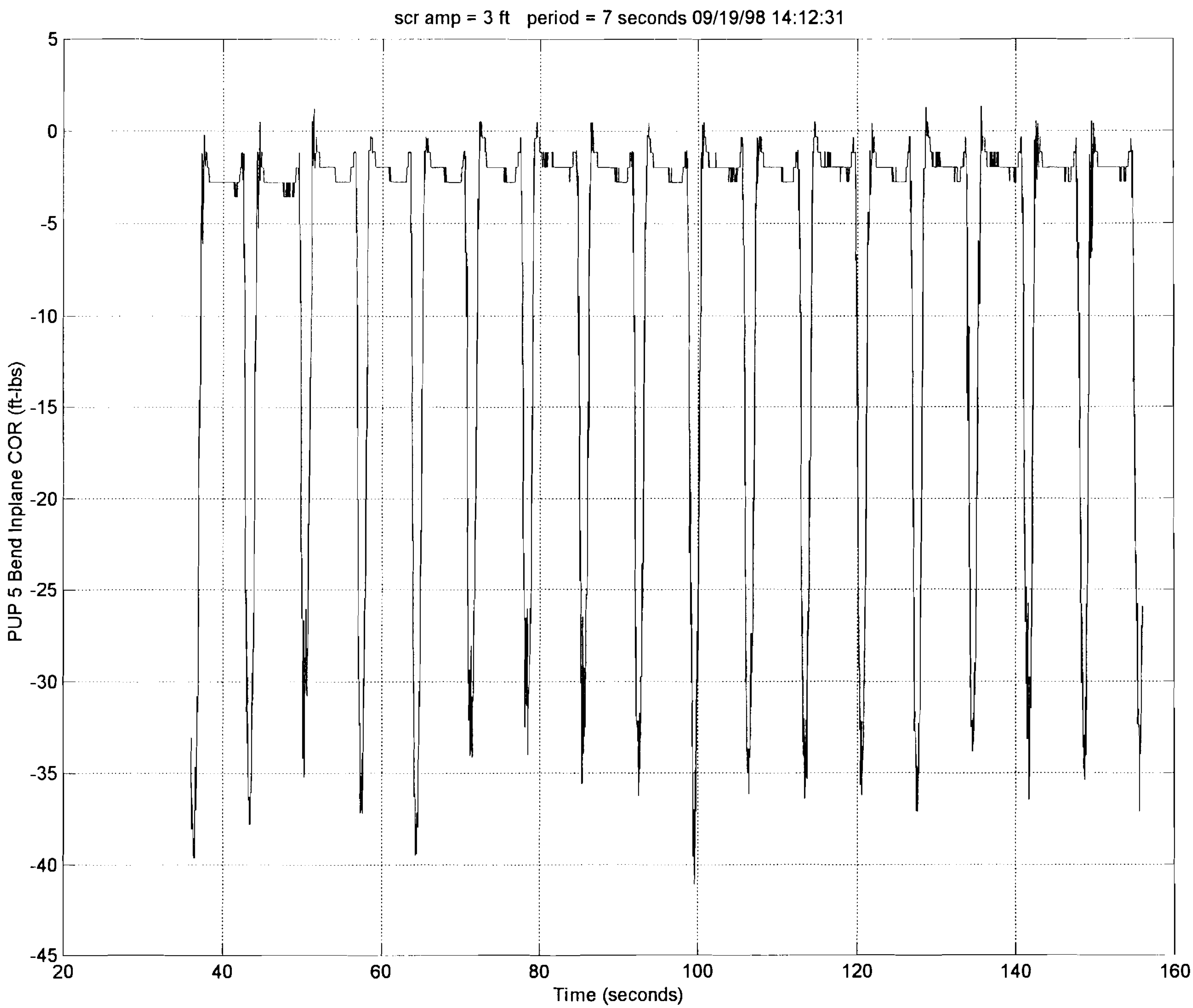

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 3 Tension COR (lbs)
2540
2535
2530
2525
2520
2515
2510
2505
2500
2495
2490
20
40
60
80
100
120
140
160
Time (seconds)

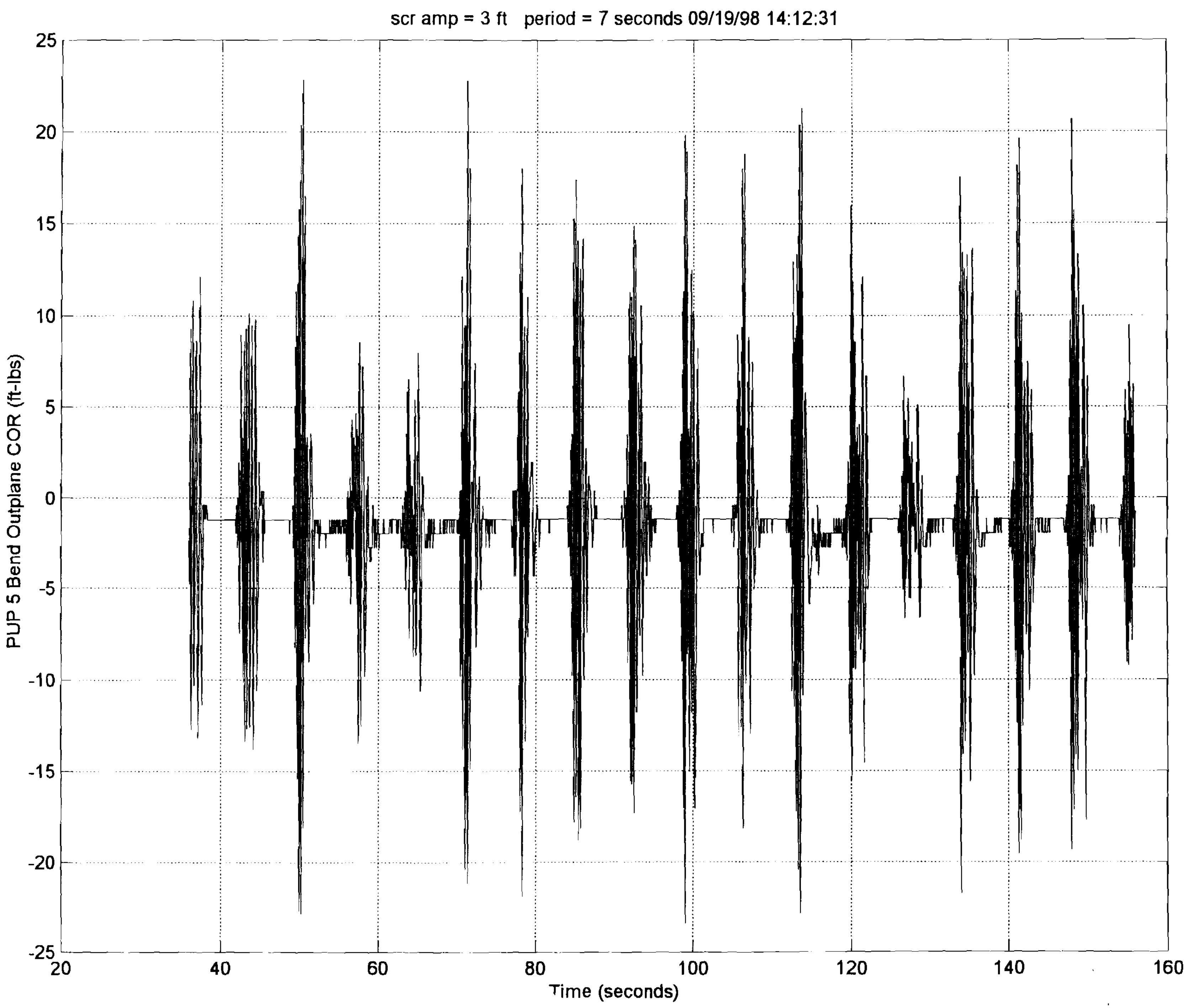

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 4 Bend Inplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
-80
20
40
60
80
100
120
140
160
Time (seconds)


scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
PUP 4 Bend Outplane COR (ft-lbs)
30
20
10
0
-10
-20
-30
-40
20
40
60
80
100
120
140
160
Time (seconds)

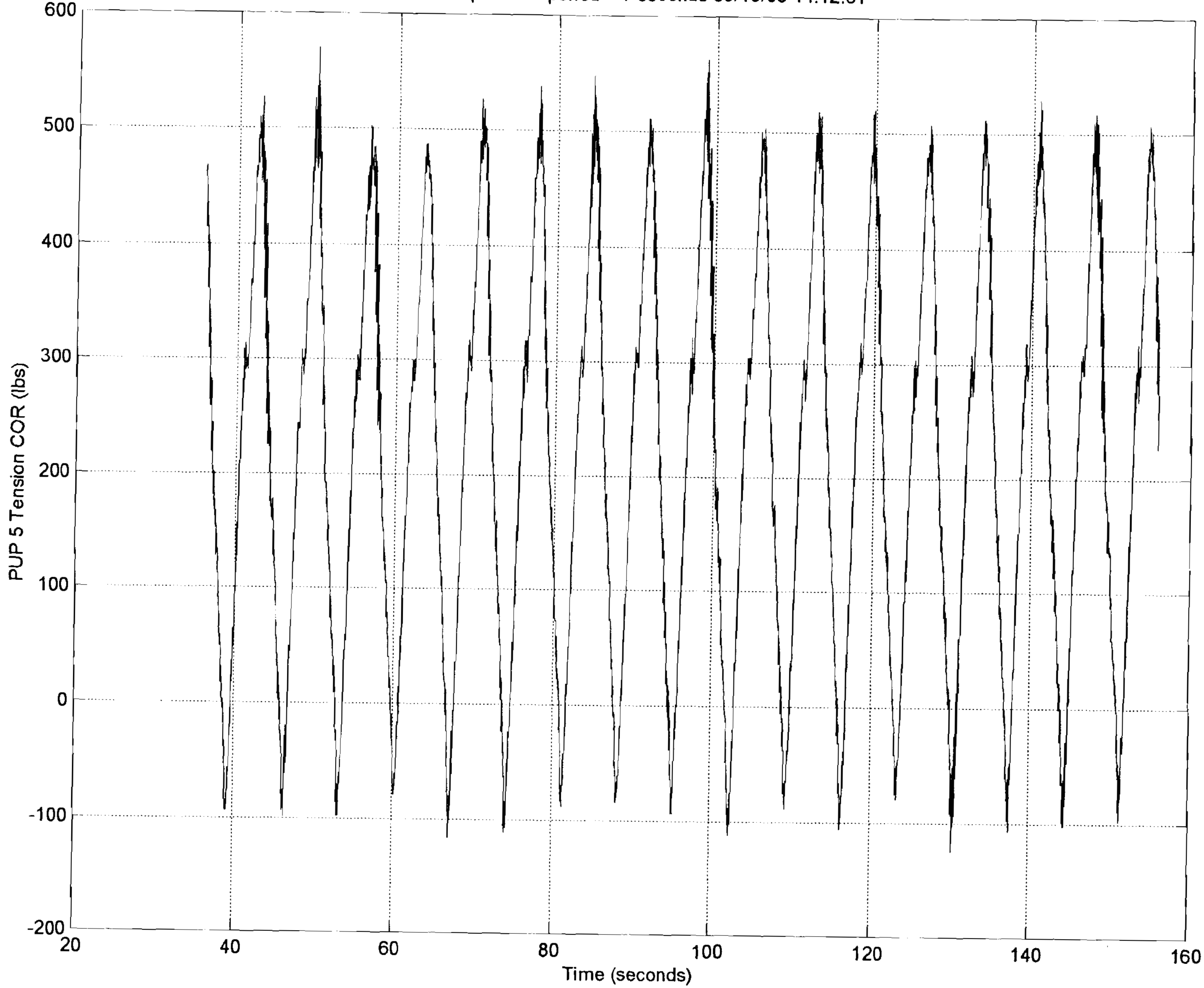


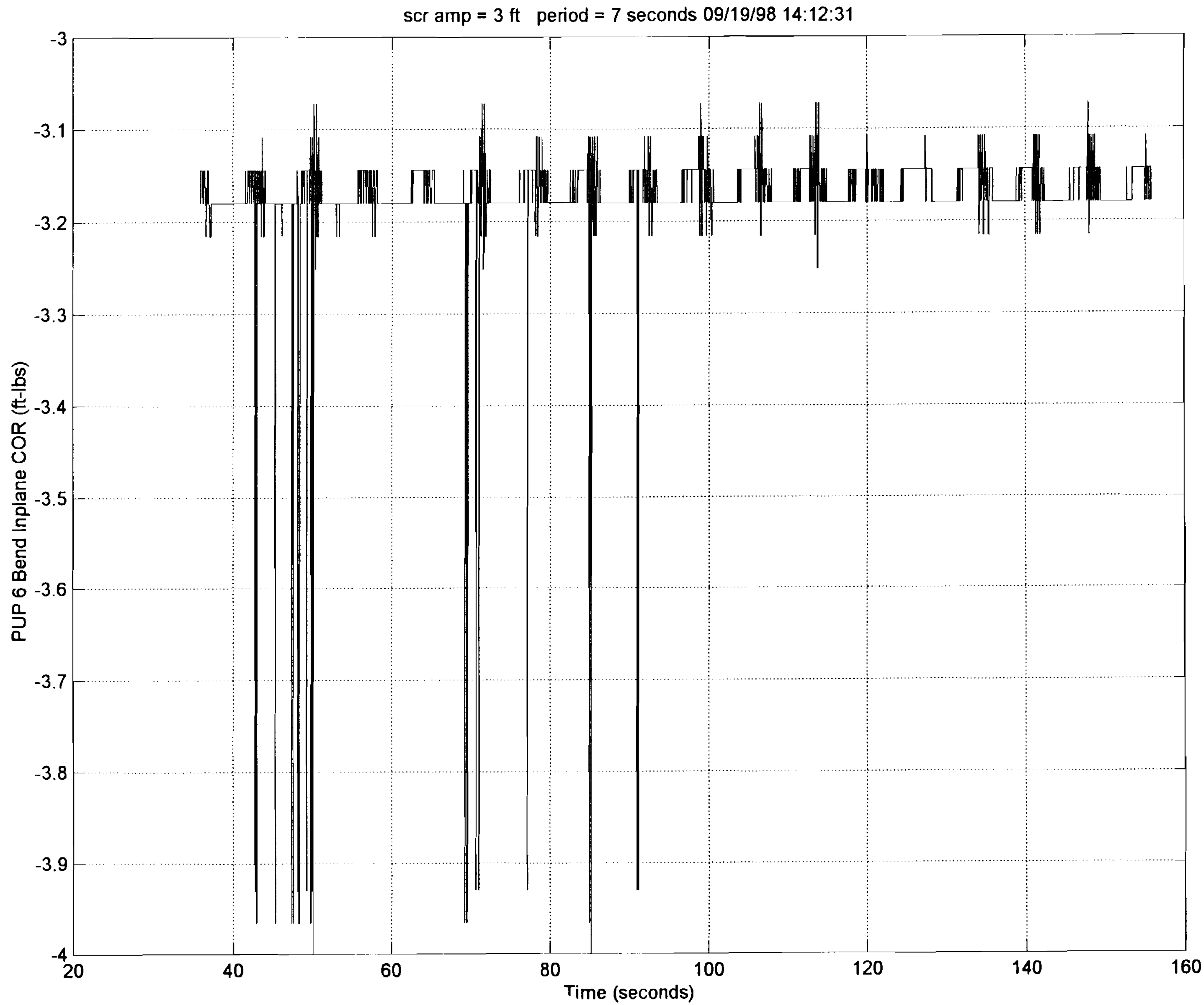
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 4 Tension COR (lbs)
700
600
500
400
300
200
100
0
-100
20
40
60
80
100
120
140
160
Time (seconds)

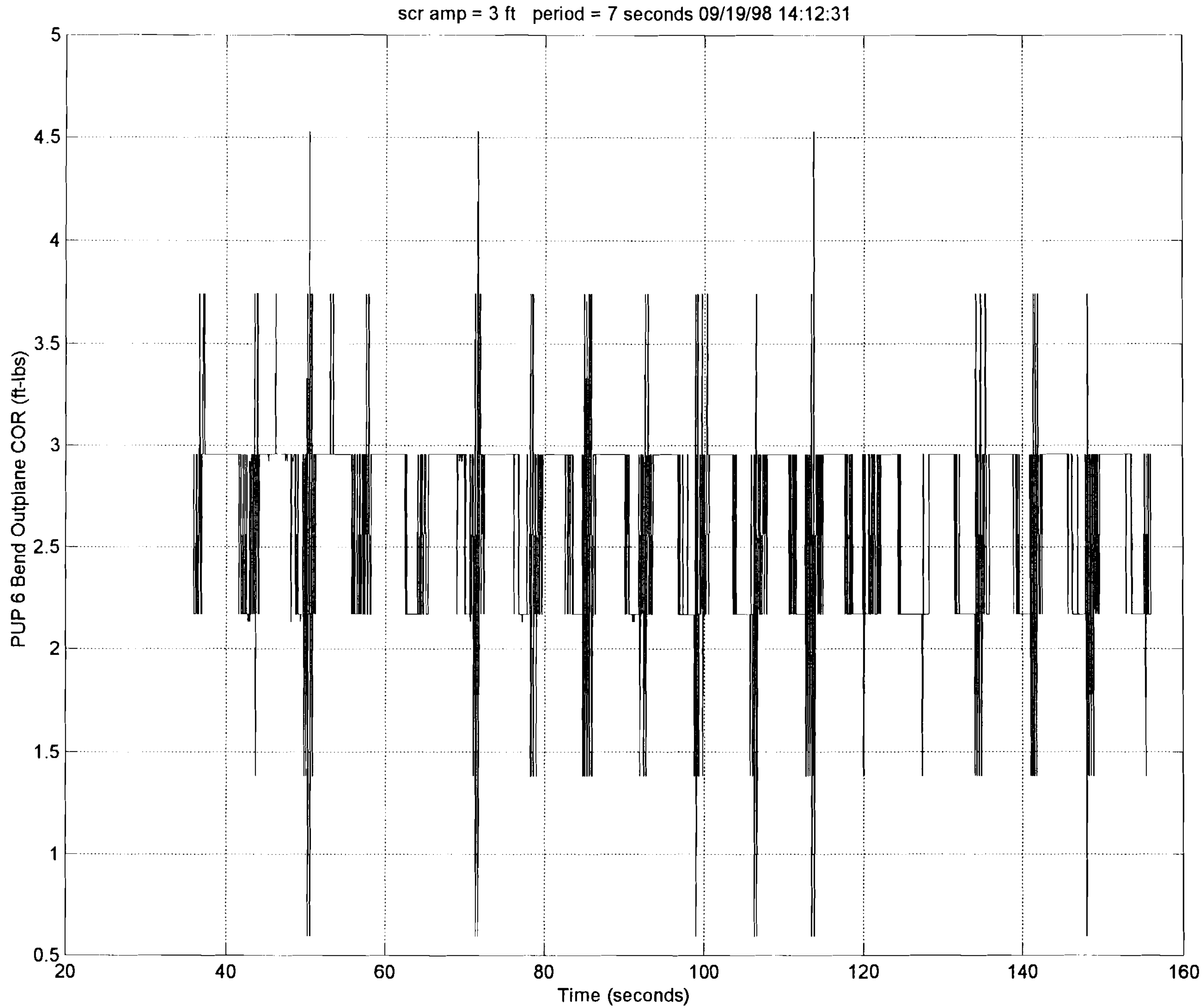

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 5 Bend Inplane COR (ft-lbs)
Time (seconds)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
20
40
60
80
100
120
140
160


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 5 Bend Outplane COR (ft-lbs)
Time (seconds)
25
20
15
10
5
0
-5
-10
-15
-20
-25
20
40
60
80
100
120
140
160

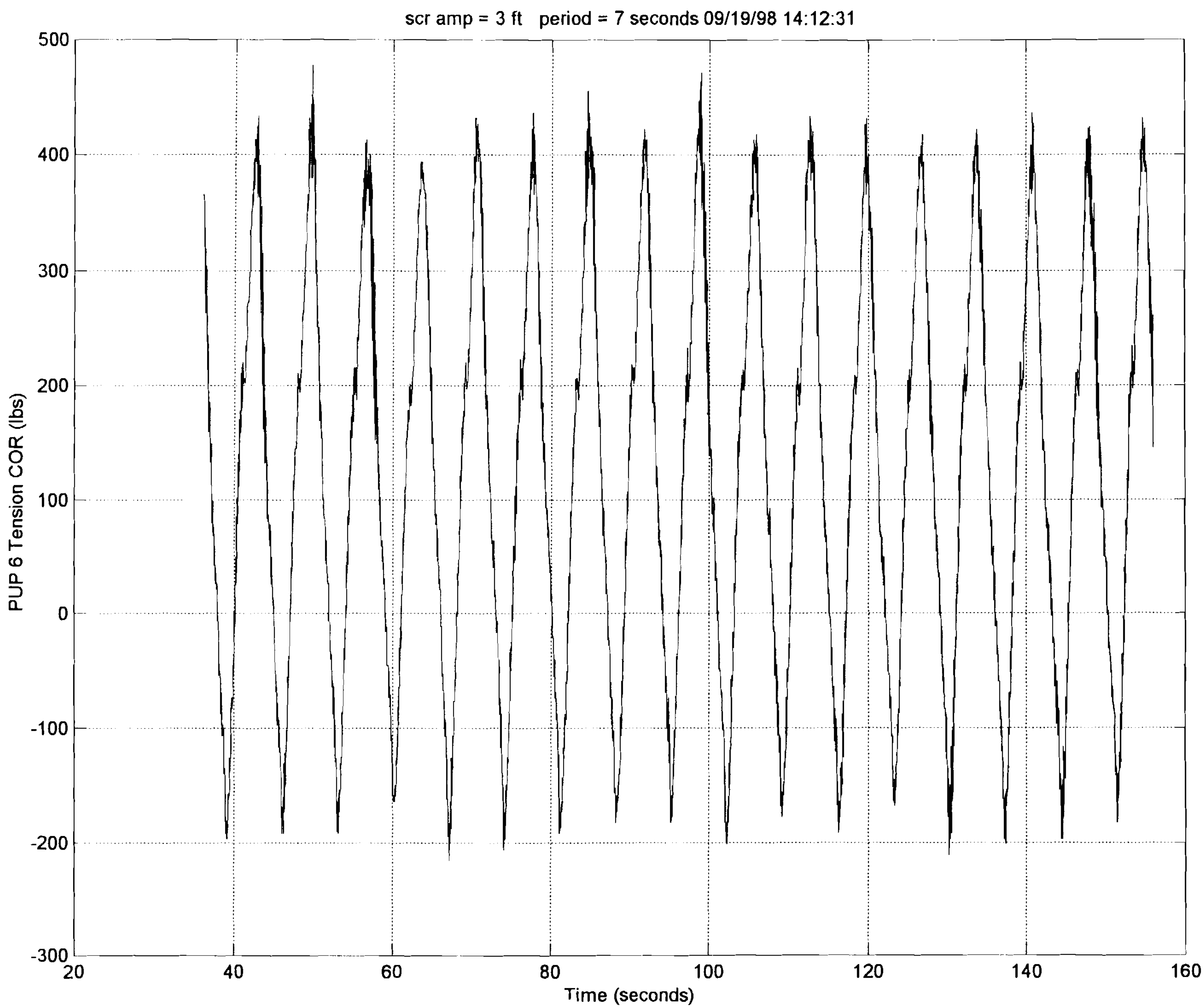
scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31

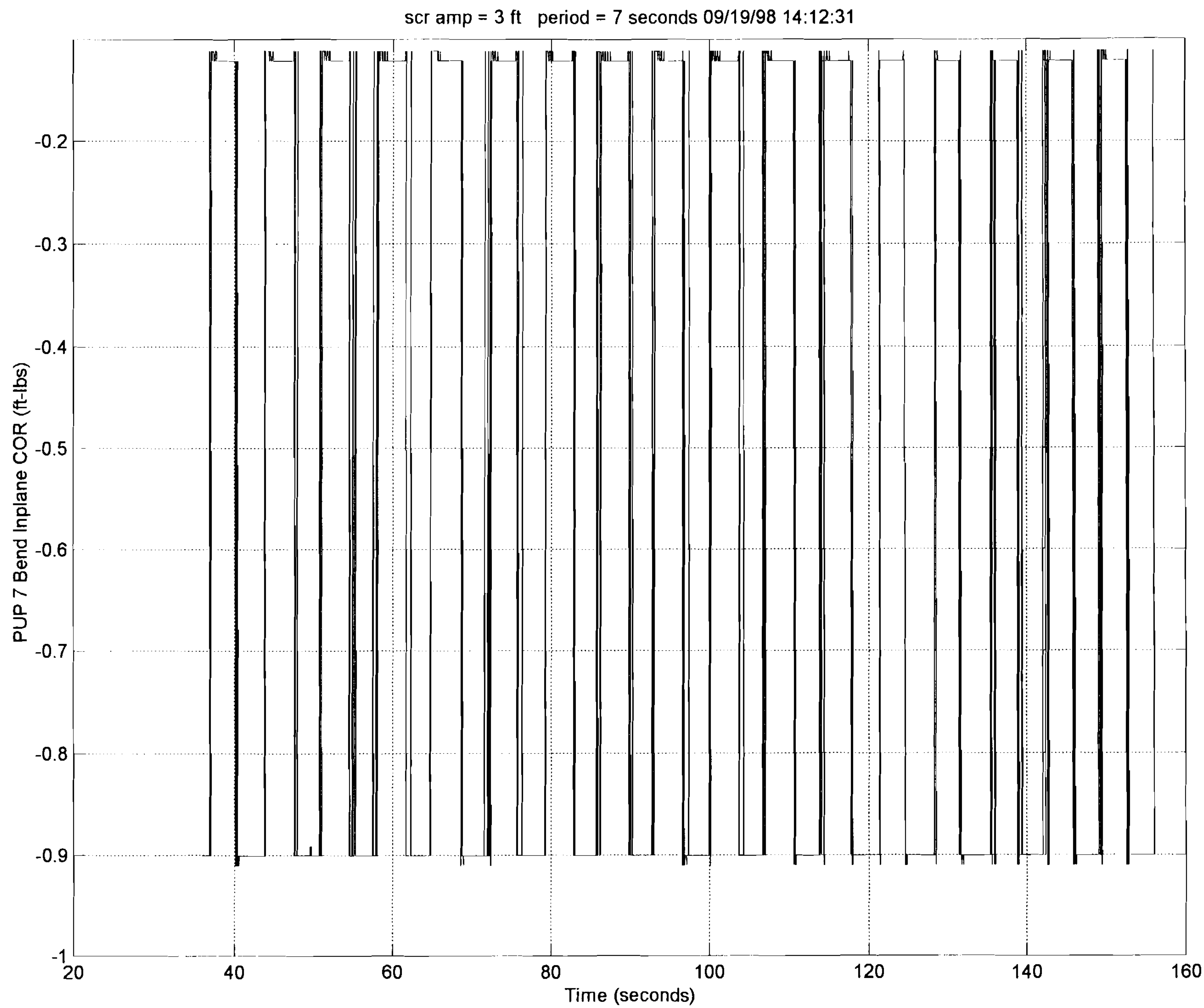


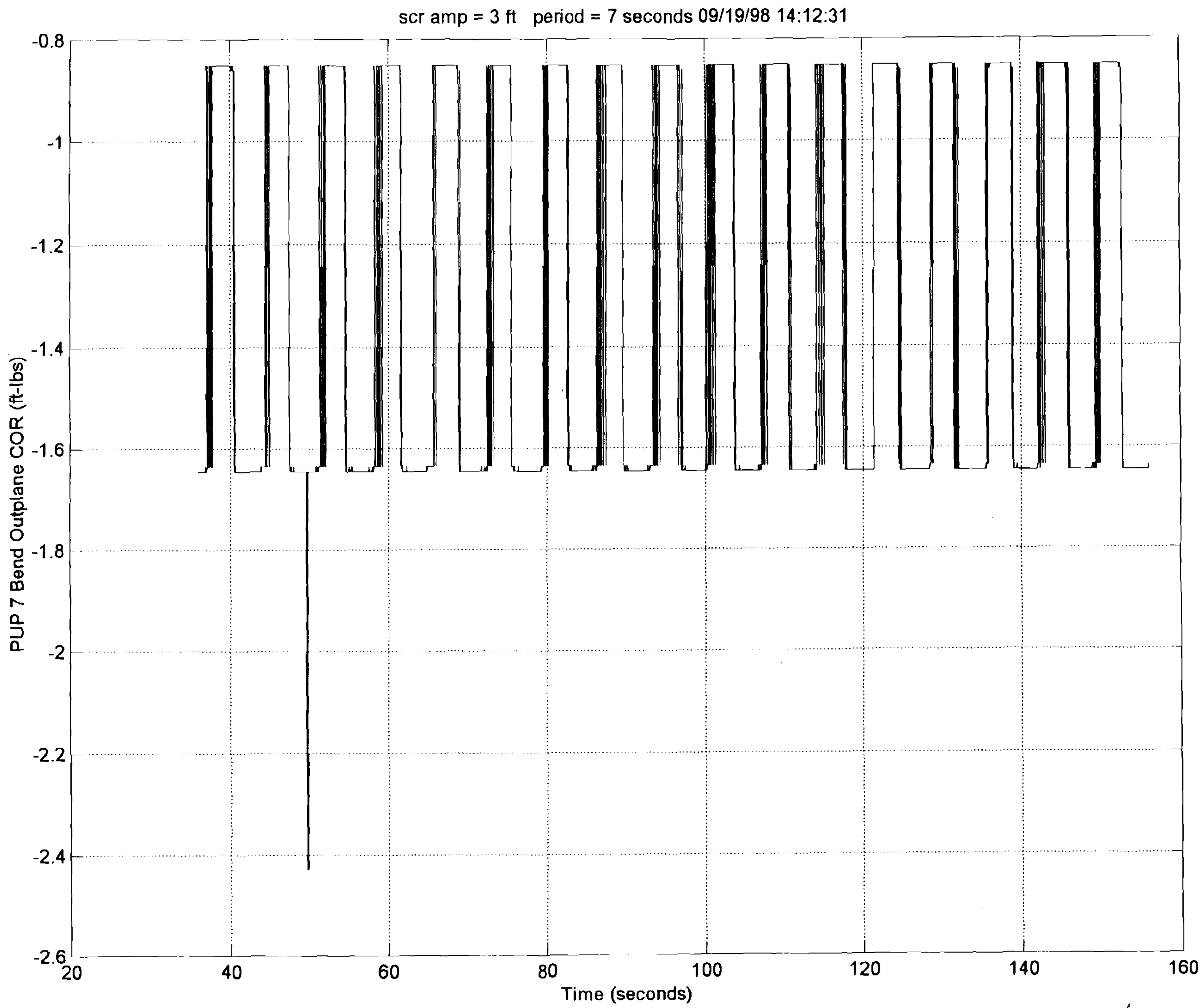

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 6 Bend Inplane COR (ft-lbs)
-3
-3.1
-3.2
-3.3
-3.4
-3.5
-3.6
-3.7
-3.8
-3.9
-4
20
40
60
80
100
120
140
160
Time (seconds)



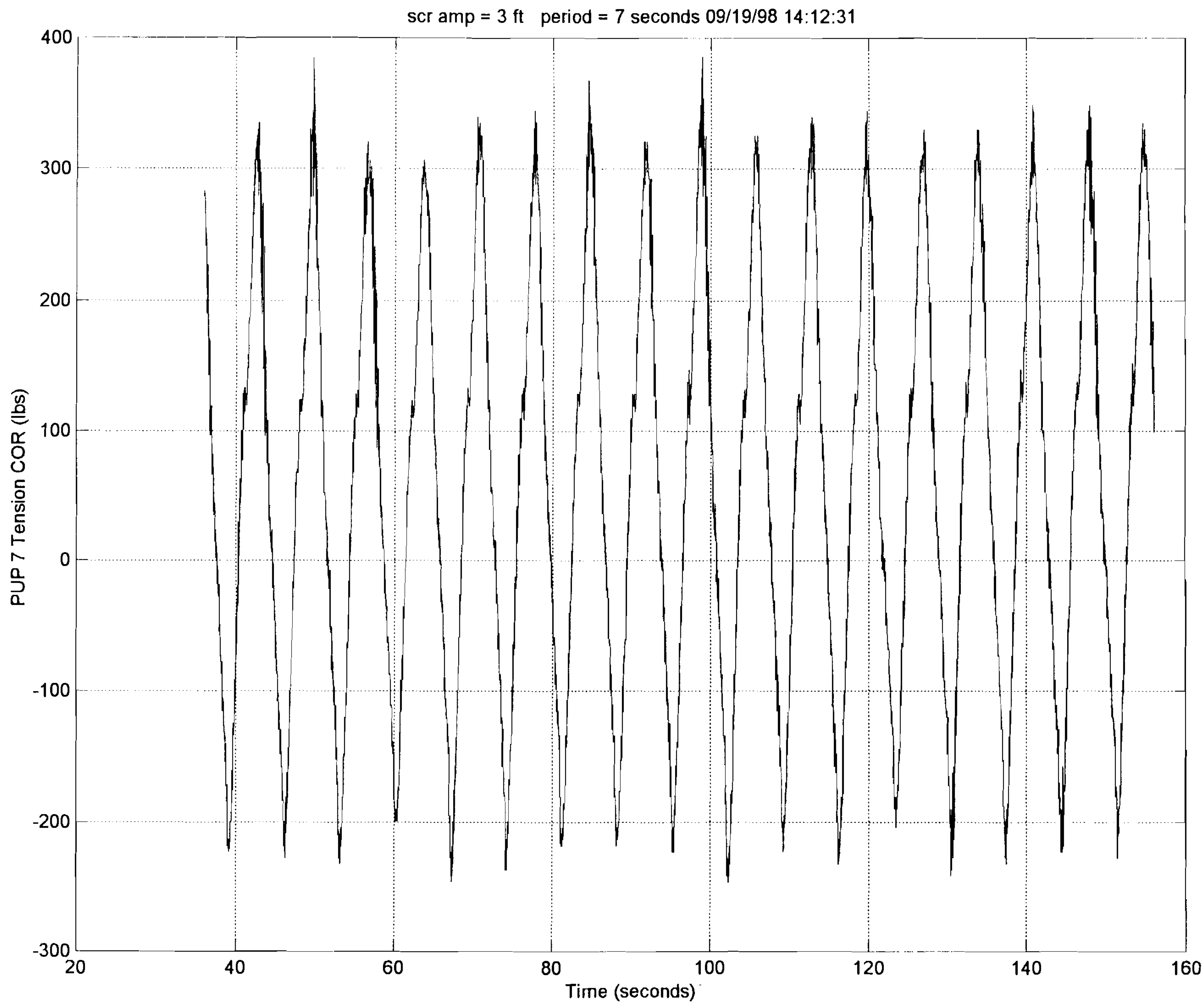
scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
PUP 6 Bend Outplane COR (ft-lbs)
Time (seconds)
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
20
40
60
80
100
120
140
160

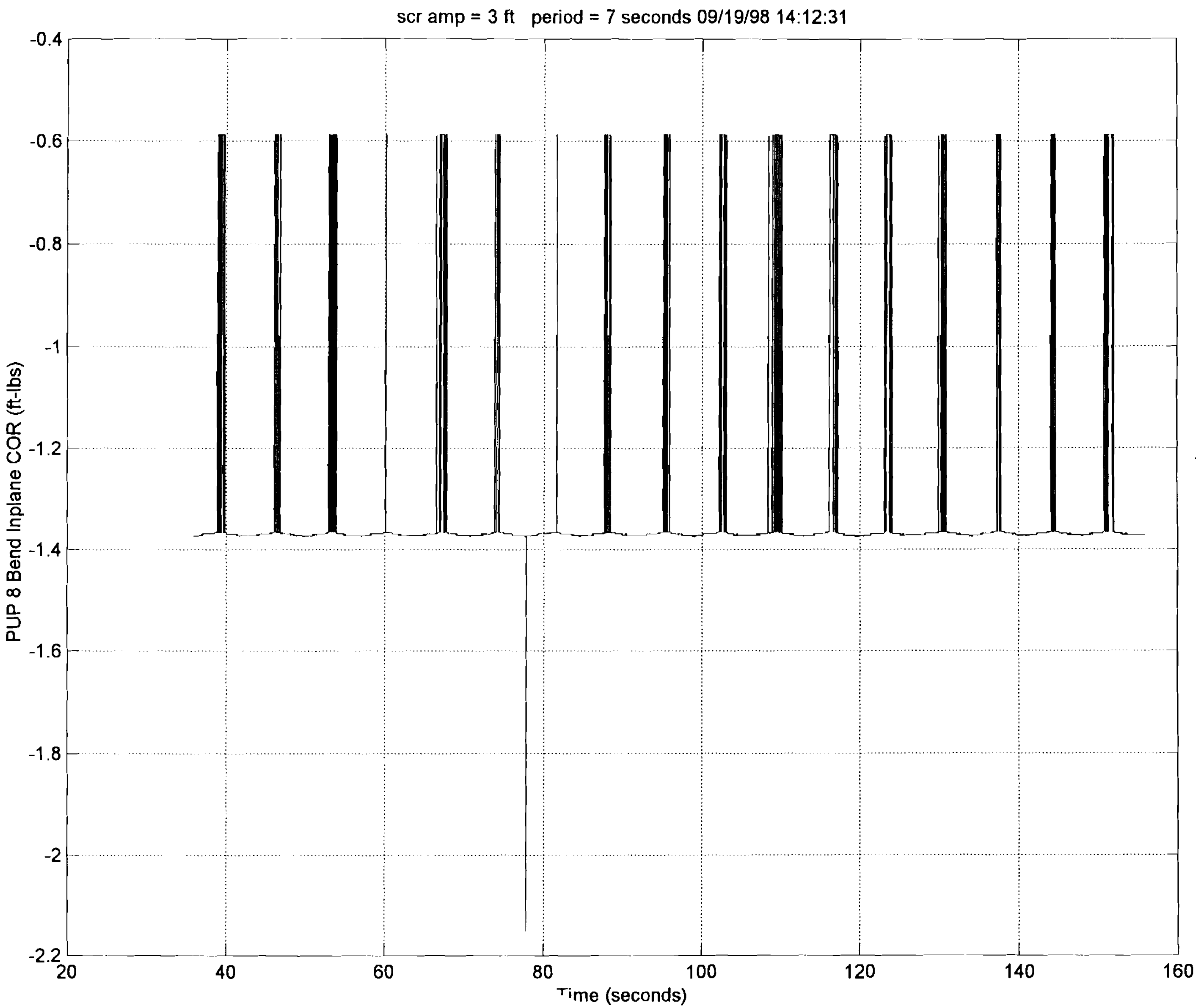

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 6 Tension COR (lbs)
Time (seconds)
500
400
300
200
100
0
-100
-200
-300
20
40
60
80
100
120
140
160

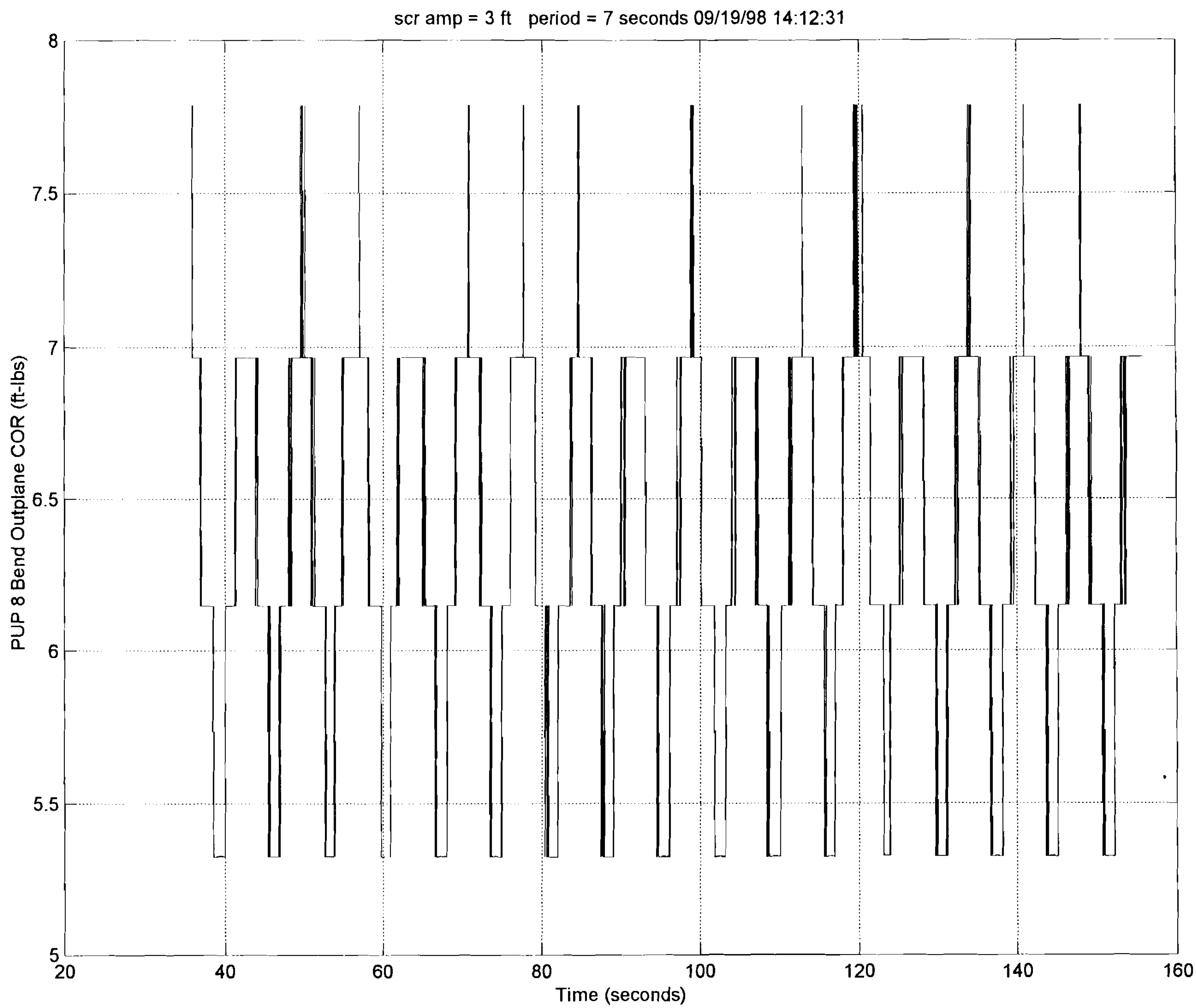

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 7 Bend Inplane COR (ft-lbs)
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
20
40
60
80
100
120
140
160
Time (seconds)

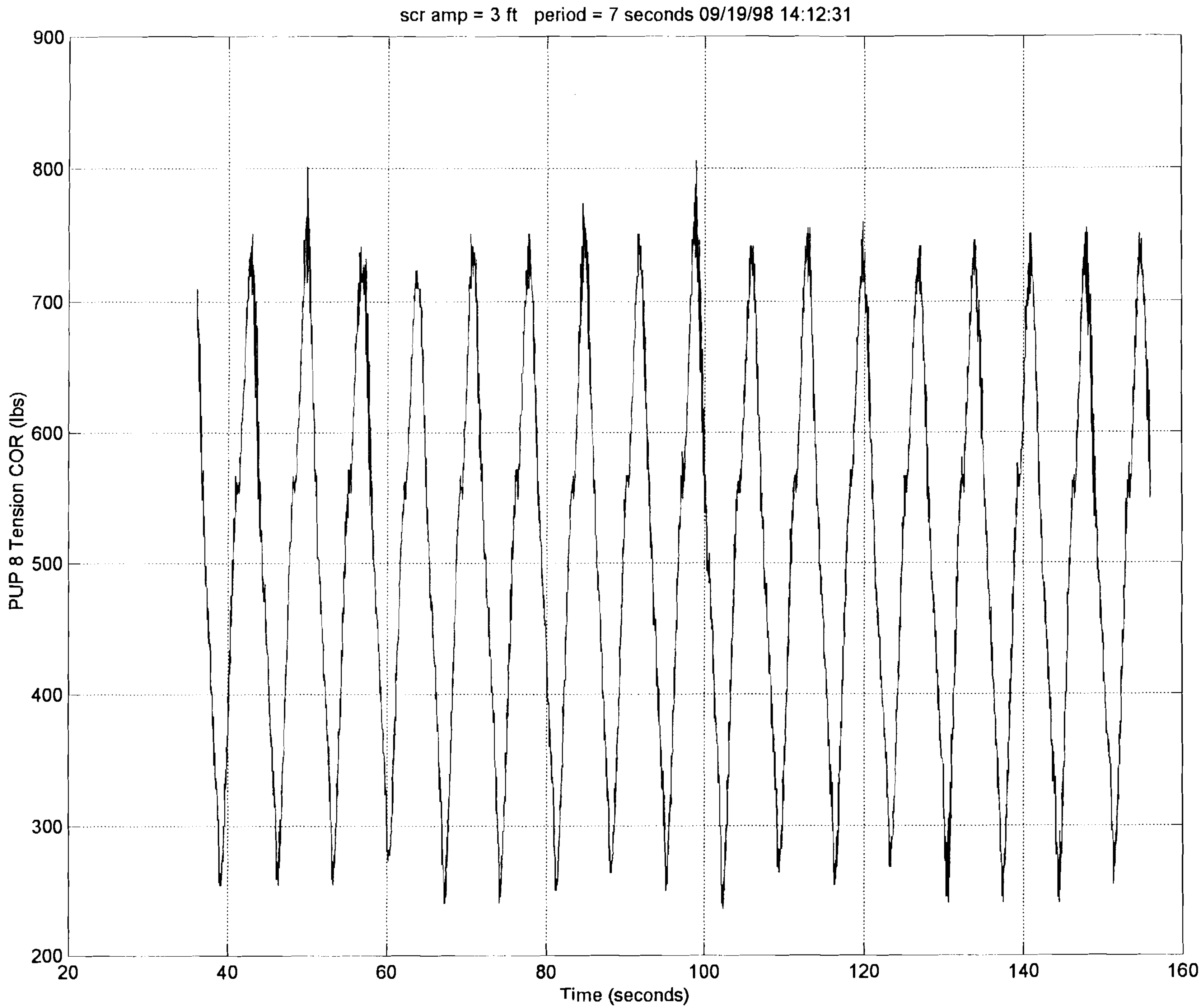


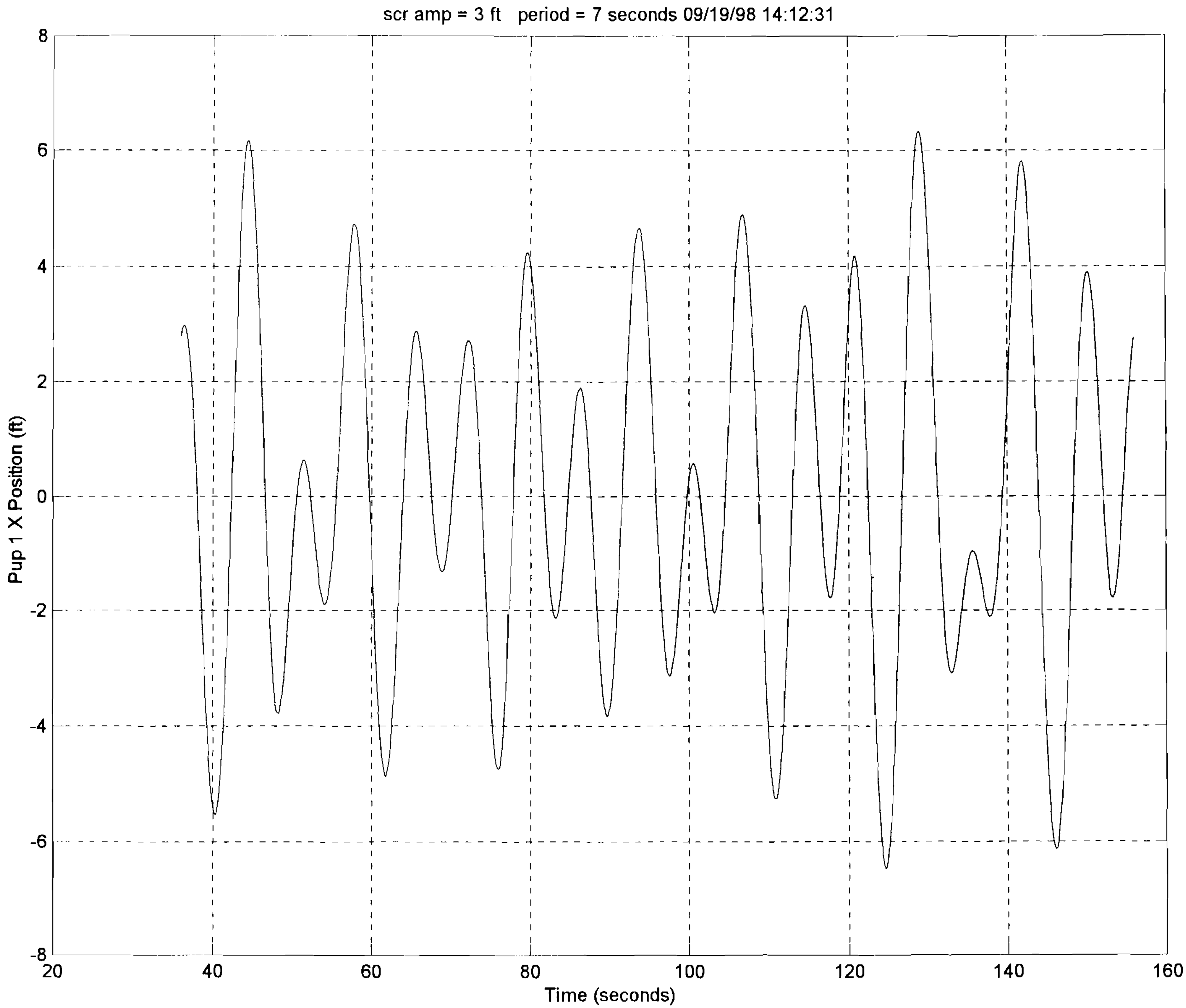
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 7 Bend Outplane COR (ft-lbs)
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
20
40
60
80
100
120
140
160
Time (seconds)

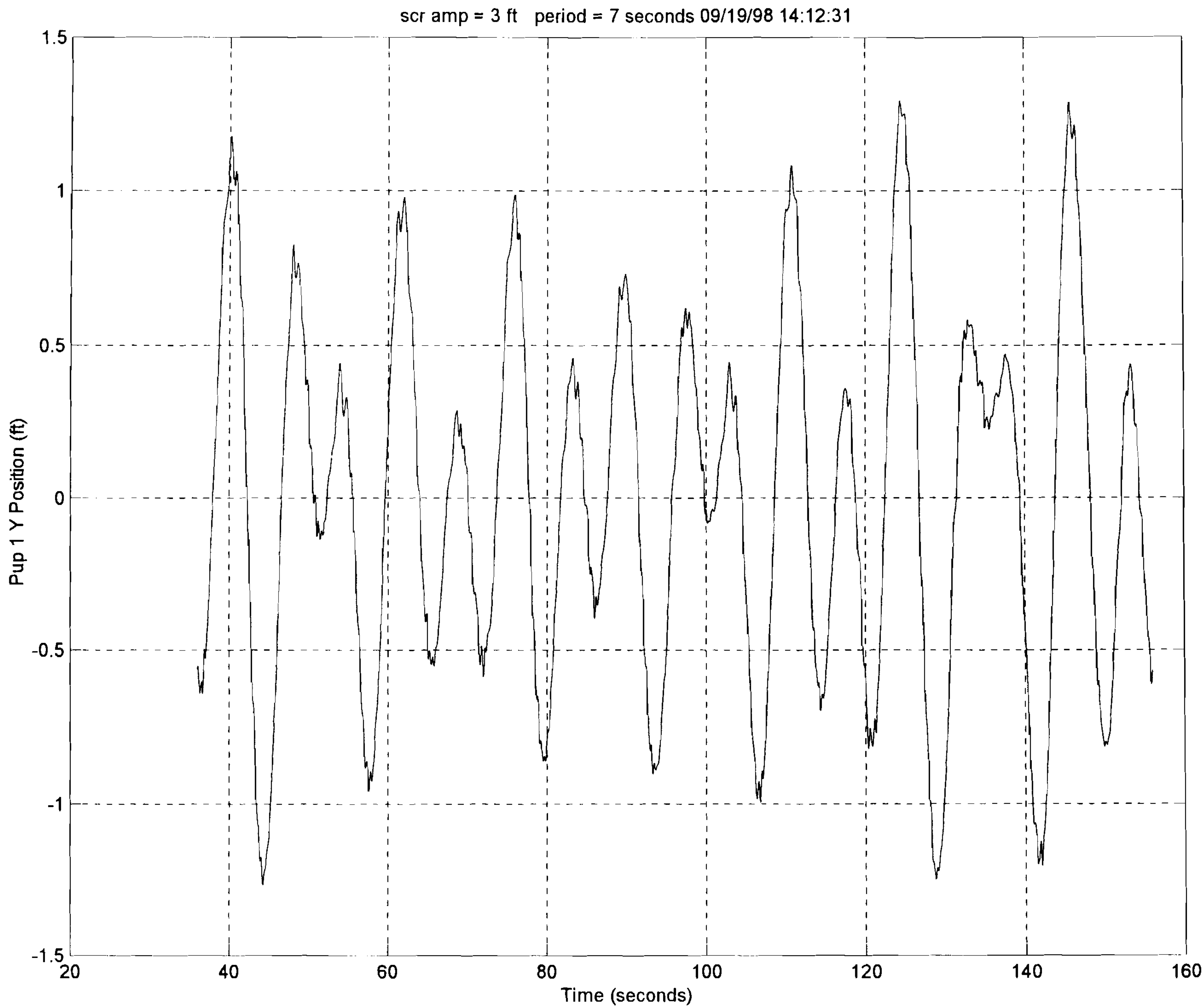

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 7 Tension COR (lbs)
Time (seconds)
400
300
200
100
0
-100
-200
-300
20
40
60
80
100
120
140
160

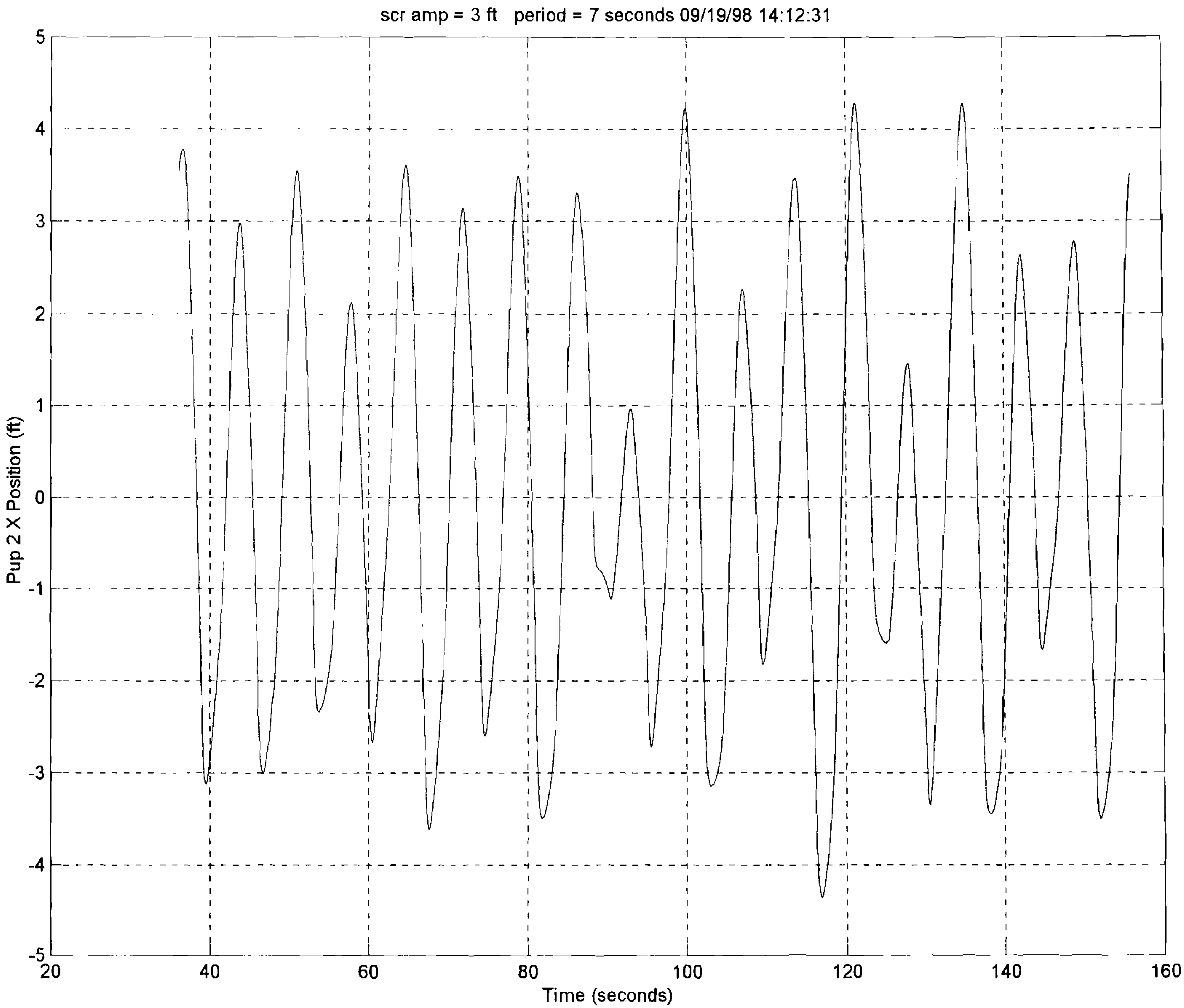

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 8 Bend Inplane COR (ft-lbs)
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
20
40
60
80
100
120
140
160
Time (seconds)

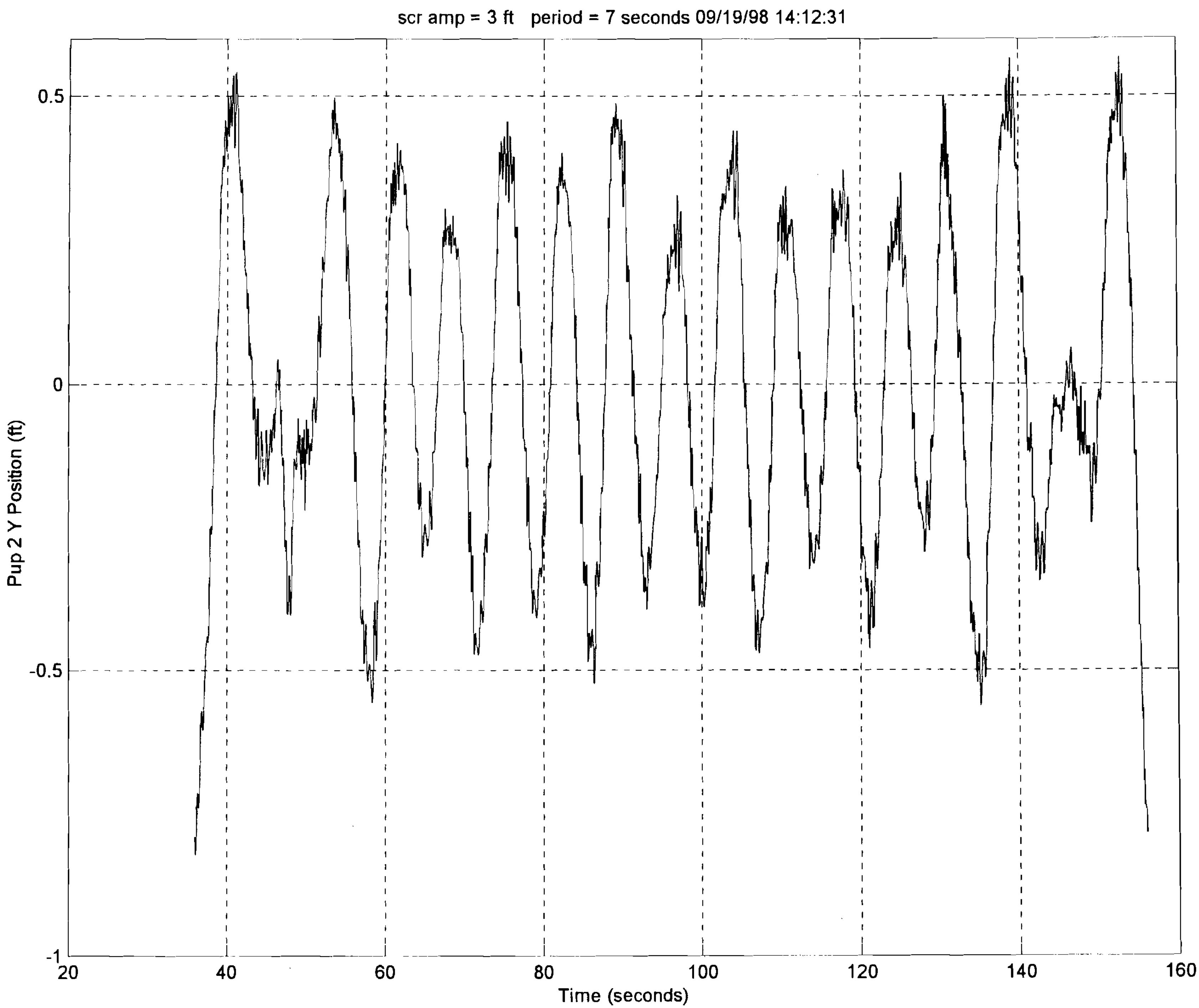

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
PUP 8 Bend Outplane COR (ft-lbs)
8
7.5
7
6.5
6
5.5
5
20
40
60
80
100
120
140
160
Time (seconds)


scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
PUP 8 Tension COR (lbs)
Time (seconds)
900
800
700
600
500
400
300
200
20
40
60
80
100
120
140
160

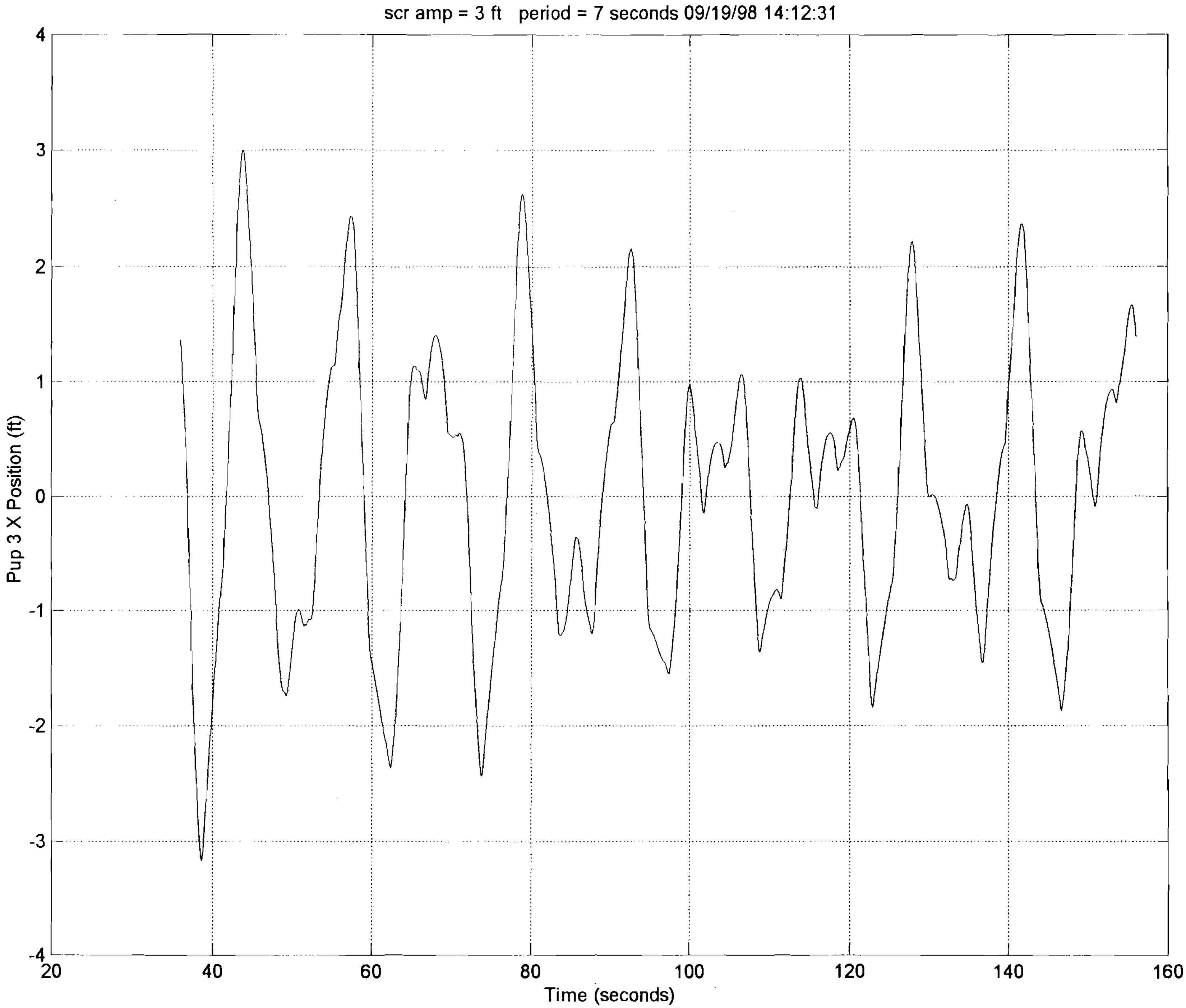

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 1 X Position (ft)
8
6
4
2
0
-2
-4
-6
-8
20
40
60
80
100
120
140
160
Time (seconds)

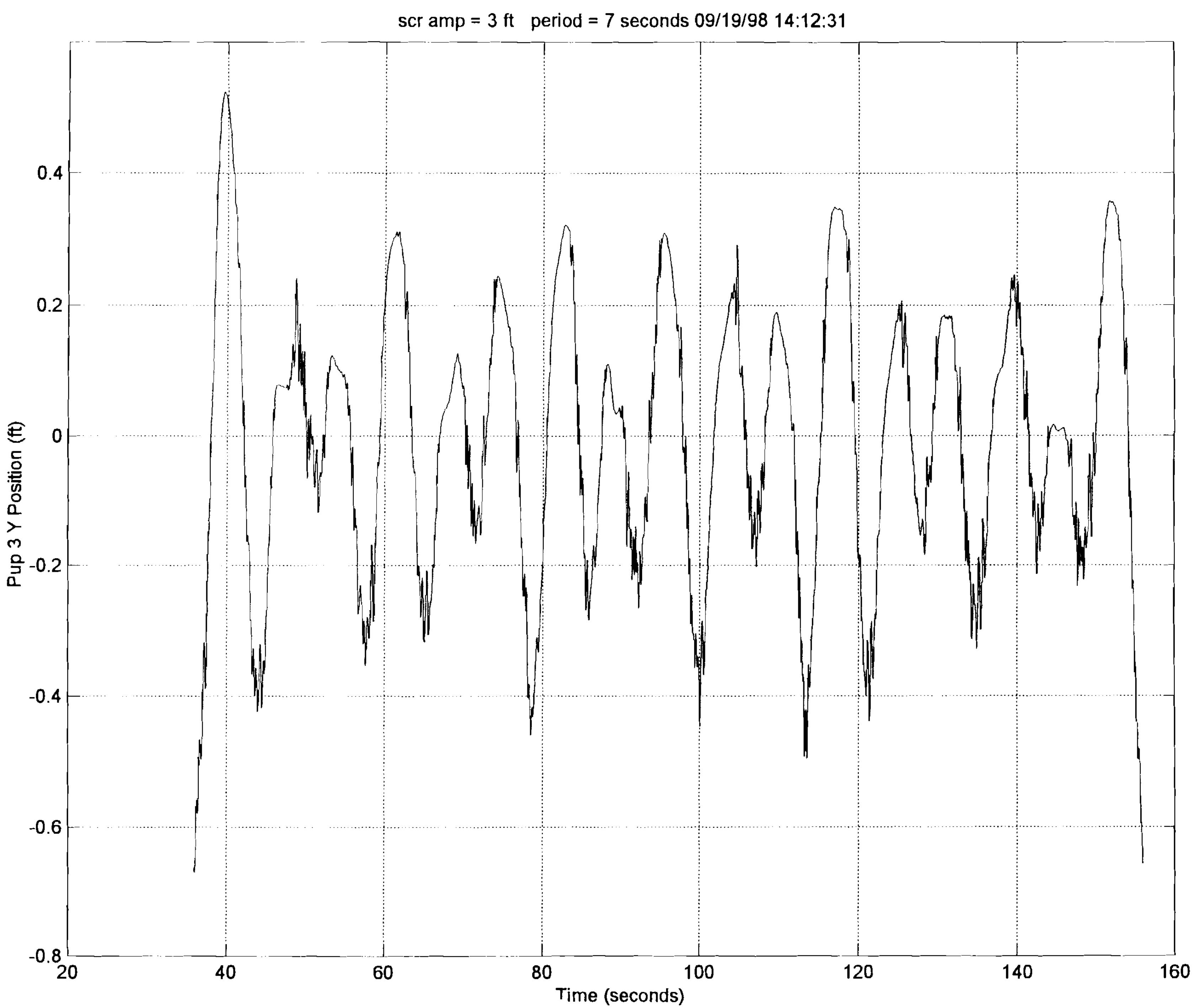

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 1 Y Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
-1.5
20
40
60
80
100
120
140
160

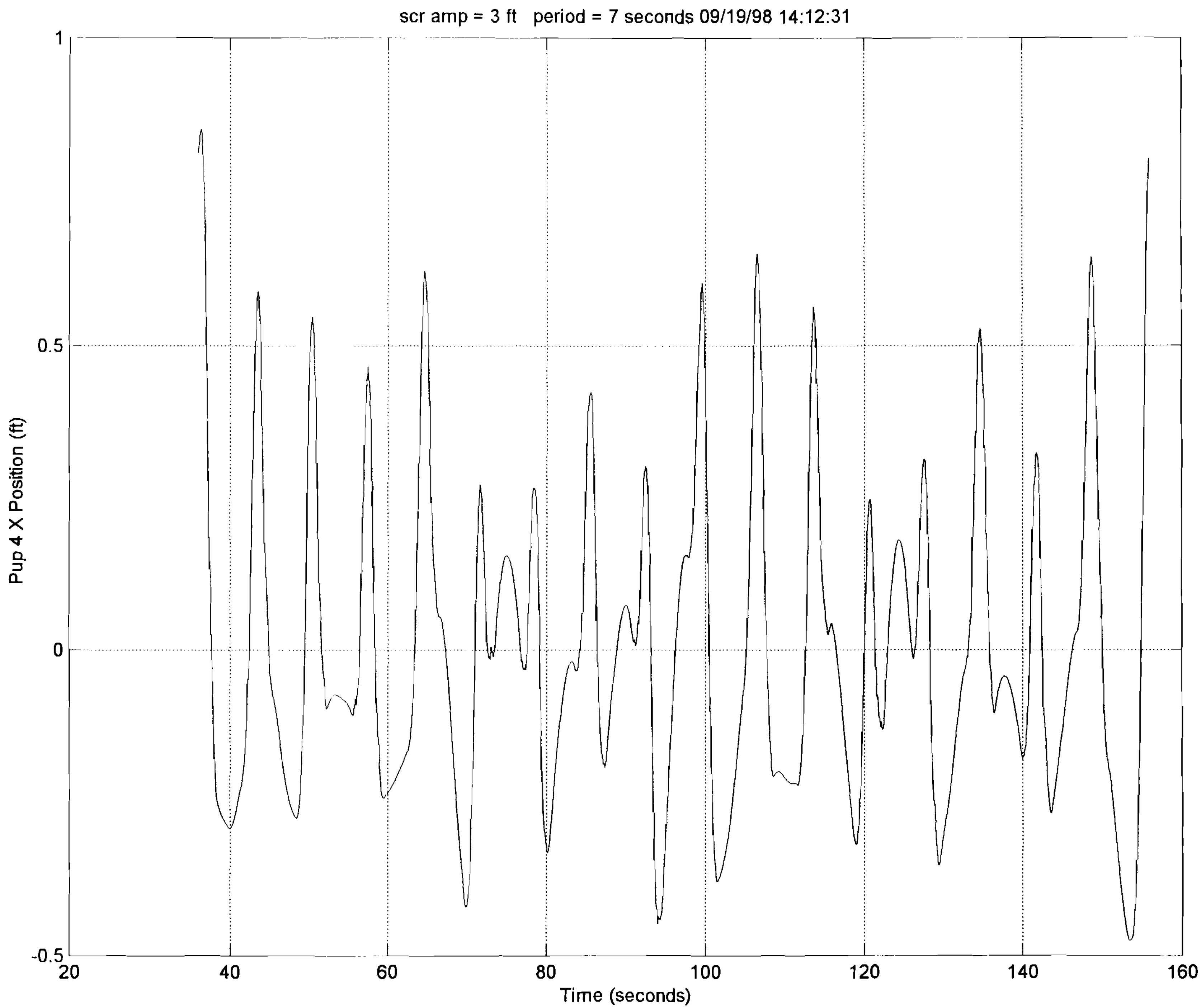

scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
Pup 2 X Position (ft)
5
4
3
2
1
0
-1
-2
-3
-4
-5
20
40
60
80
100
120
140
160
Time (seconds)

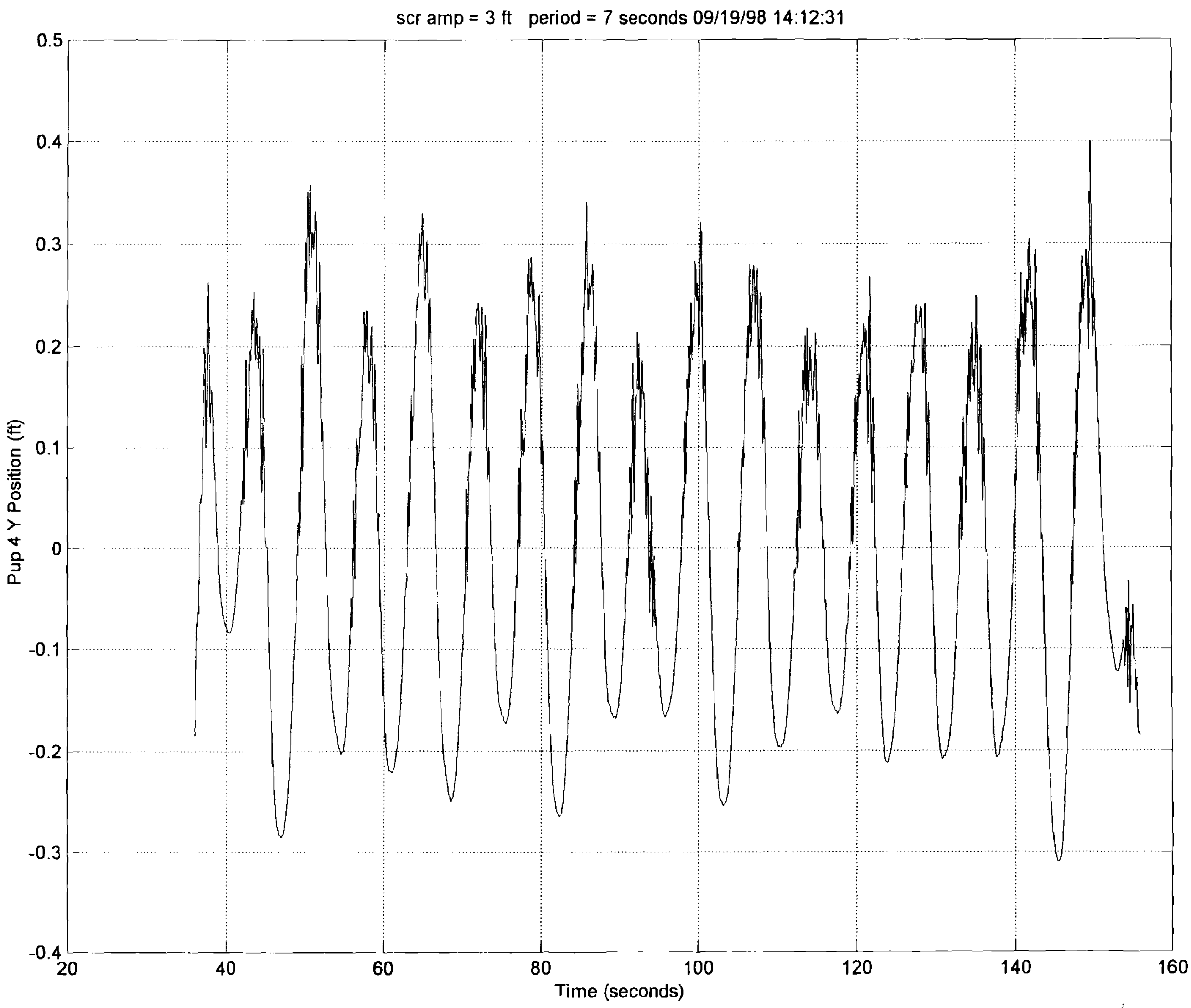


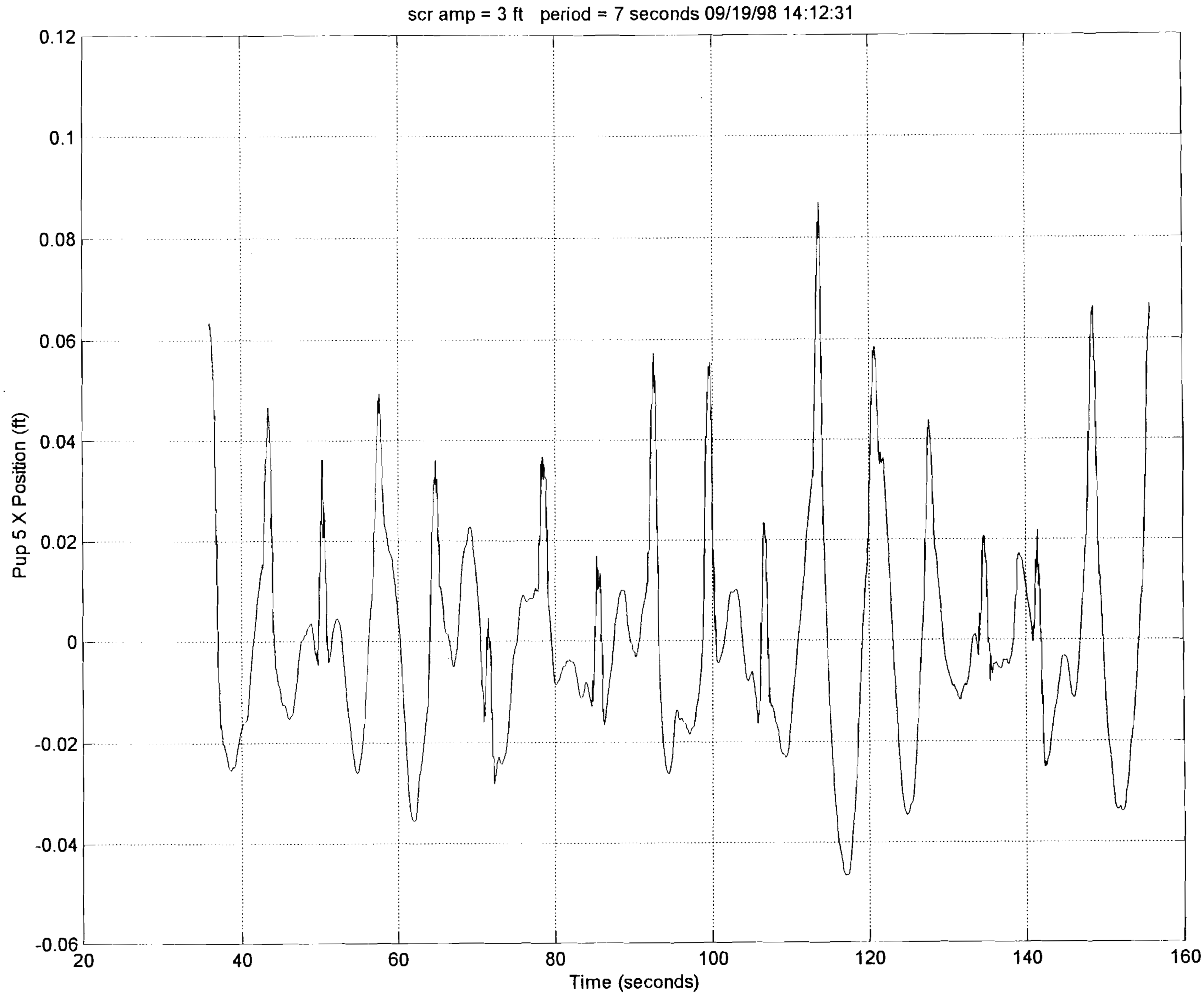
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 2 Y Position (ft)
0.5
0
-0.5
-1
20
40
60
80
100
120
140
160
Time (seconds)


scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
Pup 3 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
20
40
60
80
100
120
140
160

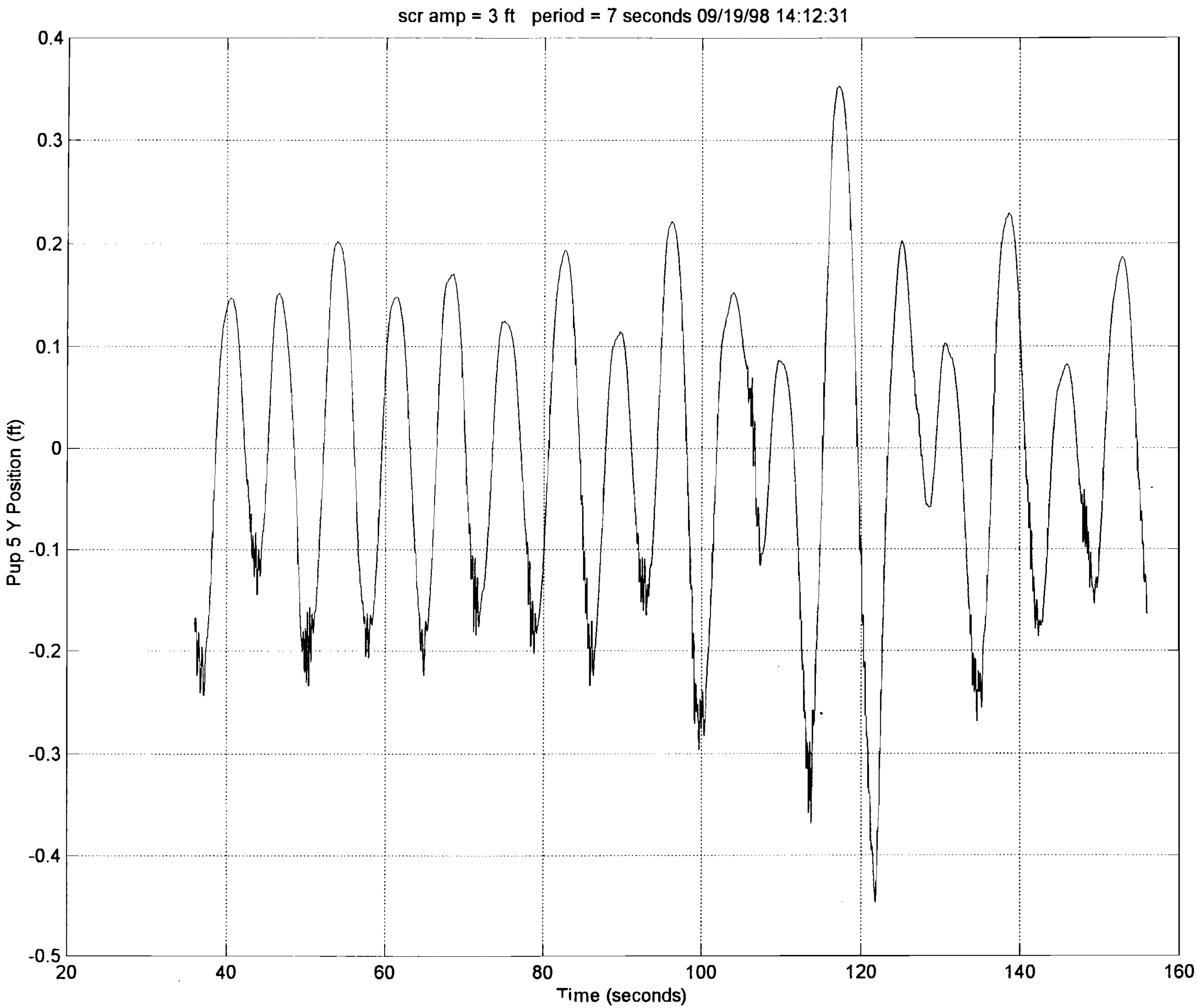

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 3 Y Position (ft)
Time (seconds)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
20
40
60
80
100
120
140
160


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 4 X Position (ft)
Time (seconds)
1
0.5
0
-0.5
20
40
60
80
100
120
140
160

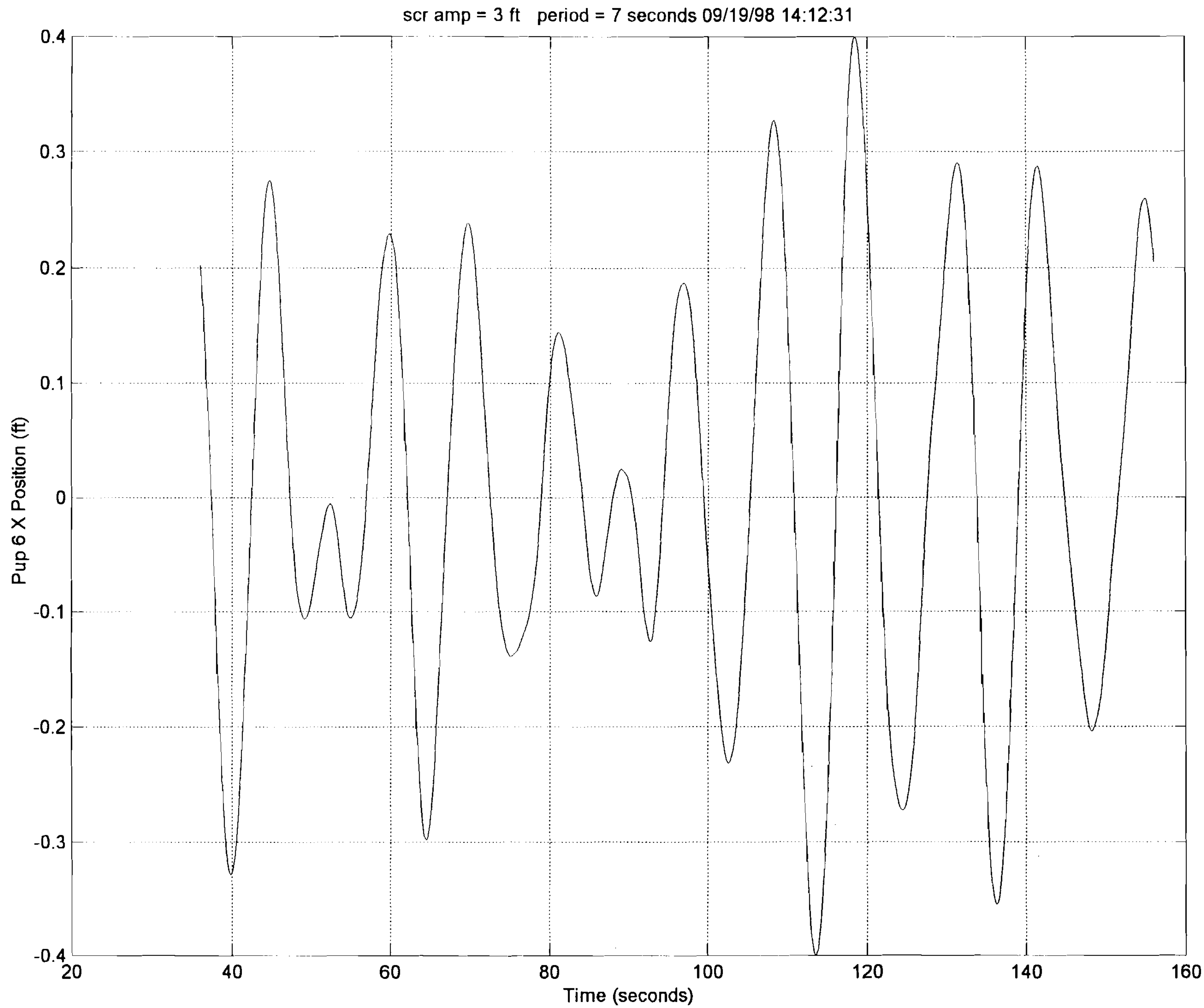

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 4 Y Position (ft)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
20
40
60
80
100
120
140
160
Time (seconds)

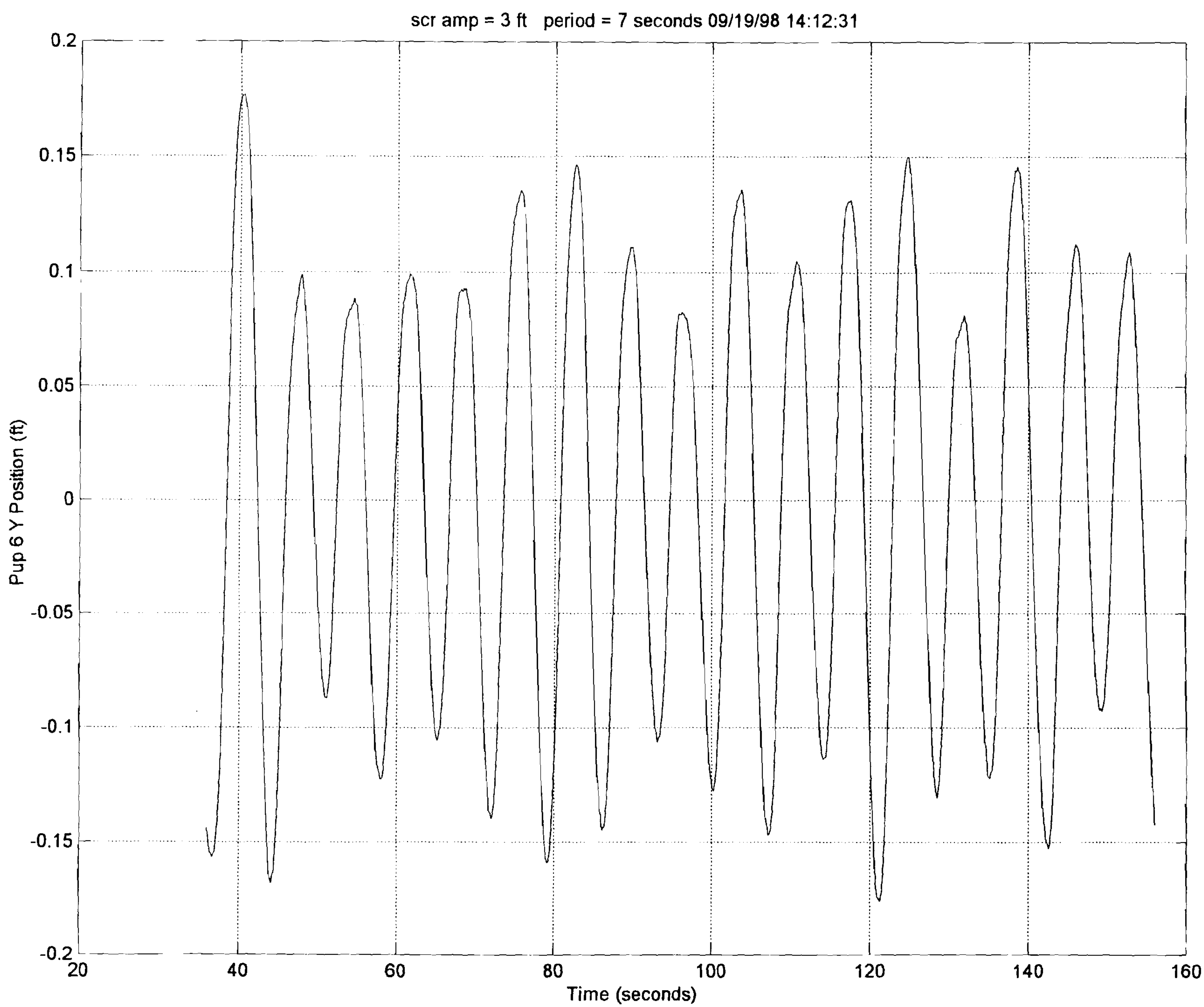


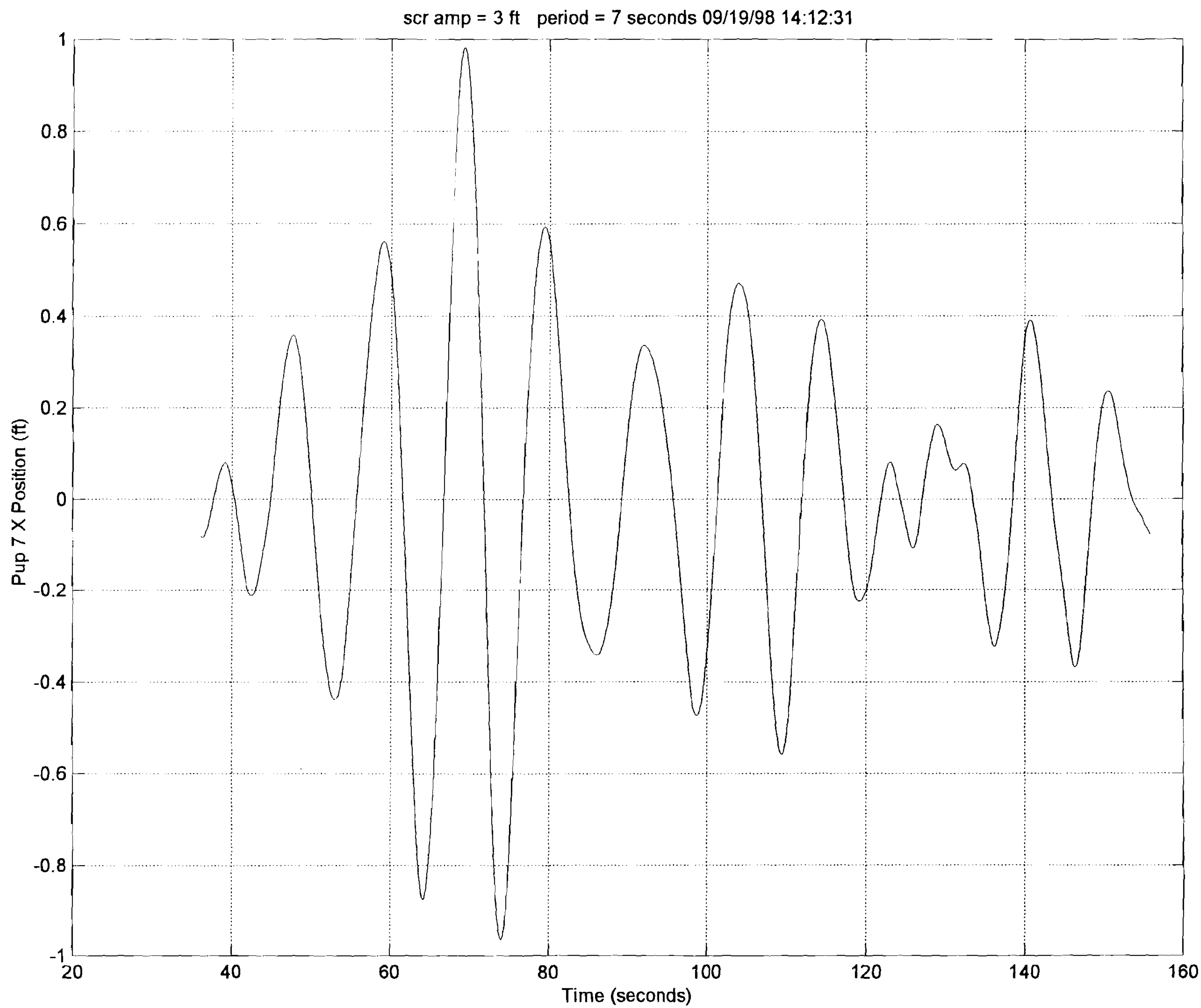
scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
Pup 5 X Position (ft)
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
20
40
60
80
100
120
140
160
Time (seconds)



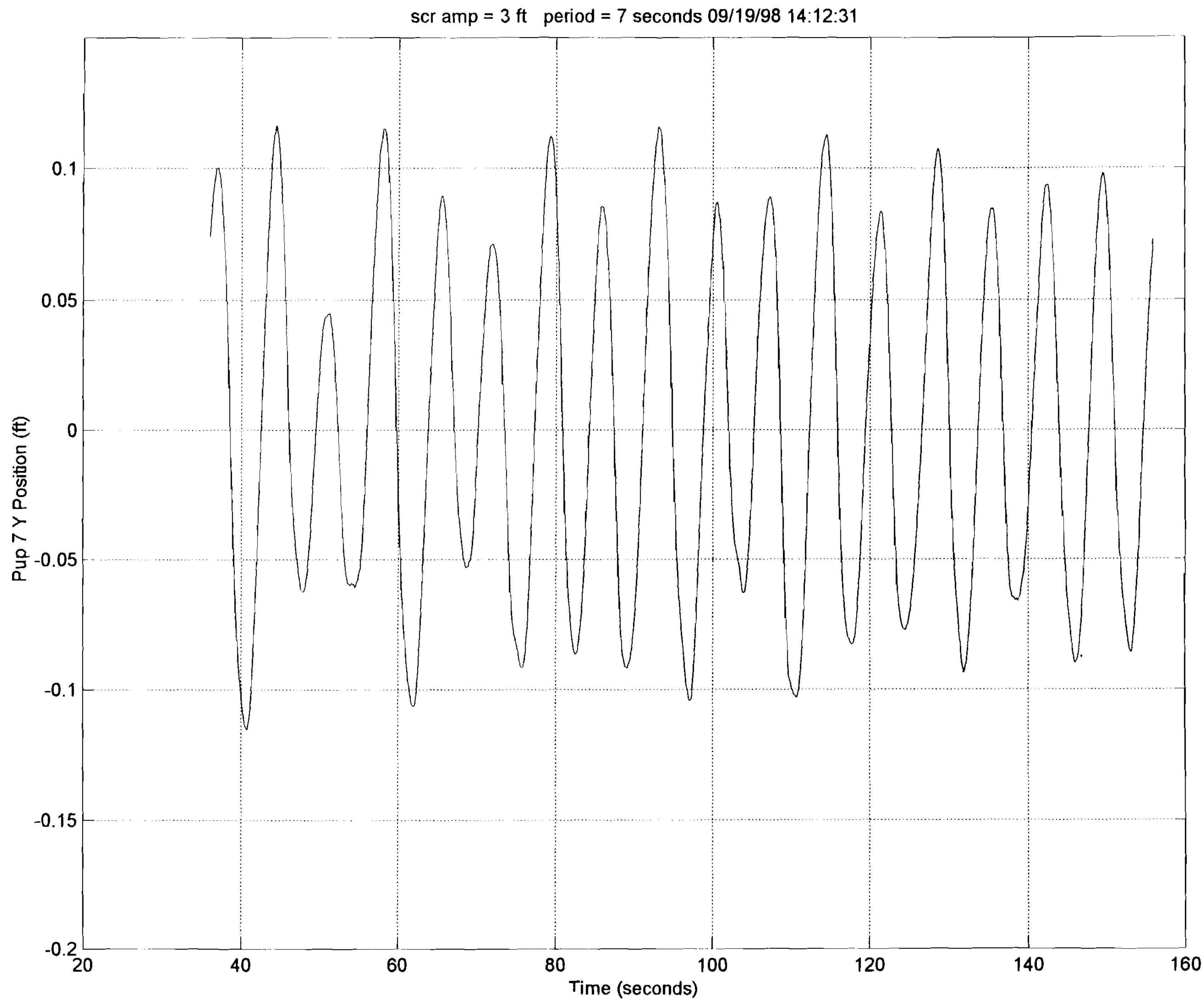
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 5 Y Position (ft)
Time (seconds)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
20
40
60
80
100
120
140
160

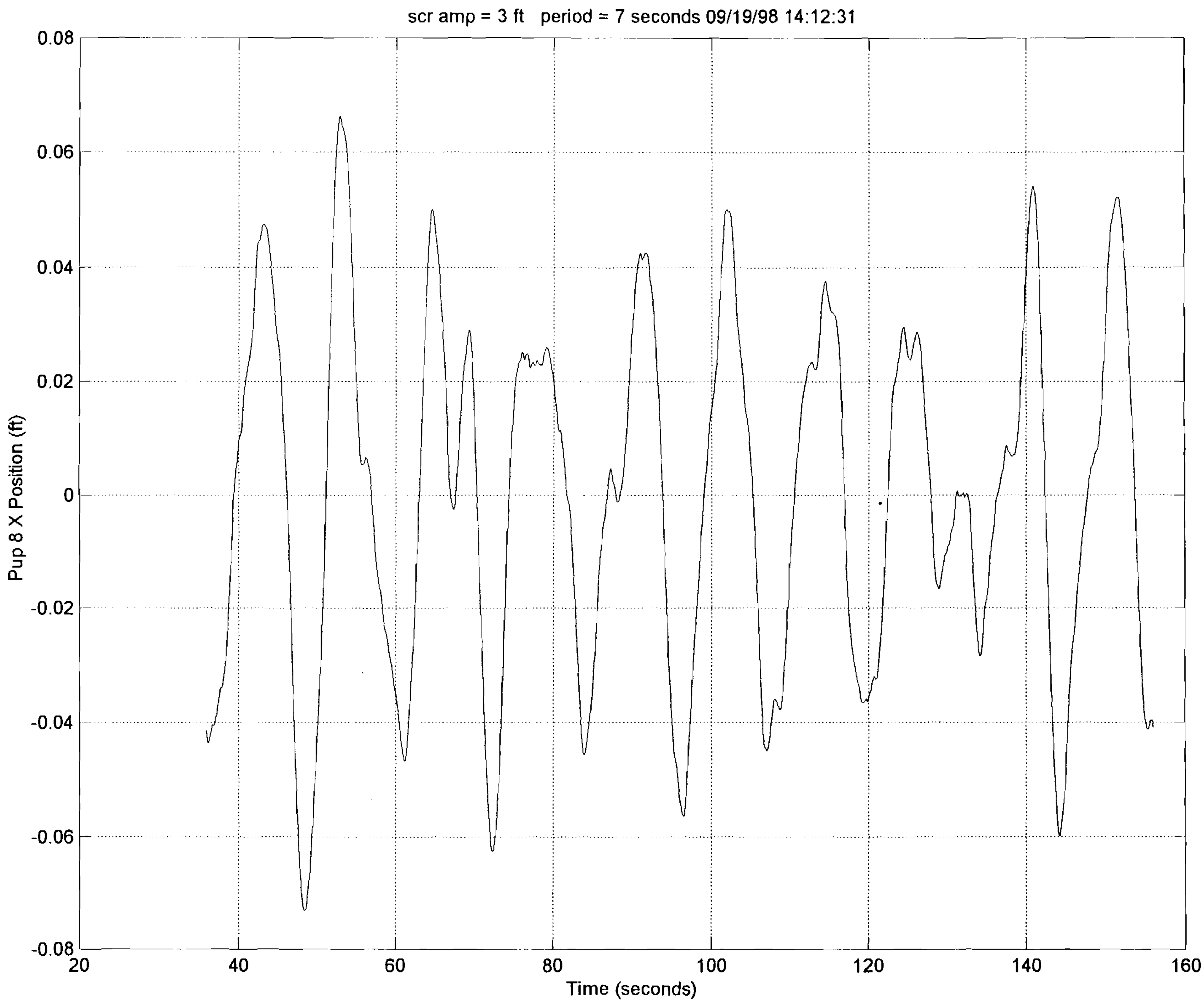

scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
Pup 6 X Position (ft)
Time (seconds)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
20
40
60
80
100
120
140
160

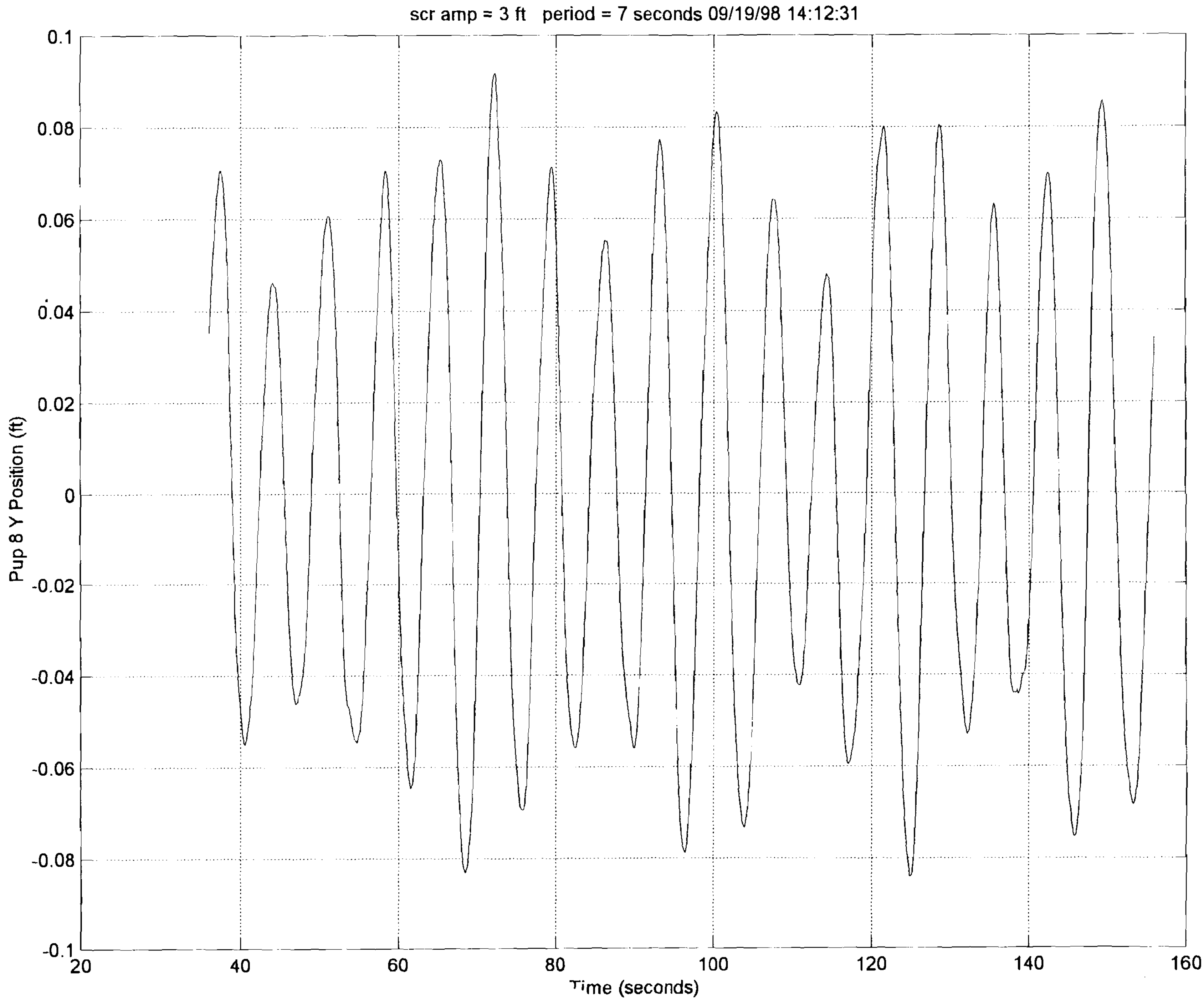

scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 6 Y Position (ft)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
20
40
60
80
100
120
140
160
Time (seconds)



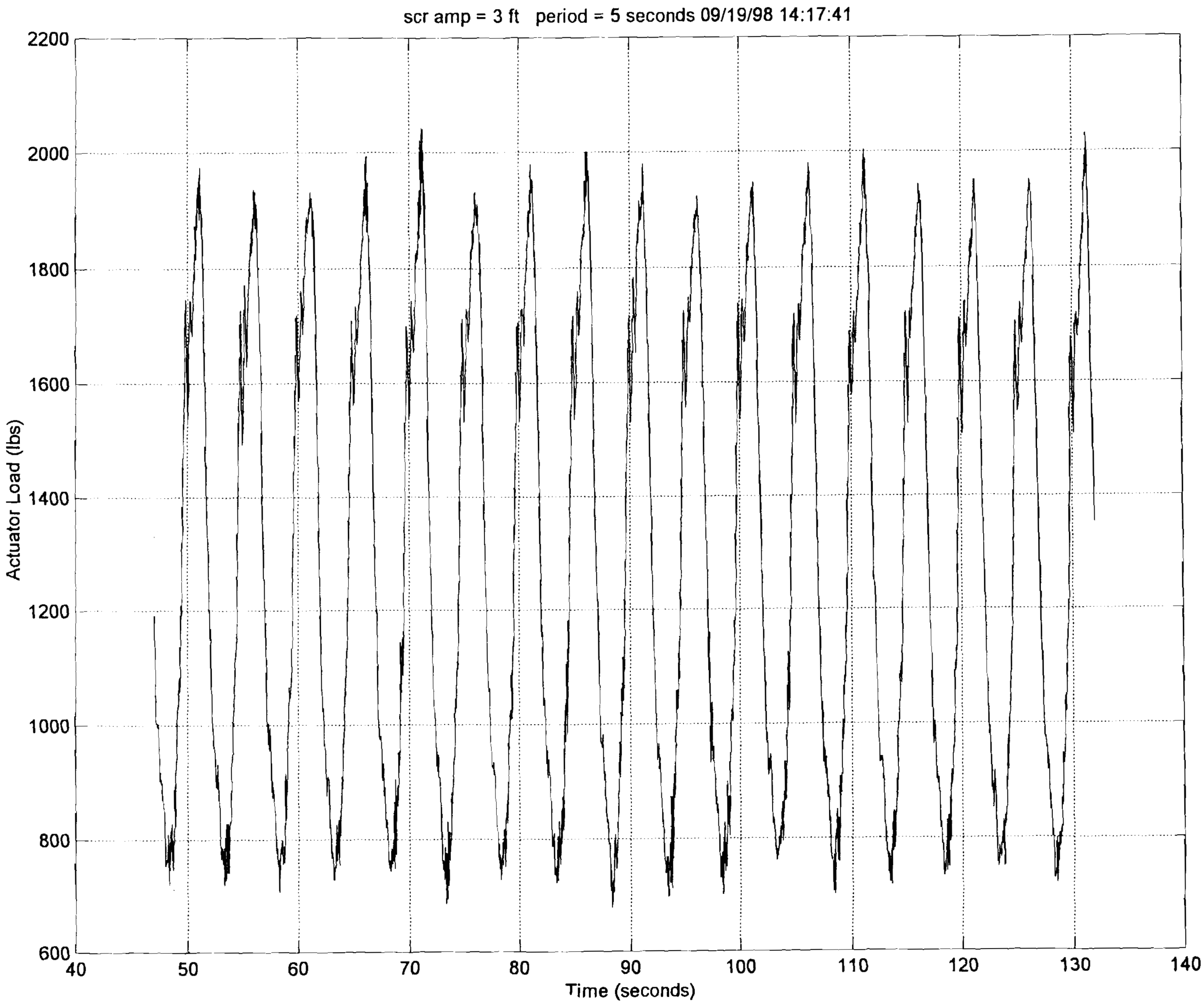
scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 7 X Position (ft)
Time (seconds)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
20
40
60
80
100
120
140
160


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 7 Y Position (ft)
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
20
40
60
80
100
120
140
160
Time (seconds)

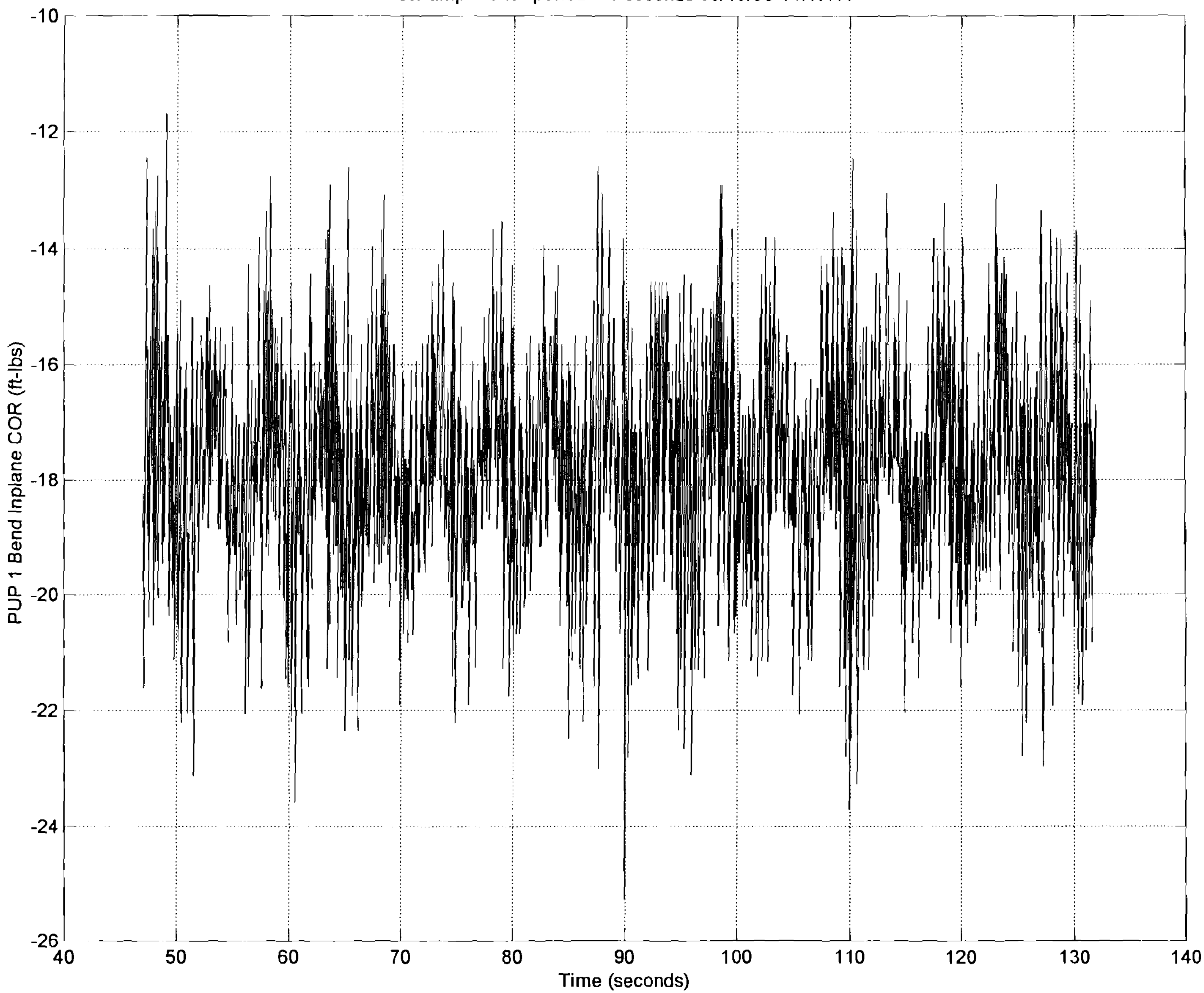

scr amp = 3 ft   period = 7 seconds 09/19/98 14:12:31
Pup 8 X Position (ft)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
20
40
60
80
100
120
140
160
Time (seconds)

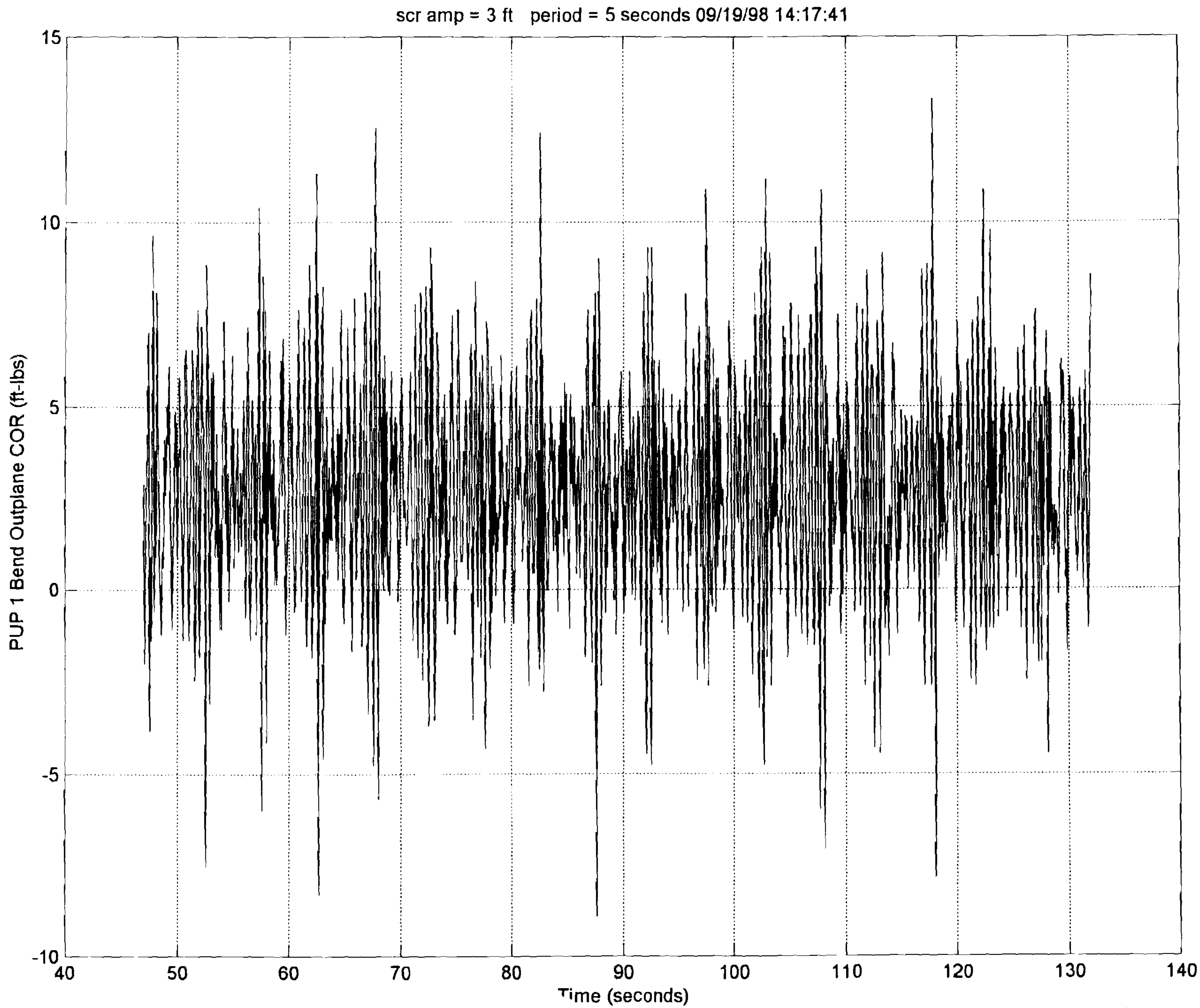


scr amp = 3 ft period = 7 seconds 09/19/98 14:12:31
Pup 8 Y Position (ft)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
20
40
60
80
100
120
140
160
Time (seconds)

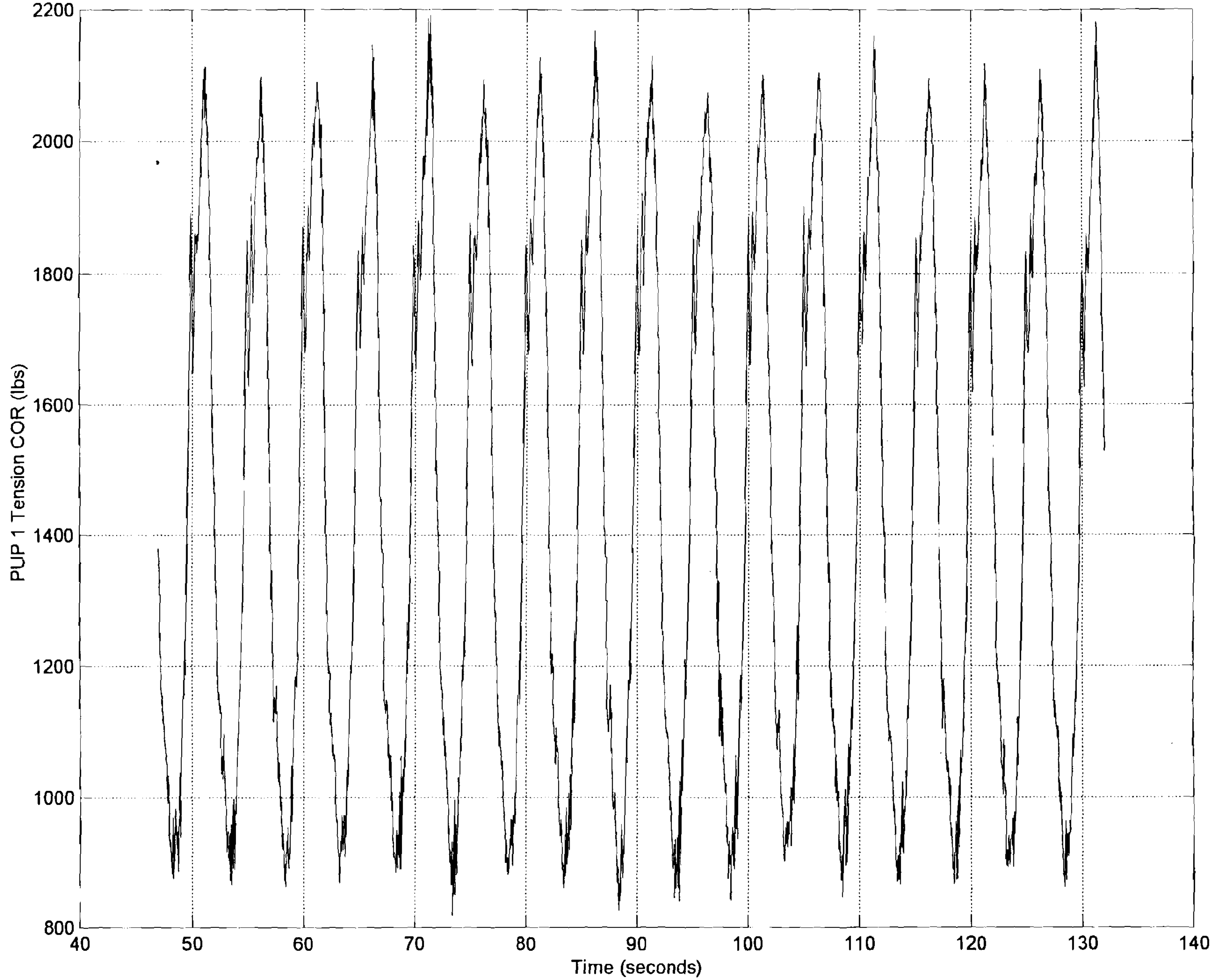

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Actuator Load (lbs)
2200
2000
1800
1600
1400
1200
1000
800
600
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

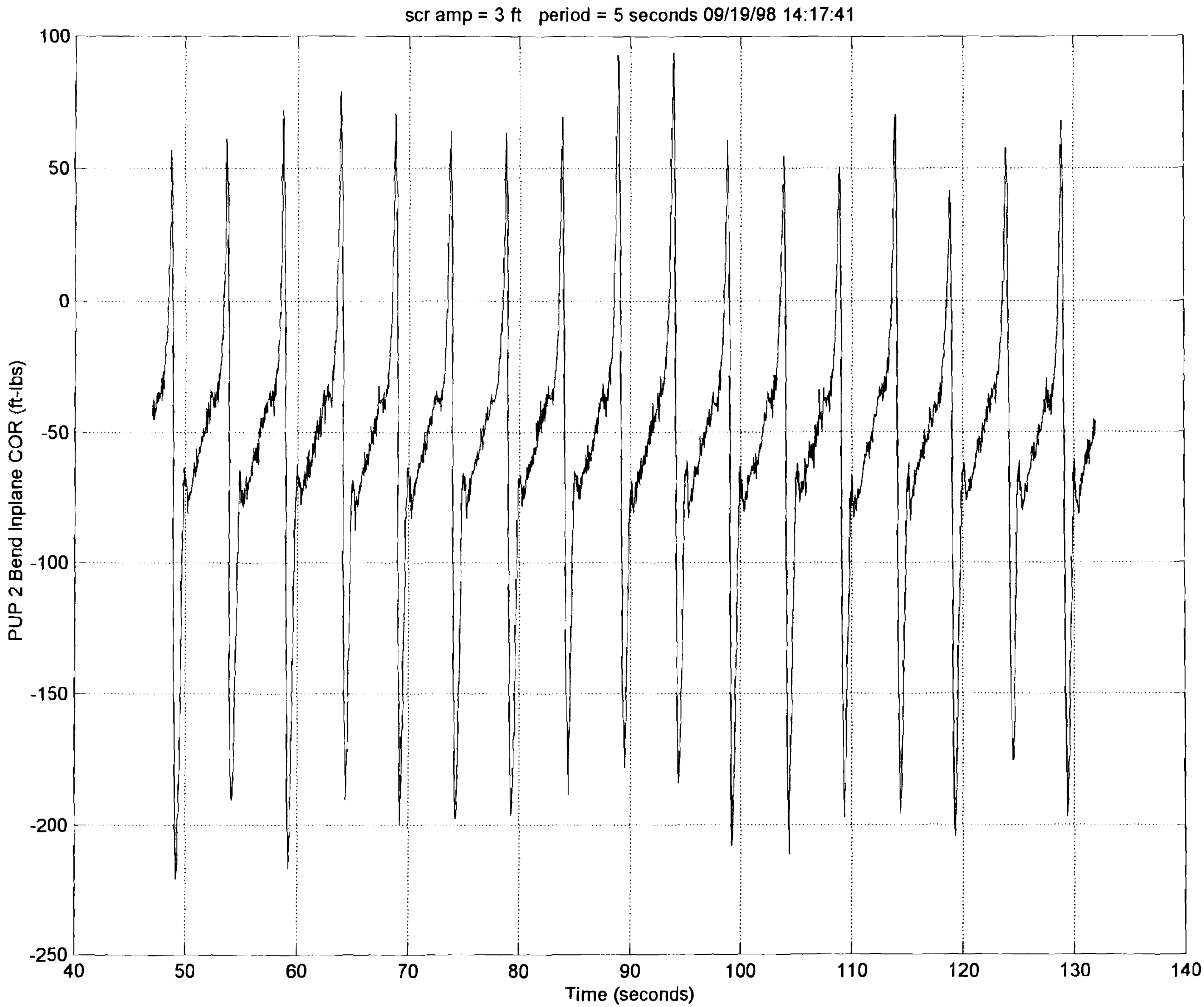
scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41

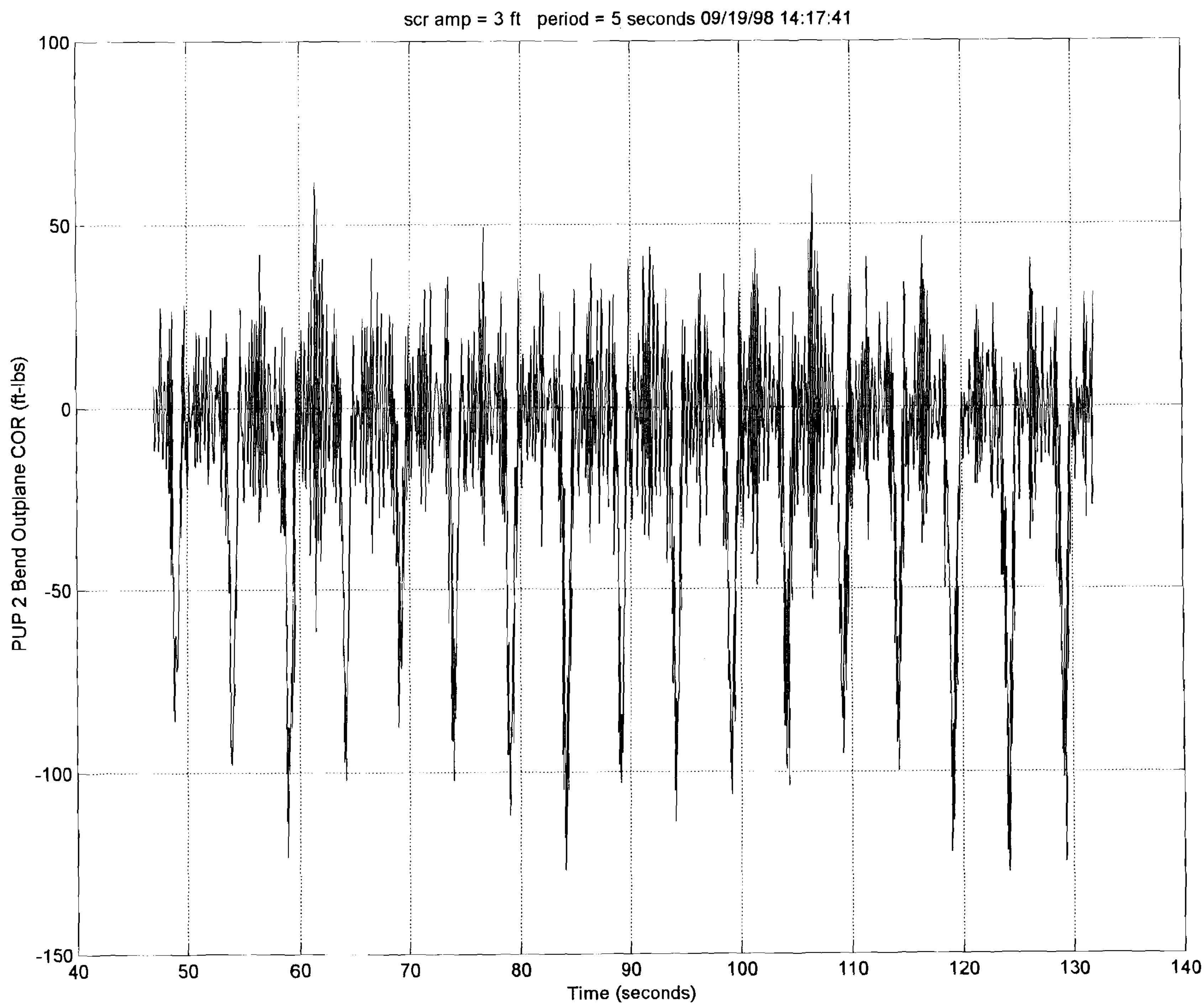



scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 1 Bend Outplane COR (ft-lbs)
Time (seconds)
15
10
5
0
-5
-10
40
50
60
70
80
90
100
110
120
130
140

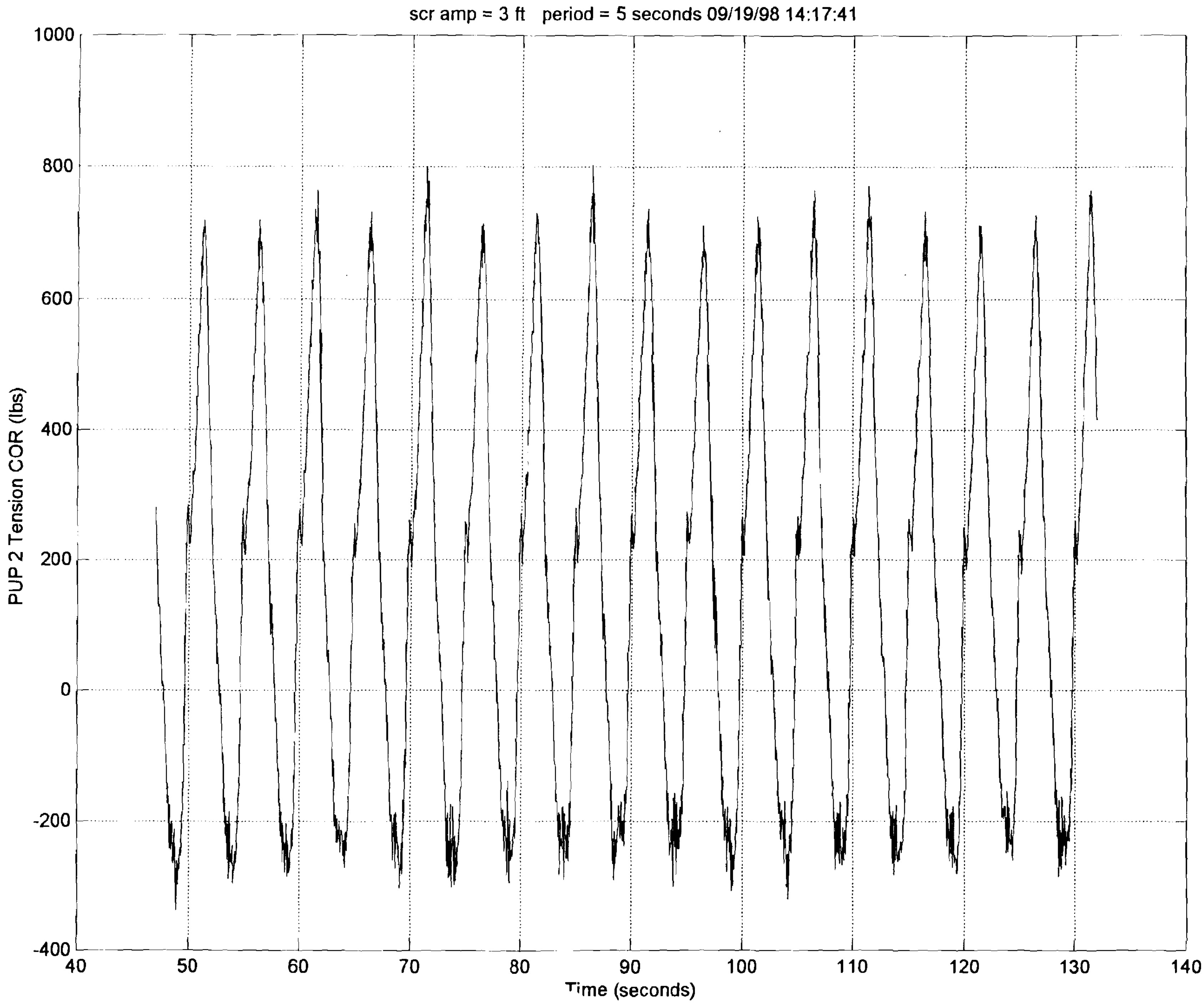
scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41




scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
PUP 2 Bend Inplane COR (ft-lbs)
100
50
0
-50
-100
-150
-200
-250
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

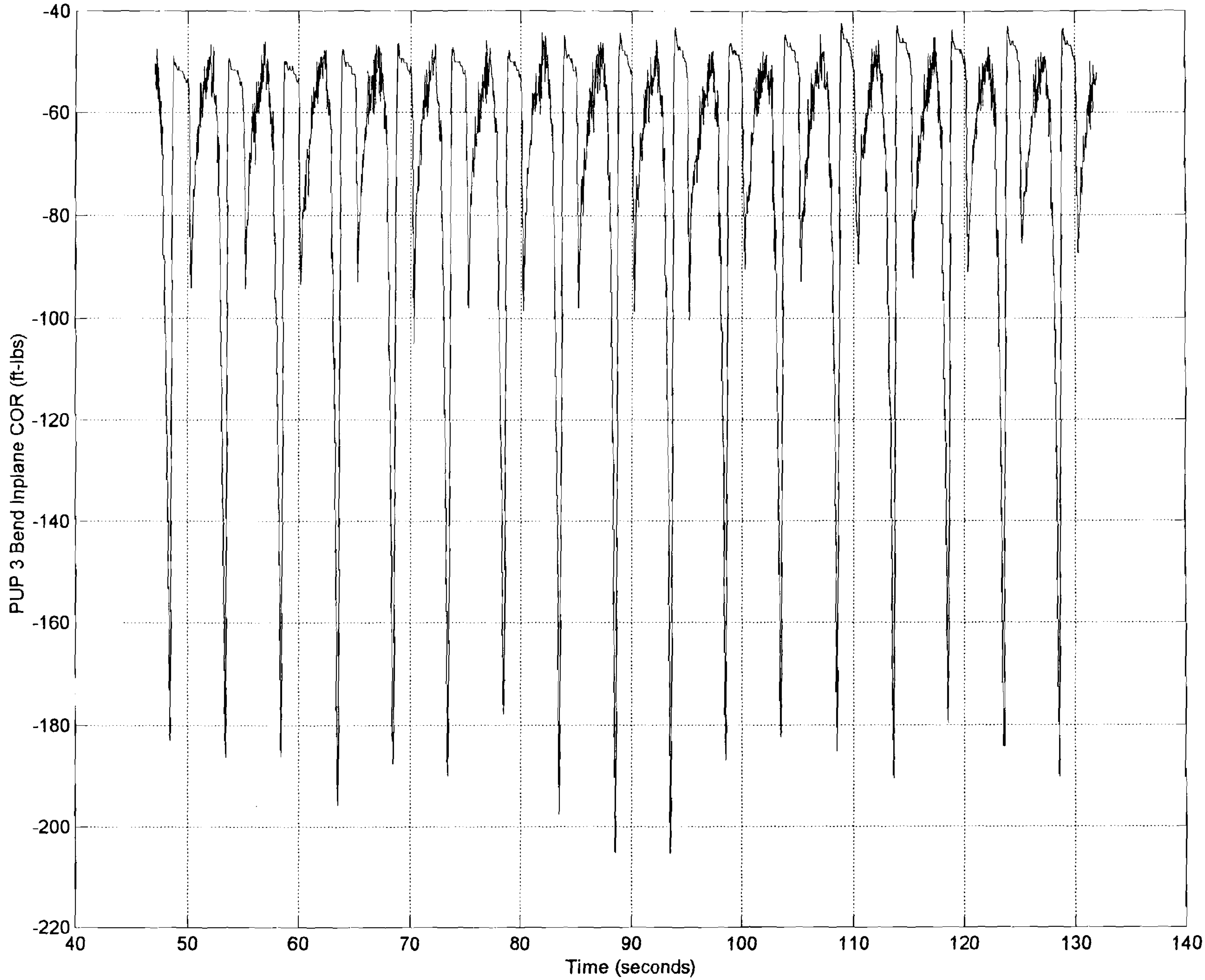


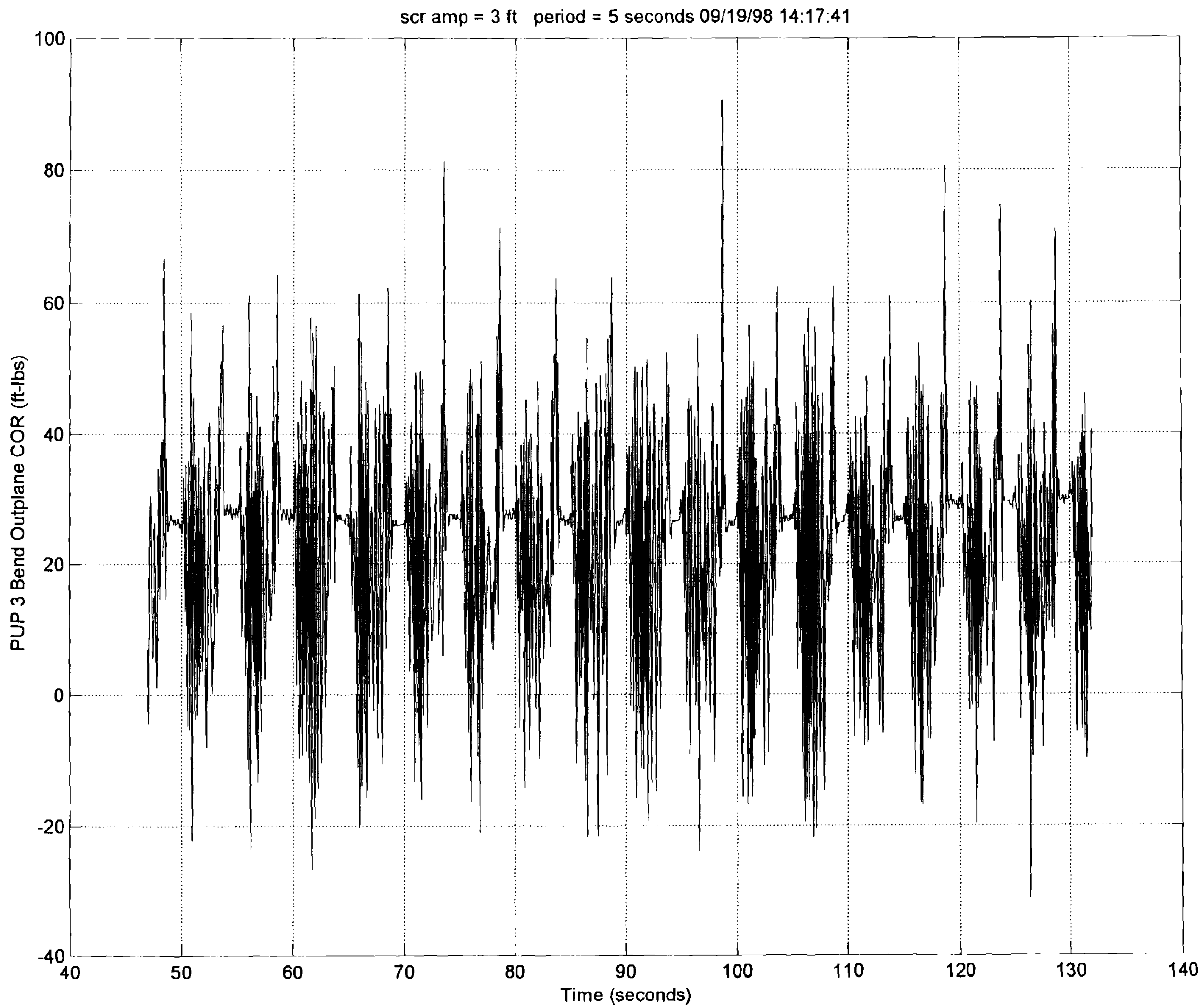
scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 2 Bend Outplane COR (ft-lbs)
100
50
0
-50
-100
-150
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

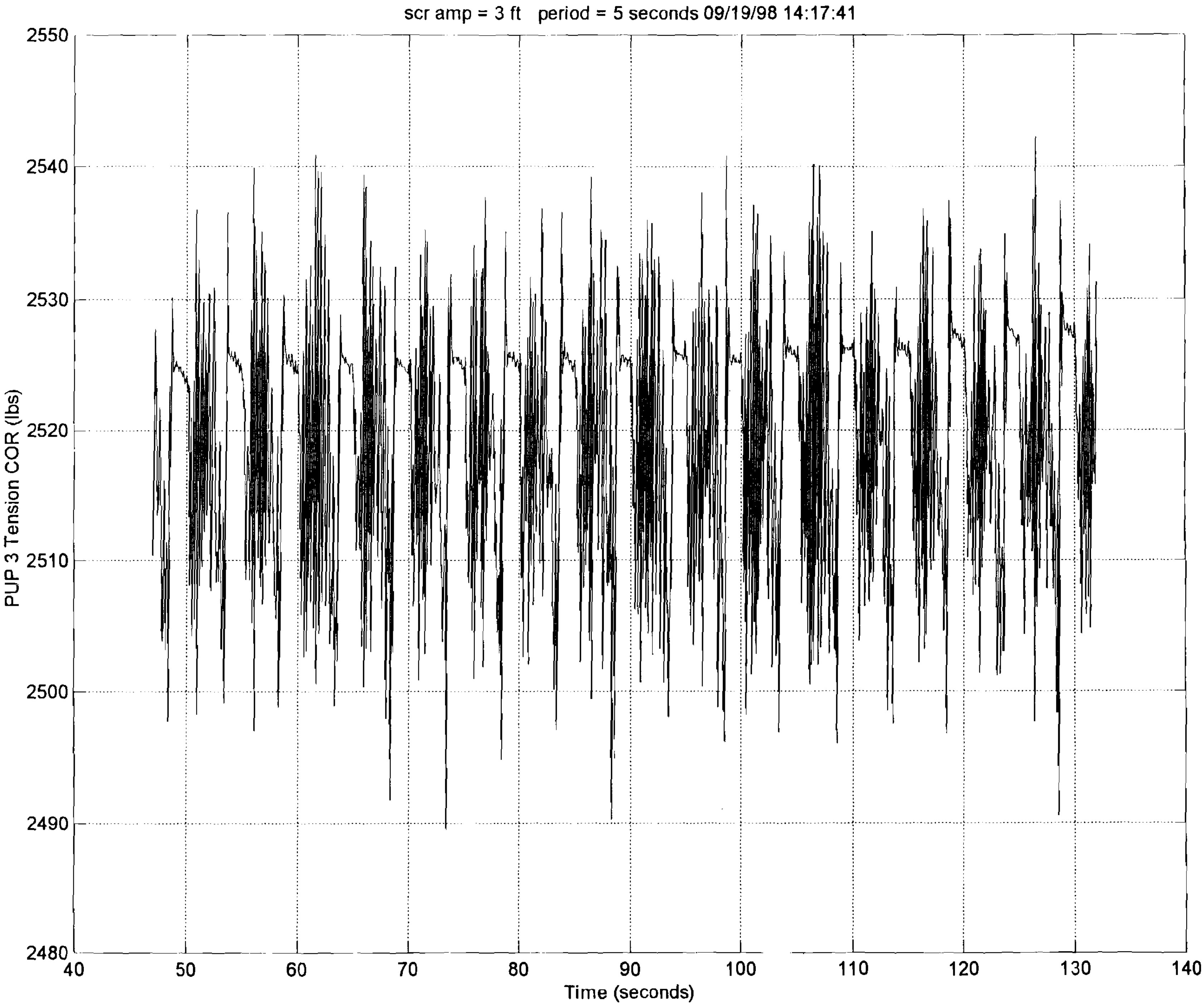


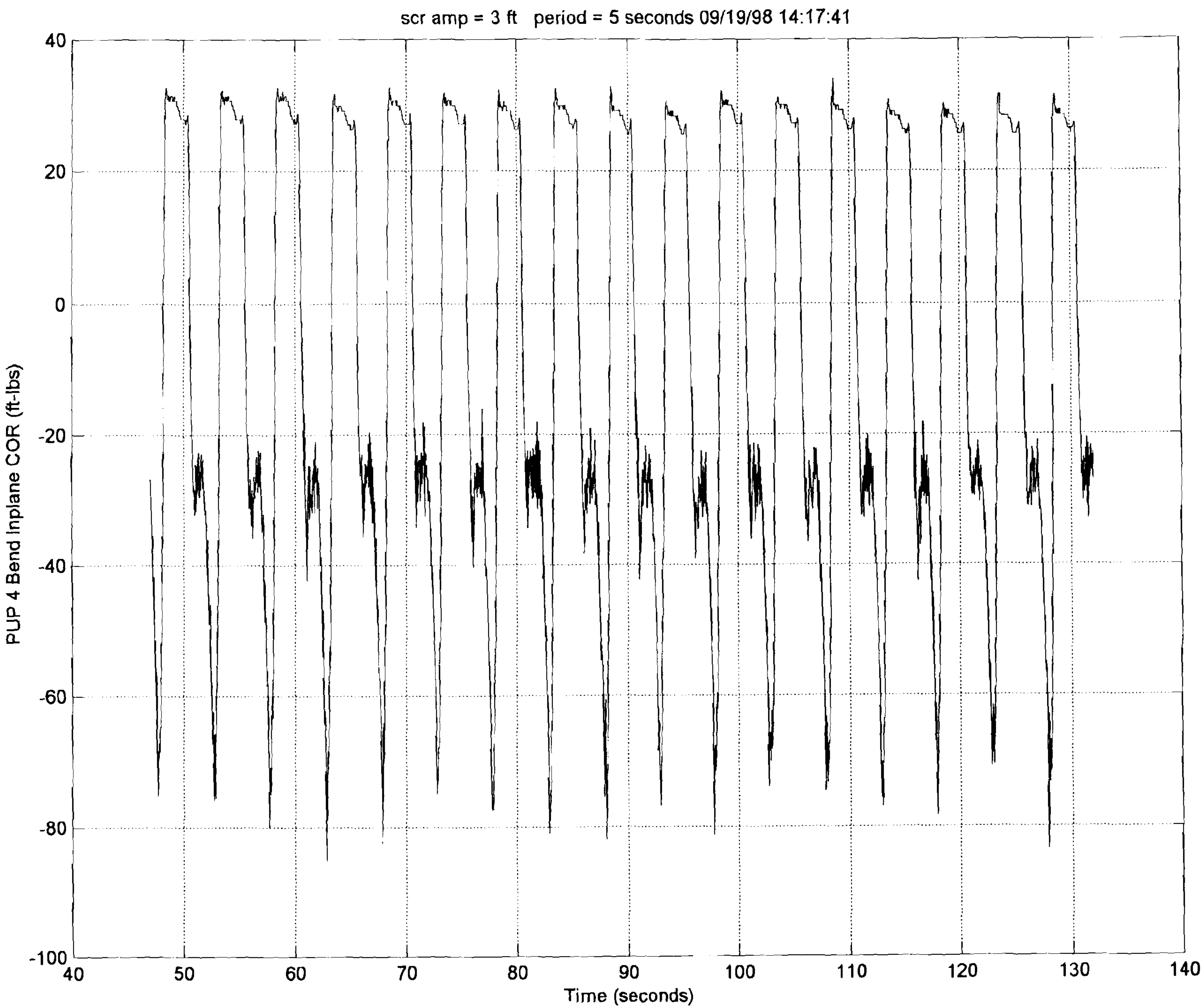
scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 2 Tension COR (lbs)
1000
800
600
400
200
0
-200
-400
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

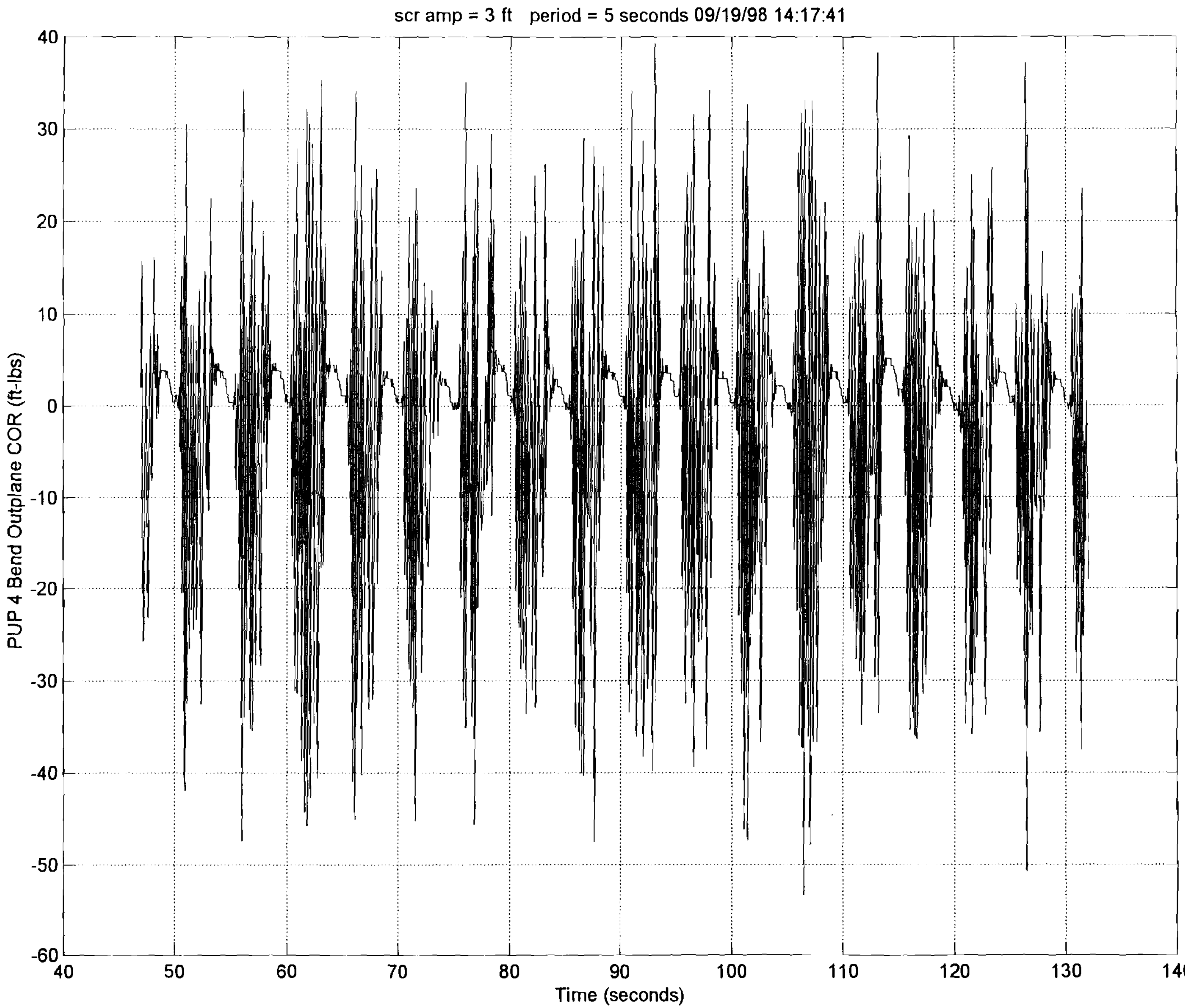
scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41



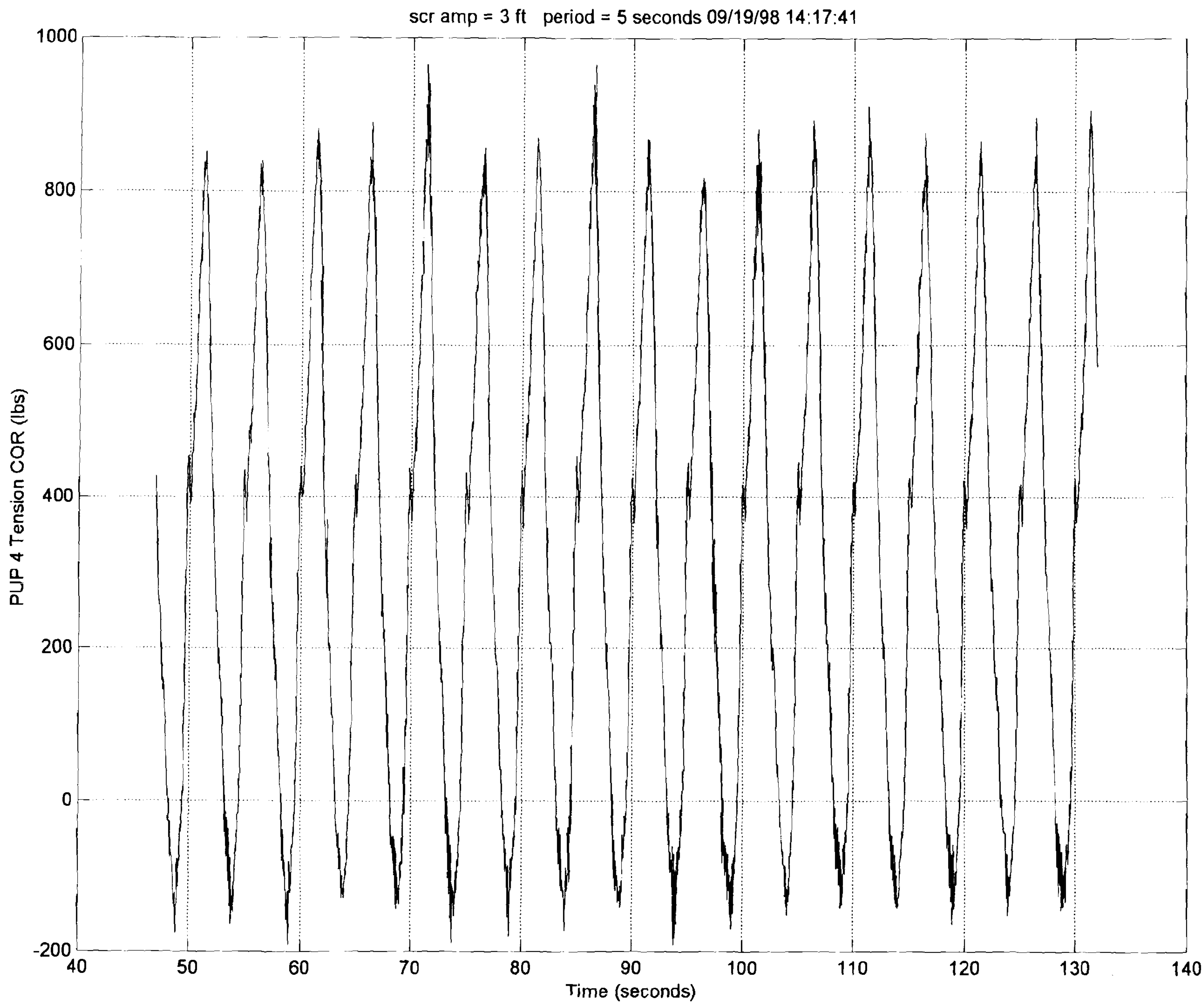

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 3 Bend Outplane COR (ft-lbs)
Time (seconds)
100
80
60
40
20
0
-20
-40
40
50
60
70
80
90
100
110
120
130
140

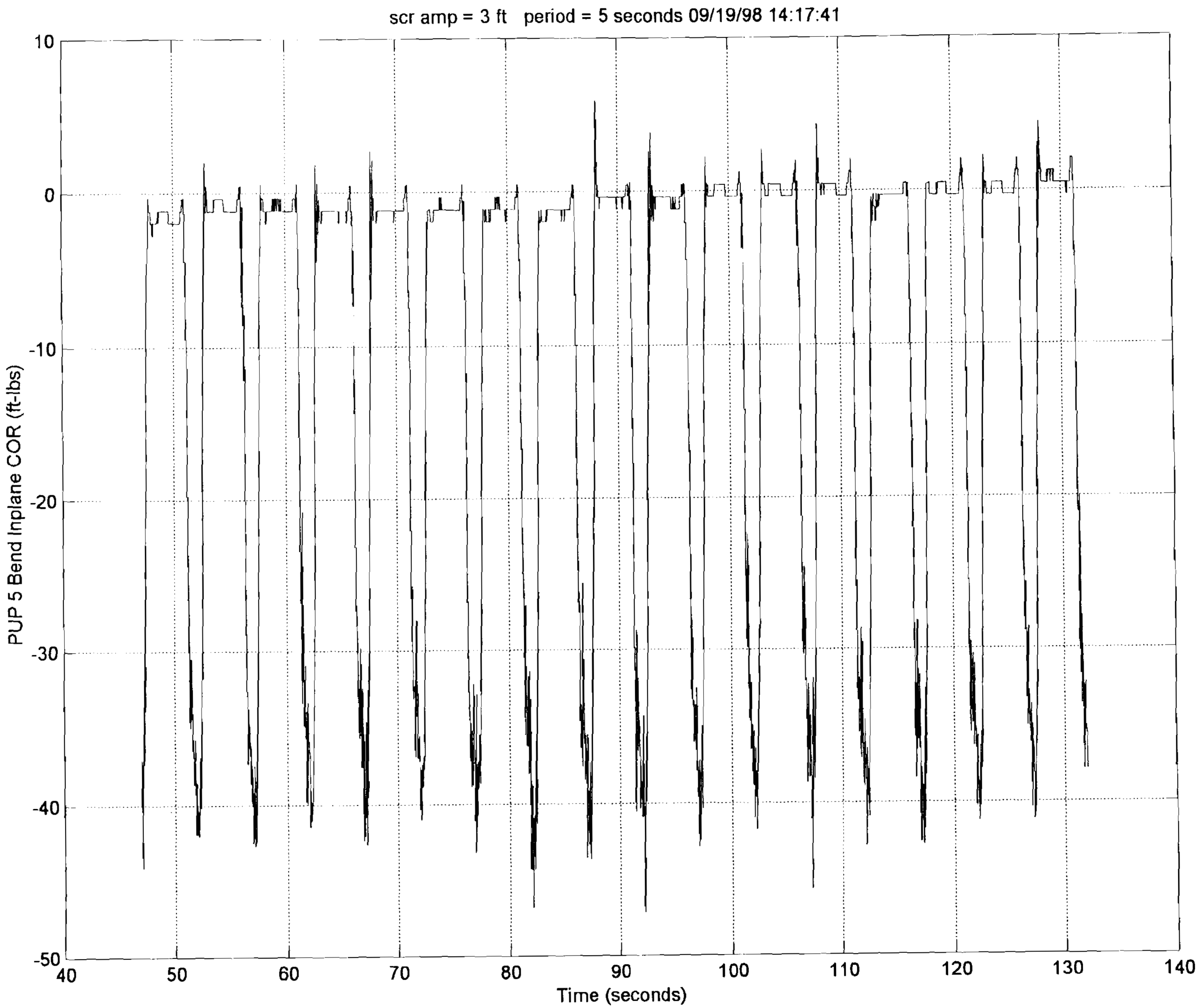

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
PUP 3 Tension COR (lbs)
2550
2540
2530
2520
2510
2500
2490
2480
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

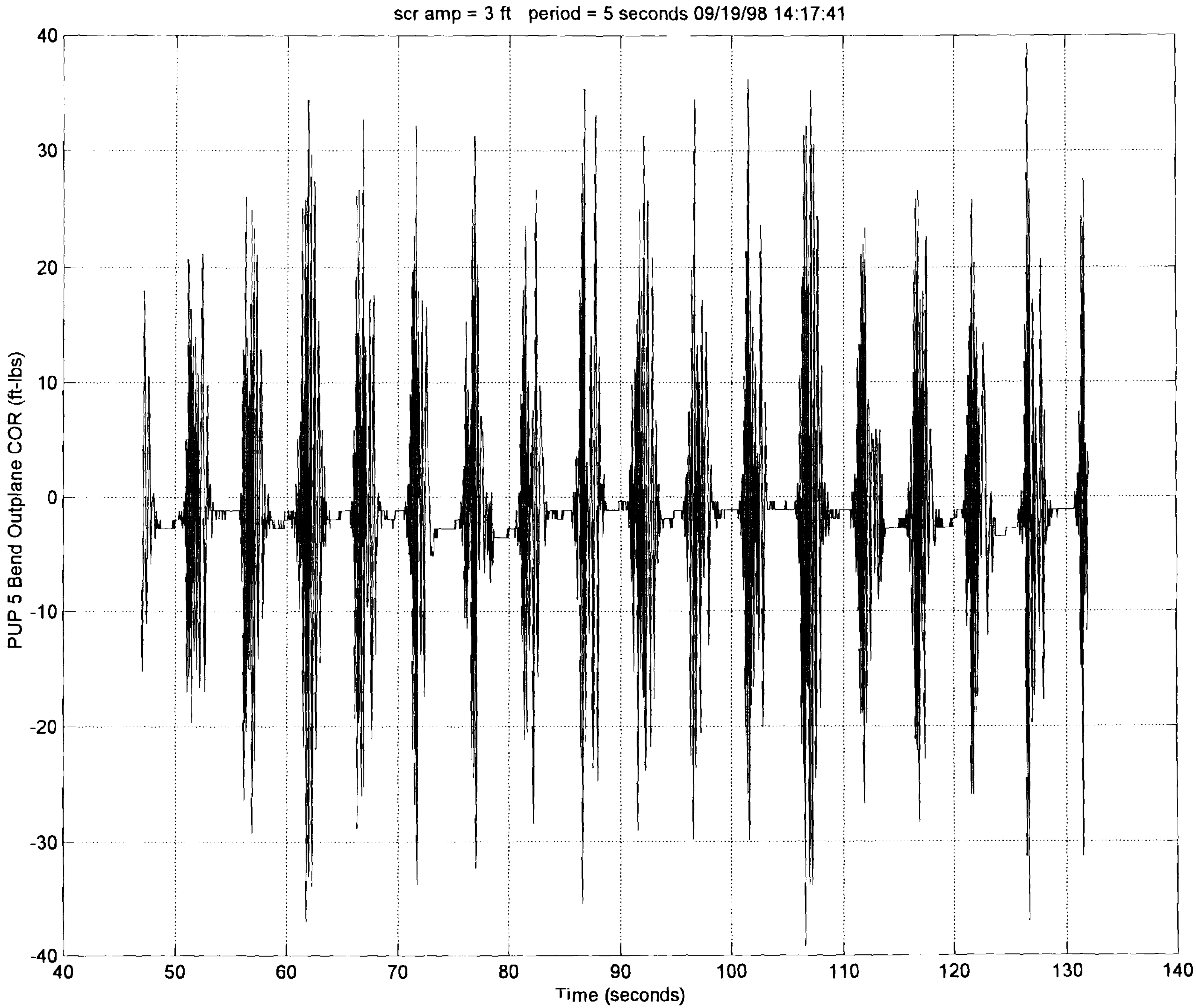

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
PUP 4 Bend Inplane COR (ft-lbs)
Time (seconds)
40
20
0
-20
-40
-60
-80
-100
40
50
60
70
80
90
100
110
120
130
140

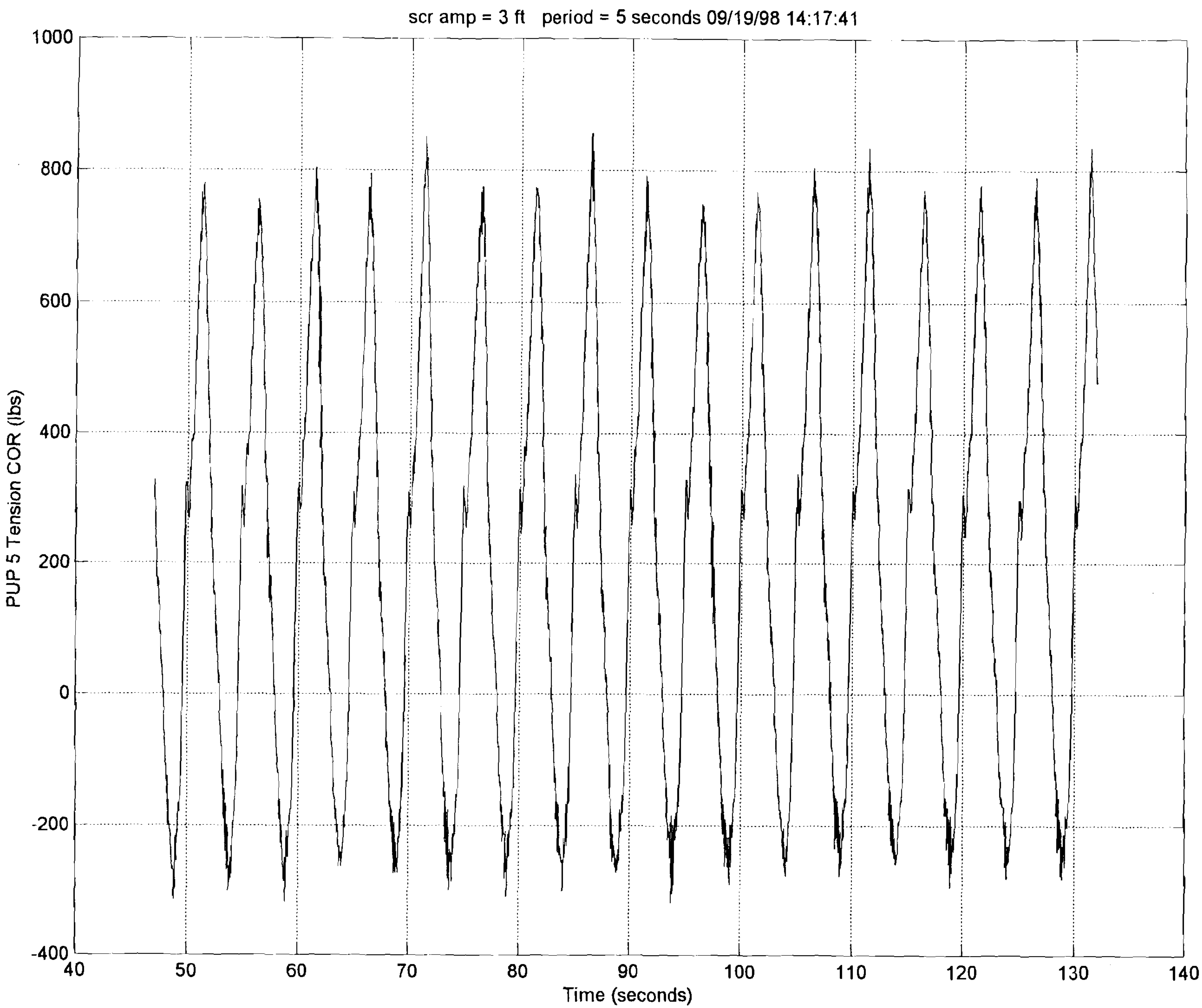


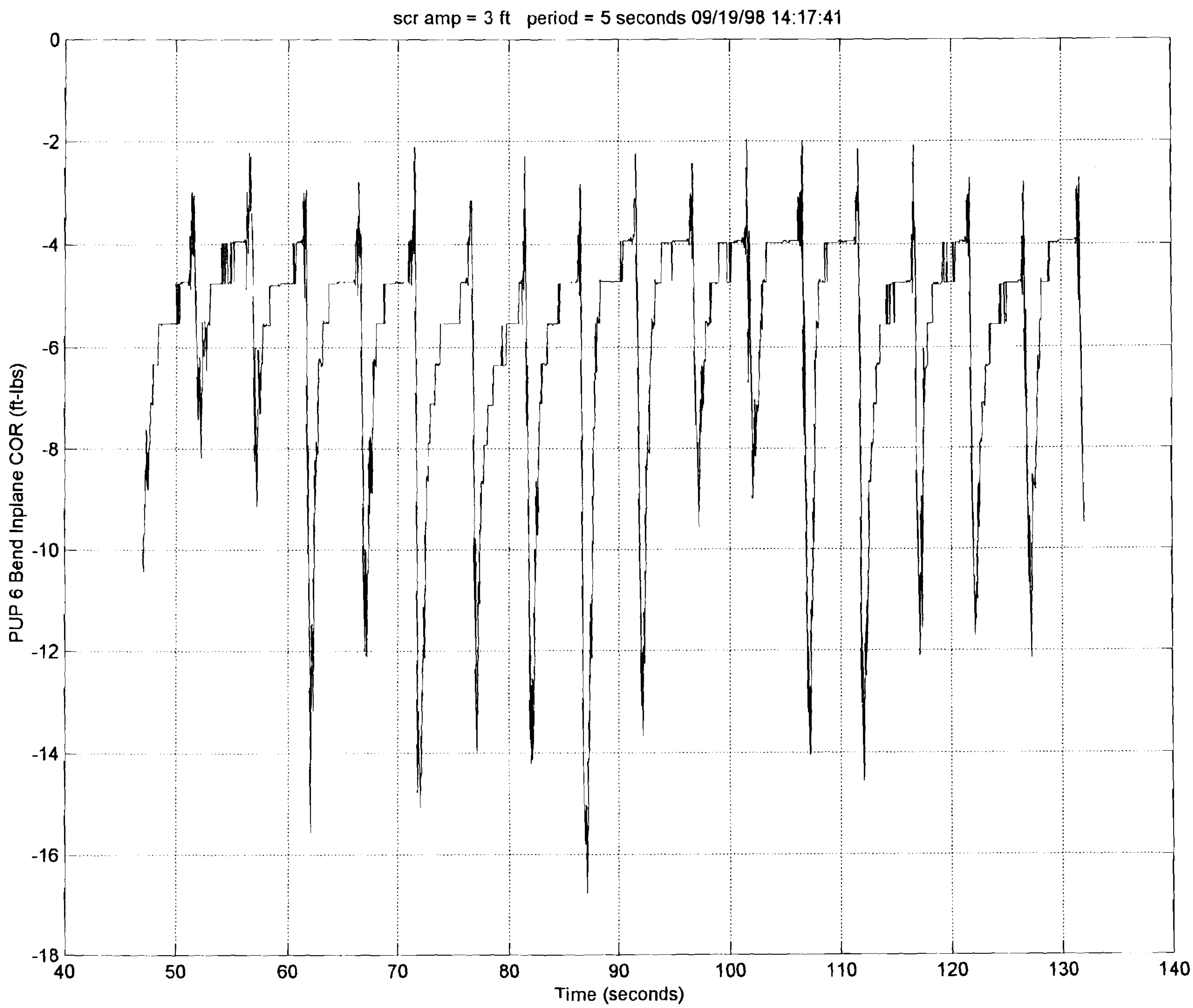
scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 4 Bend Outplane COR (ft-lbs)
Time (seconds)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
40
50
60
70
80
90
100
110
120
130
140

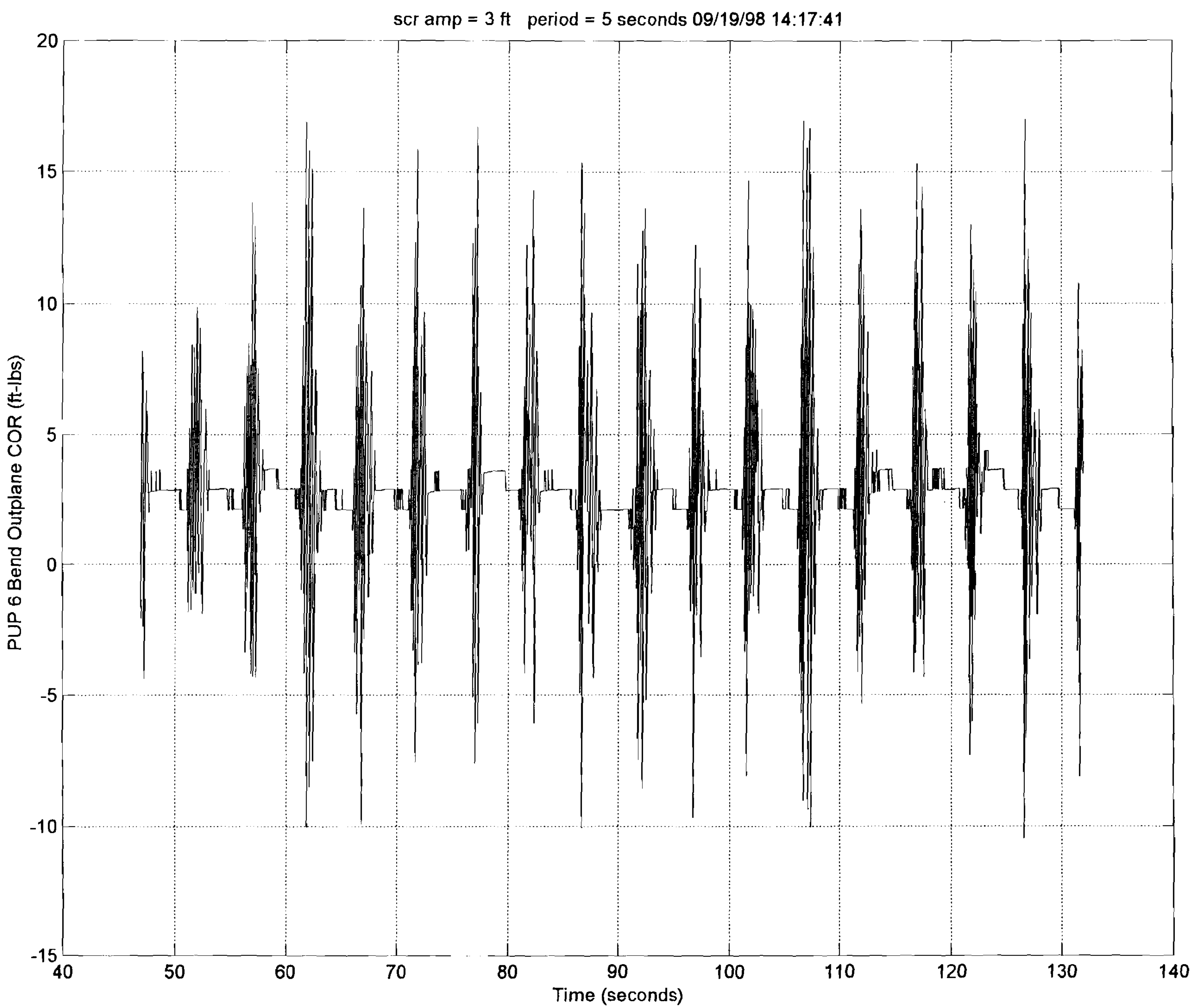

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 4 Tension COR (lbs)
Time (seconds)
1000
800
600
400
200
0
-200
40
50
60
70
80
90
100
110
120
130
140


scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 5 Bend Inplane COR (ft-lbs)
Time (seconds)
10
0
-10
-20
-30
-40
-50
40
50
60
70
80
90
100
110
120
130
140

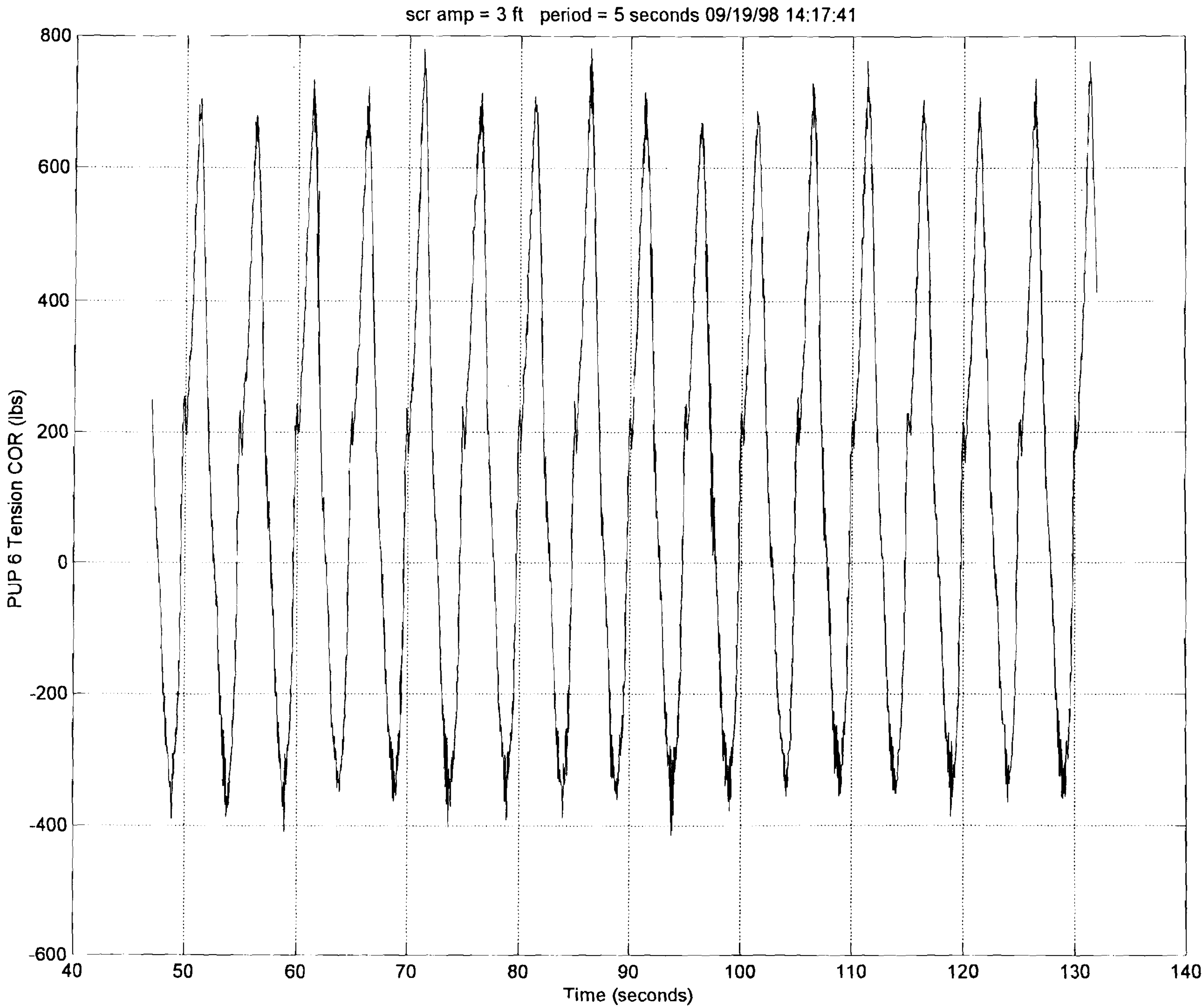

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 5 Bend Outplane COR (ft-lbs)
Time (seconds)
40
30
20
10
0
-10
-20
-30
-40
40
50
60
70
80
90
100
110
120
130
140

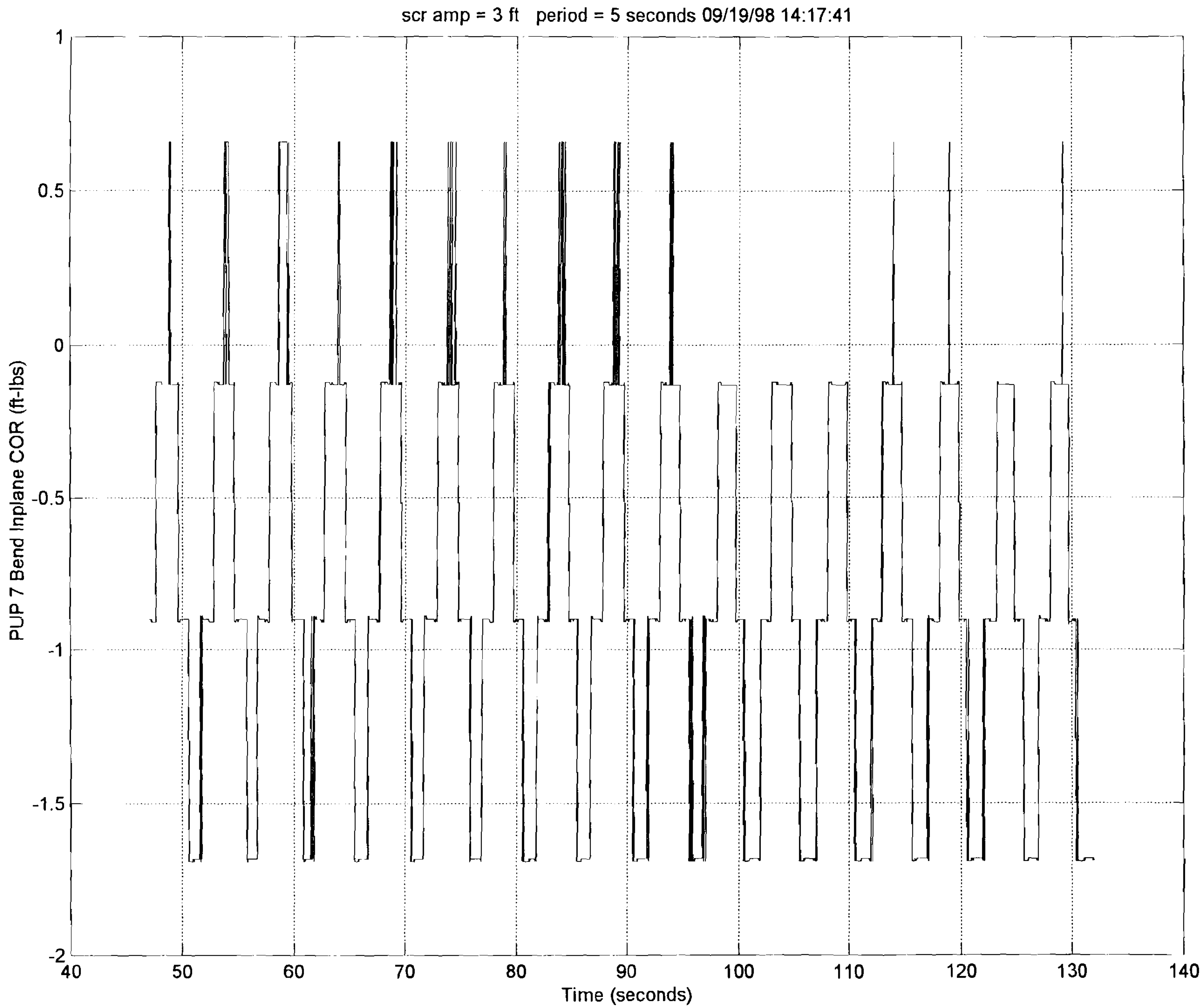

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
PUP 5 Tension COR (lbs)
1000
800
600
400
200
0
-200
-400
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

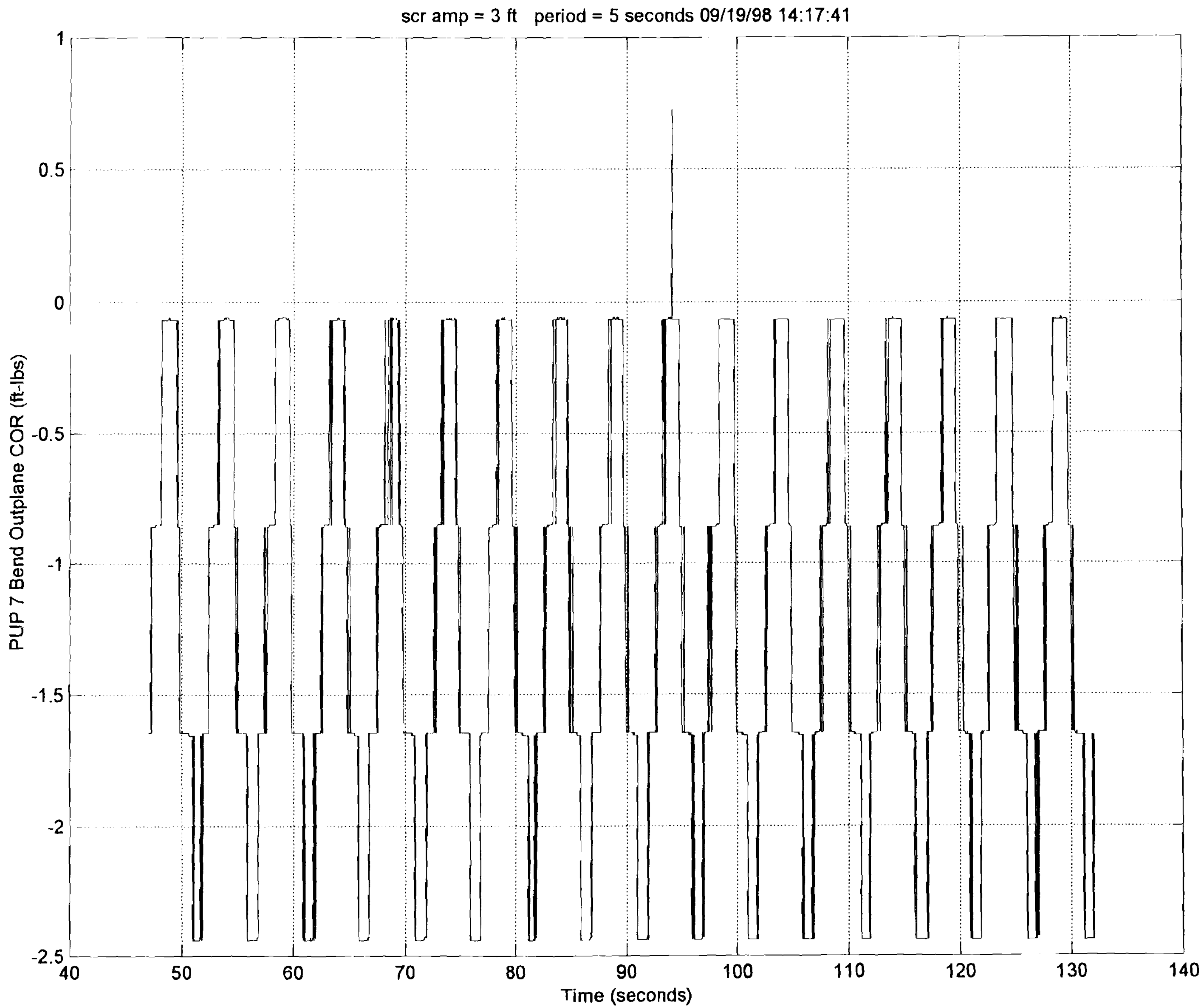

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 6 Bend Inplane COR (ft-lbs)
Time (seconds)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
40
50
60
70
80
90
100
110
120
130
140

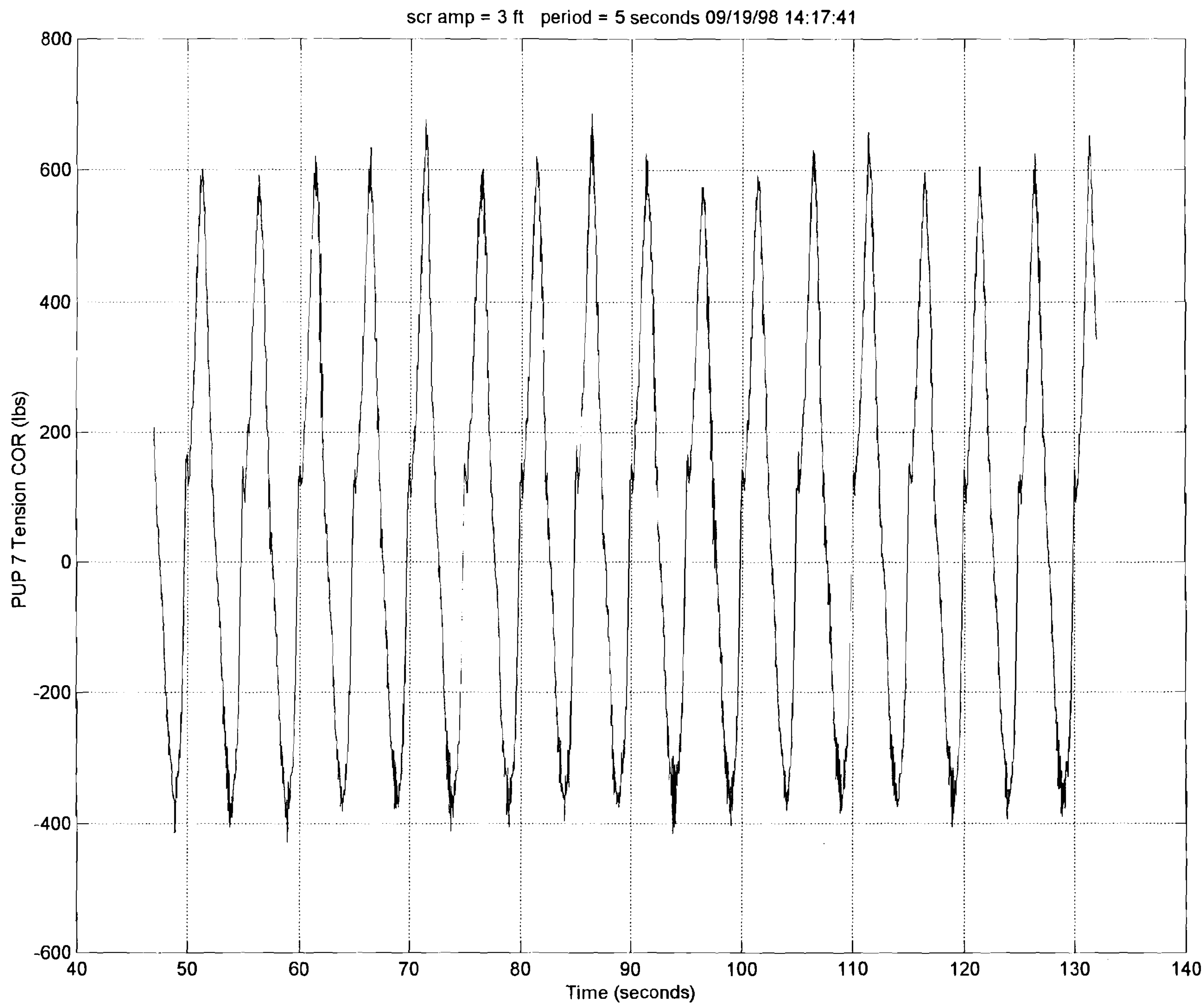


scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 6 Bend Outplane COR (ft-lbs)
Time (seconds)
20
15
10
5
0
-5
-10
-15
40
50
60
70
80
90
100
110
120
130
140

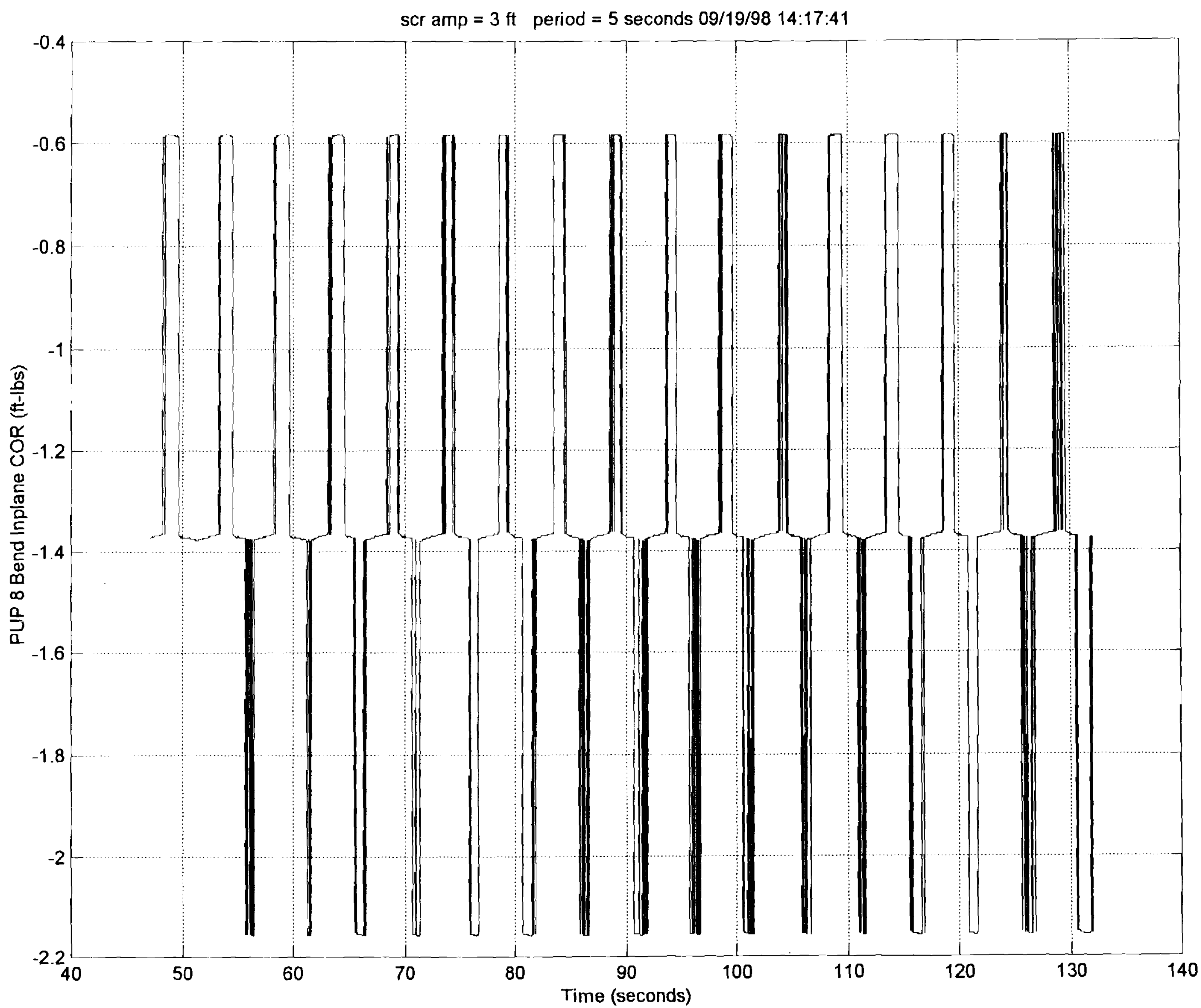

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
PUP 6 Tension COR (lbs)
800
600
400
200
0
-200
-400
-600
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

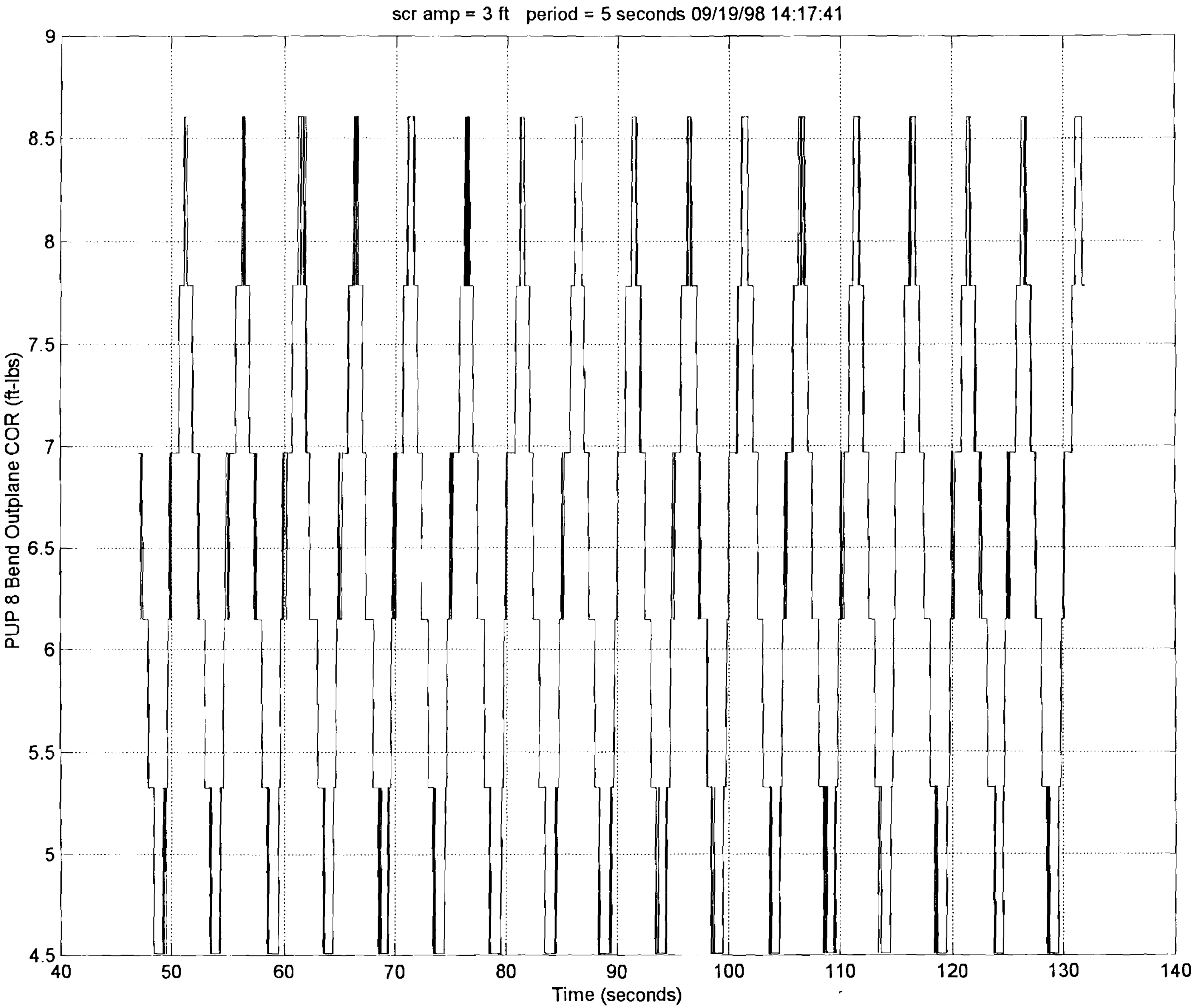

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 7 Bend Inplane COR (ft-lbs)
1
0.5
0
-0.5
-1
-1.5
-2
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

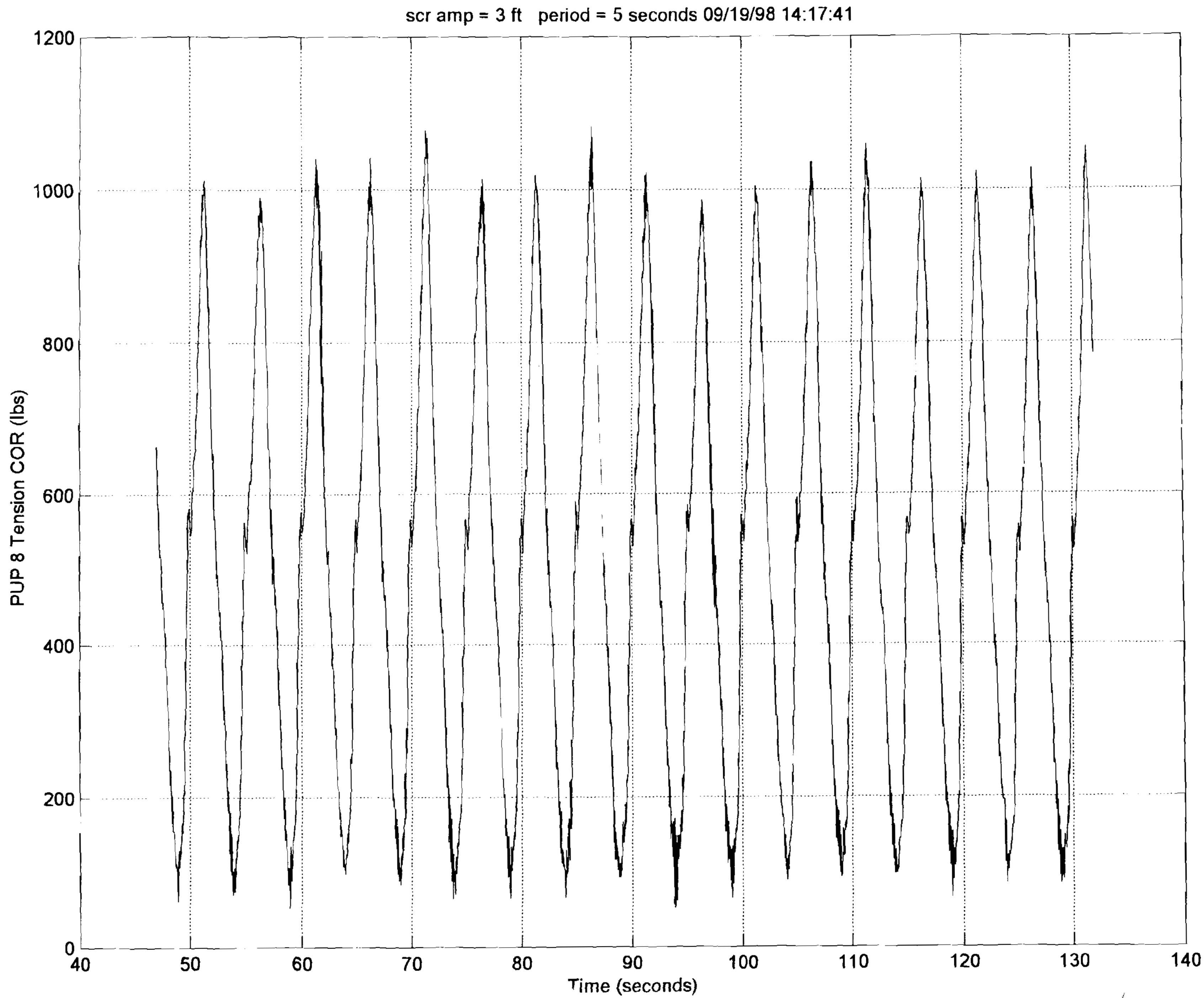

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 7 Bend Outplane COR (ft-lbs)
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

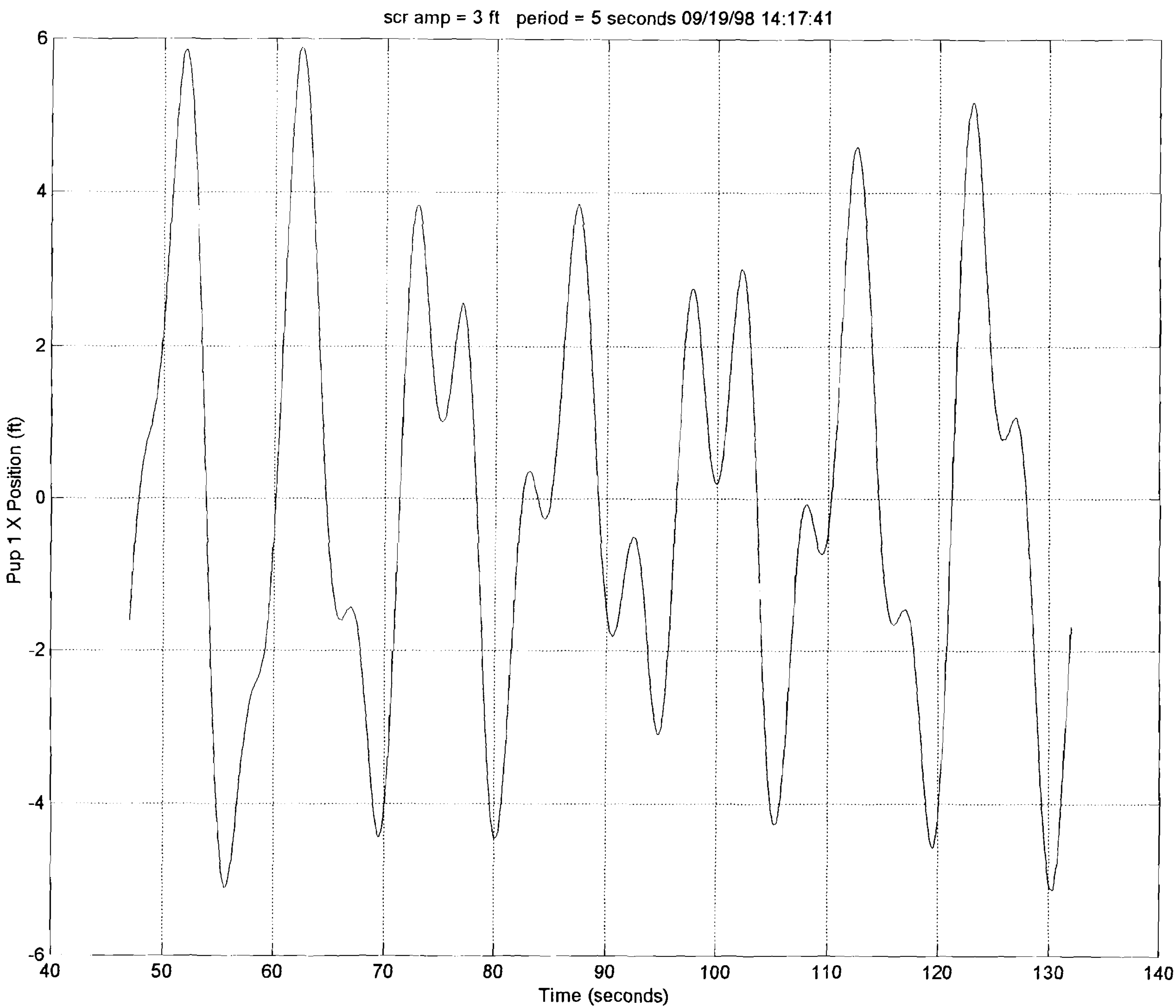


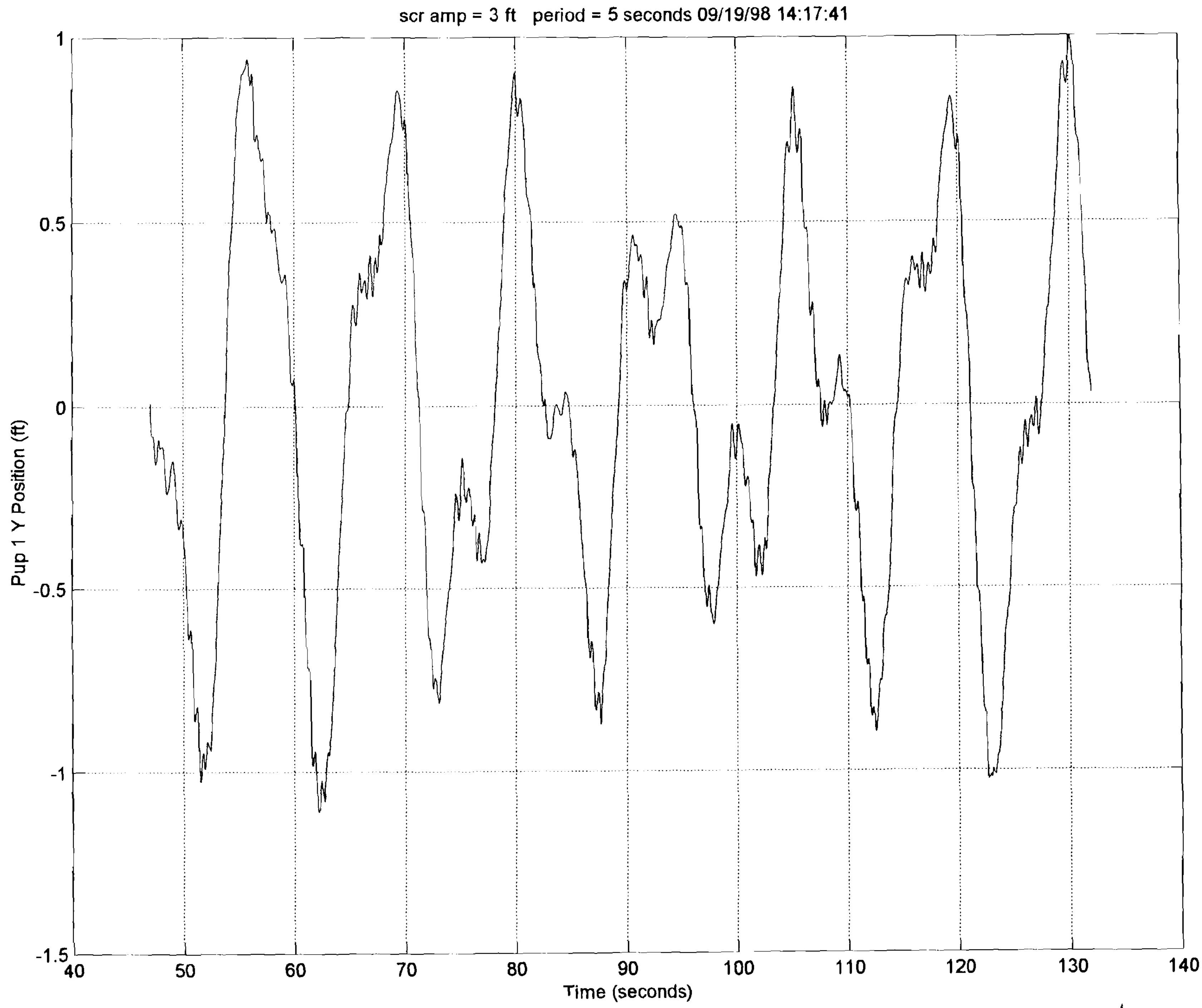
scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 7 Tension COR (lbs)
Time (seconds)
800
600
400
200
0
-200
-400
-600
40
50
60
70
80
90
100
110
120
130
140

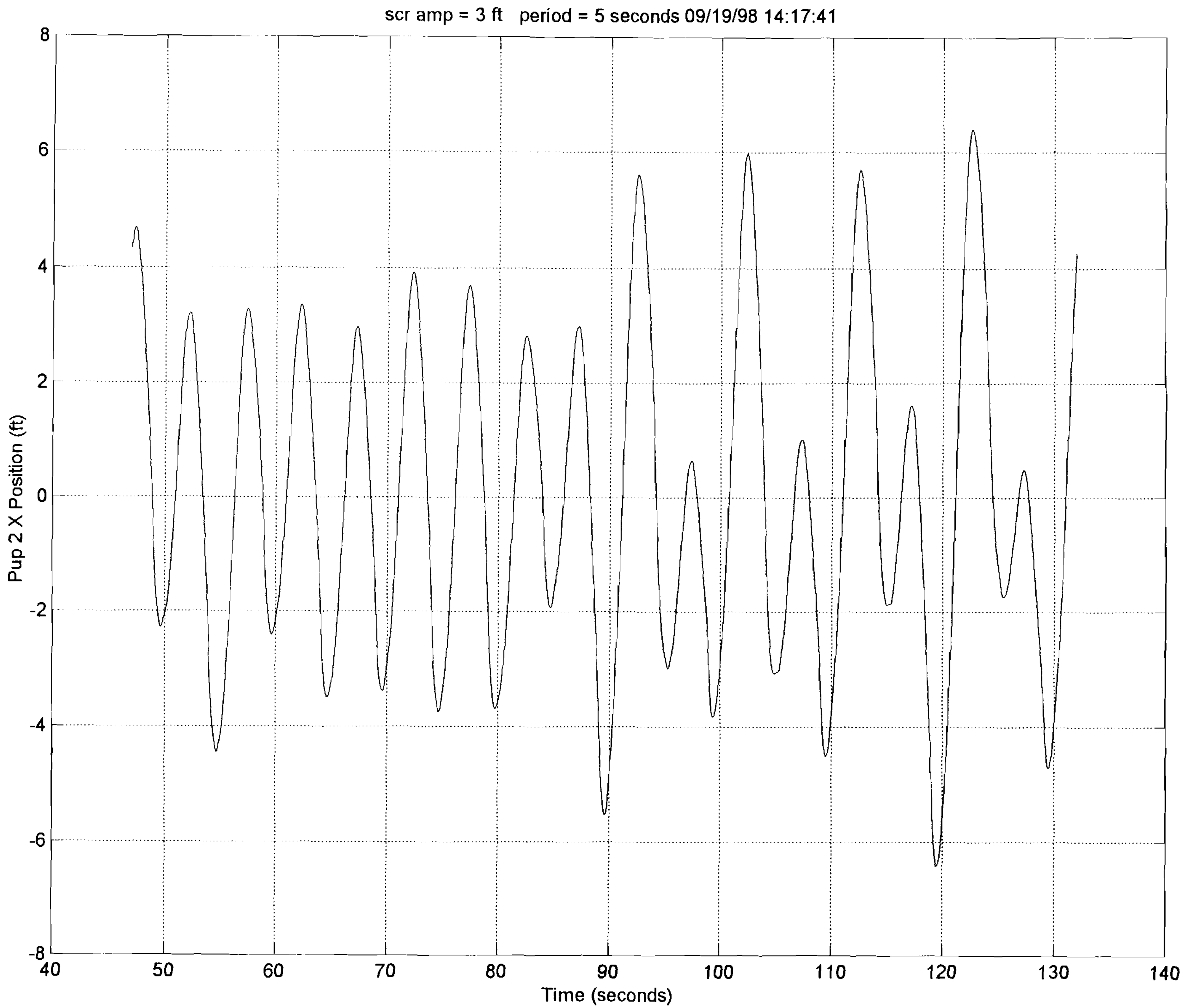

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 8 Bend Inplane COR (ft-lbs)
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)


scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
PUP 8 Bend Outplane COR (ft-lbs)
Time (seconds)
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
40
50
60
70
80
90
100
110
120
130
140

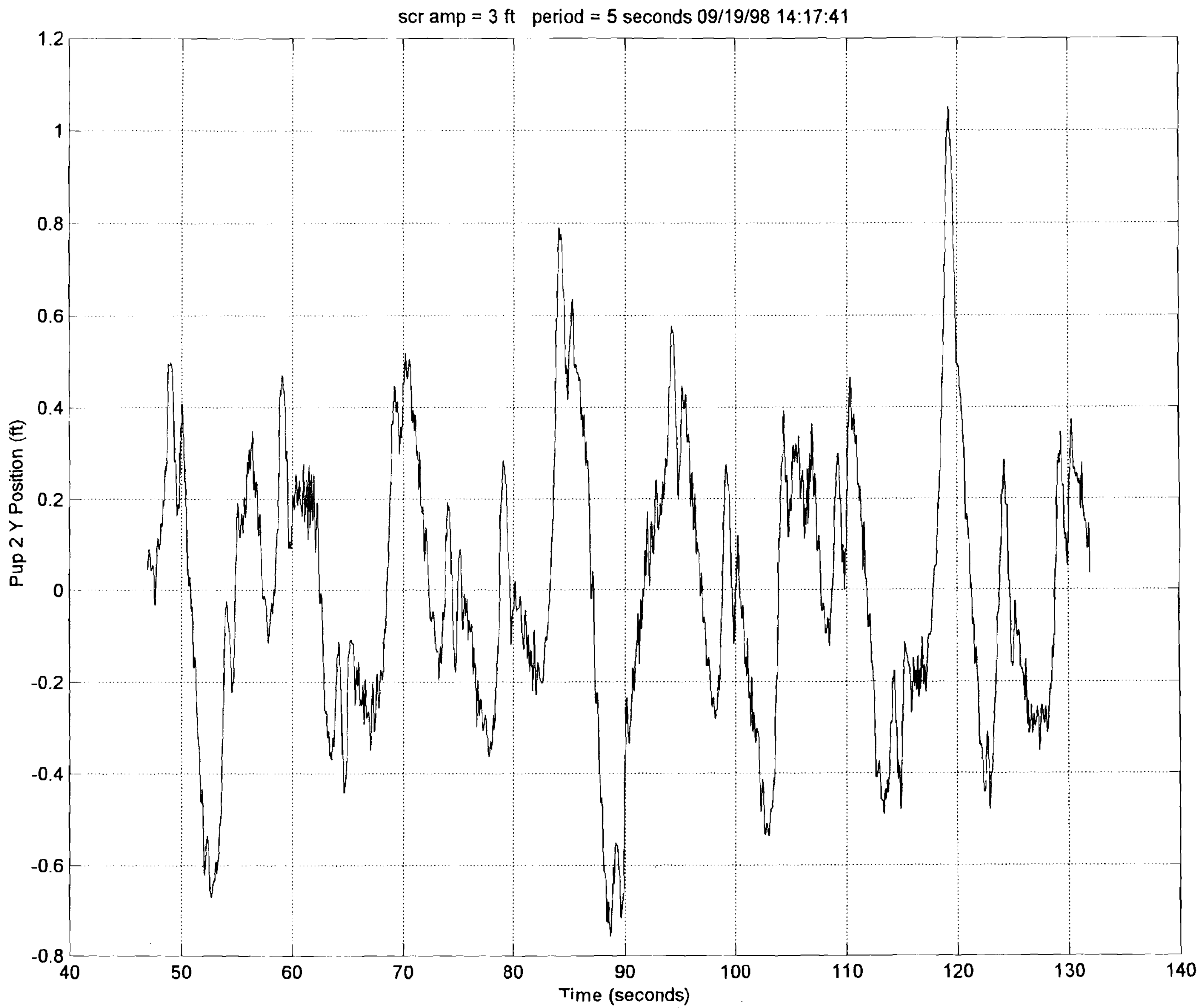

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
PUP 8 Tension COR (lbs)
Time (seconds)
0
200
400
600
800
1000
1200
40
50
60
70
80
90
100
110
120
130
140

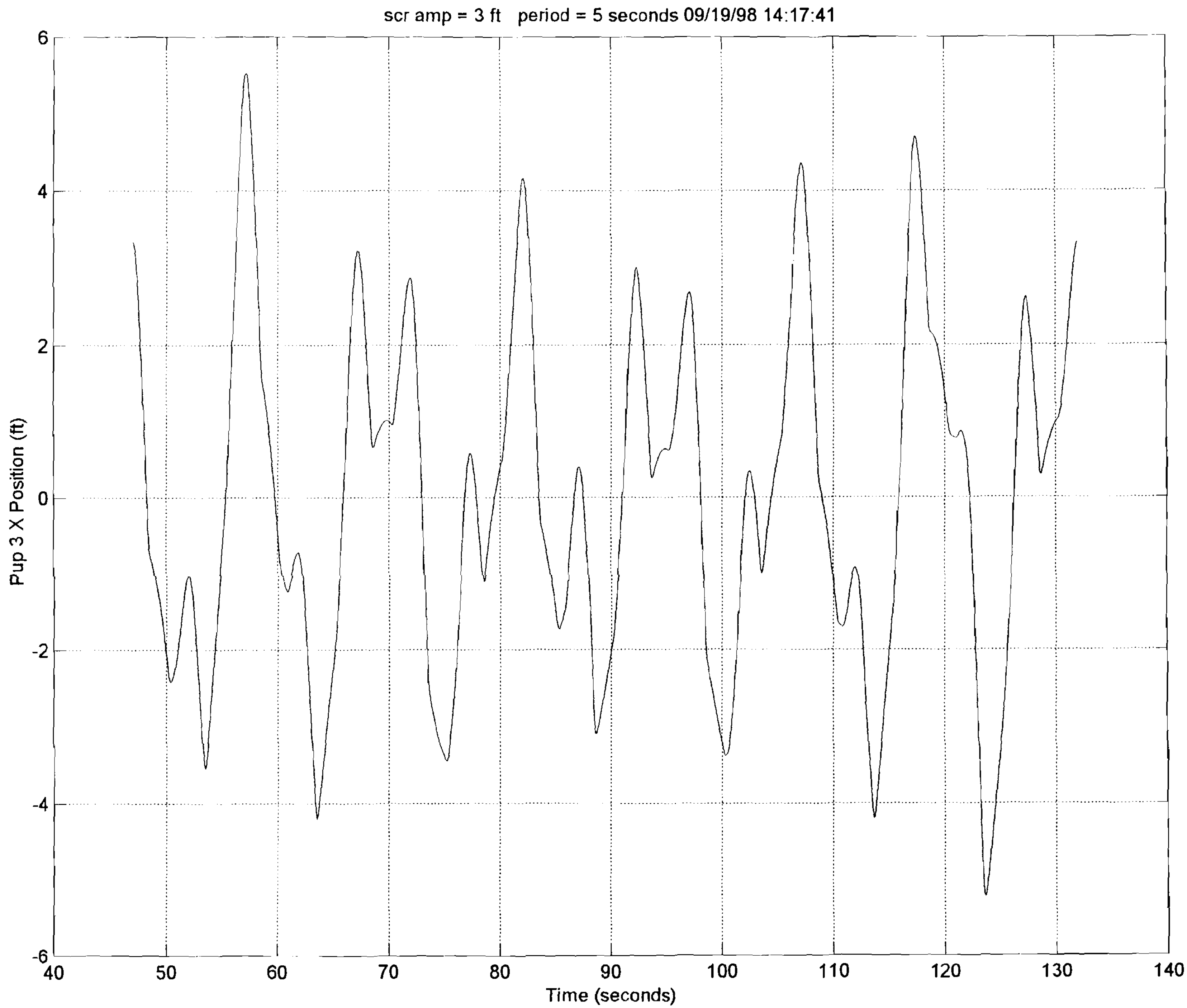

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 1 X Position (ft)
Time (seconds)
6
4
2
0
-2
-4
-6
40
50
60
70
80
90
100
110
120
130
140


scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 1 Y Position (ft)
Time (seconds)
1
0.5
0
-0.5
-1
-1.5
40
50
60
70
80
90
100
110
120
130
140

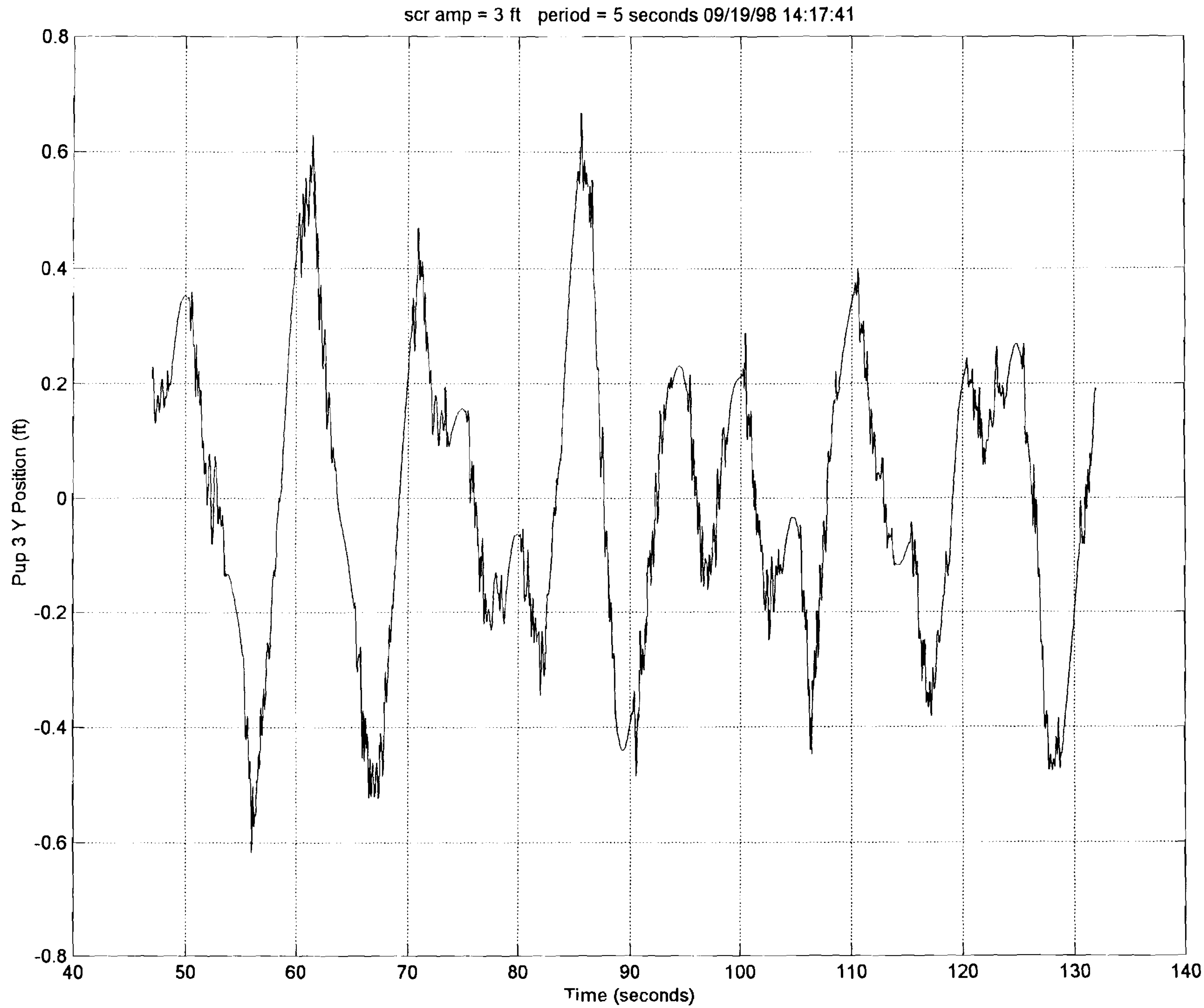


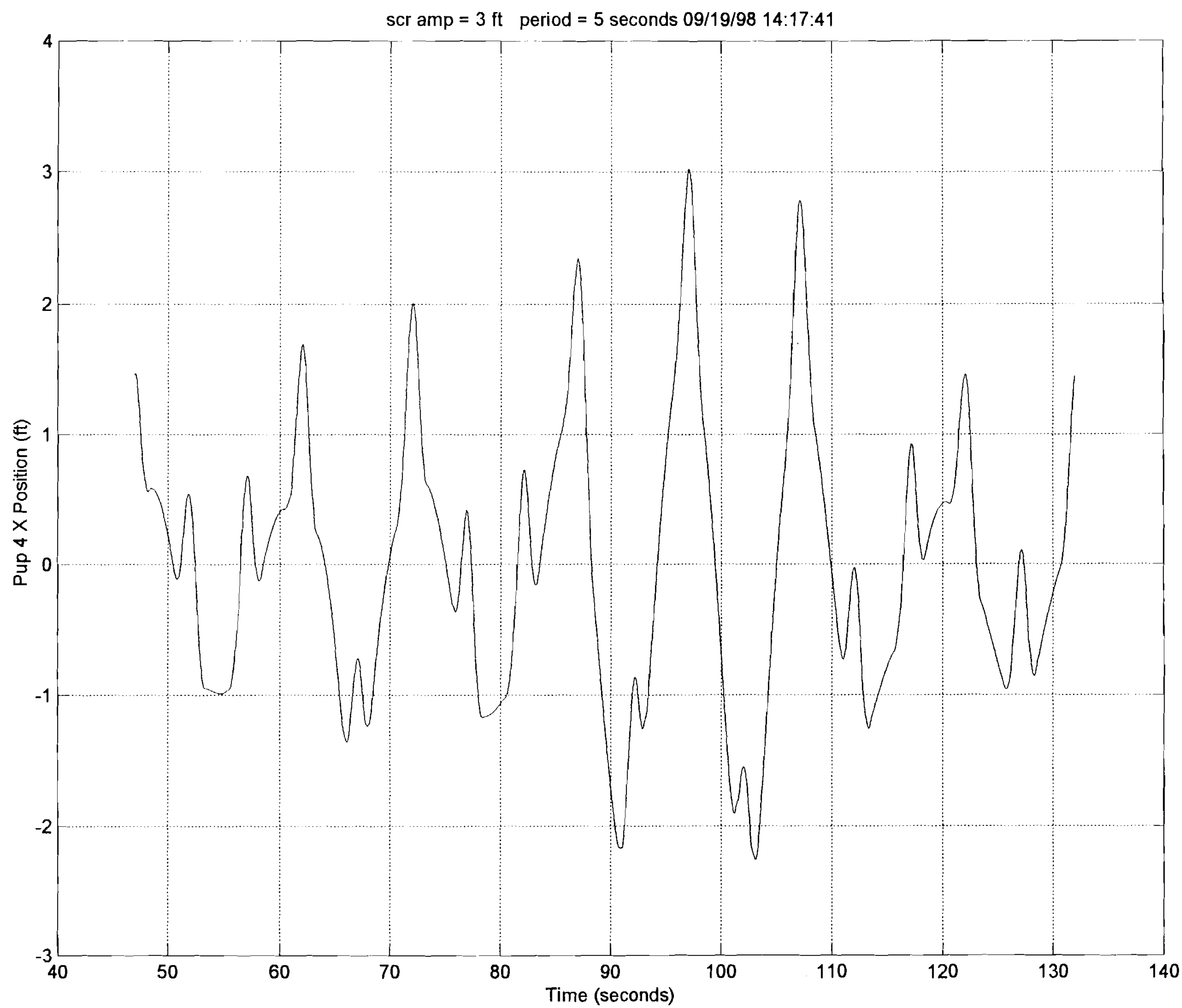
scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 2 X Position (ft)
Time (seconds)
8
6
4
2
0
-2
-4
-6
-8
40
50
60
70
80
90
100
110
120
130
140

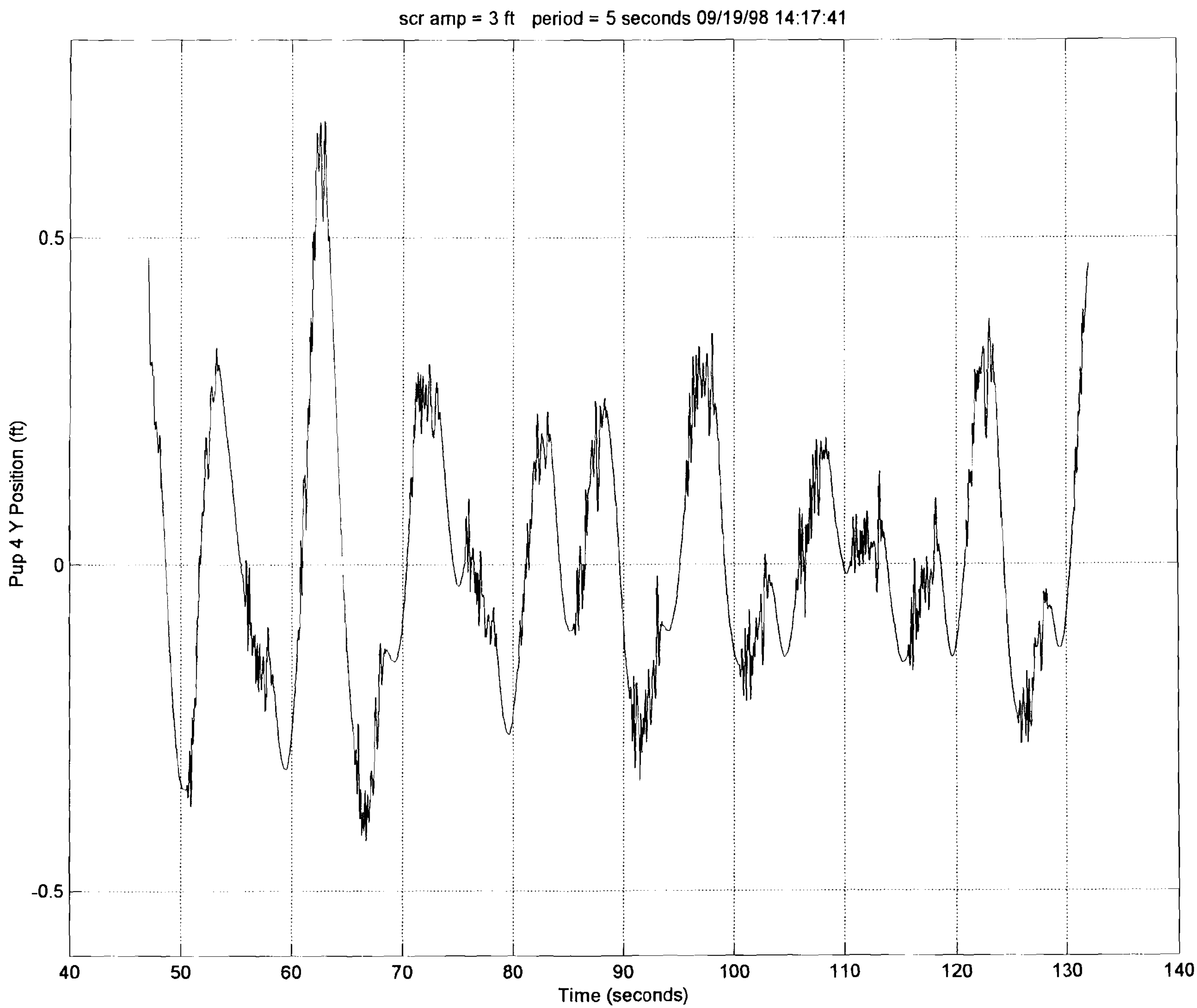

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 2 Y Position (ft)
Time (seconds)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
40
50
60
70
80
90
100
110
120
130
140

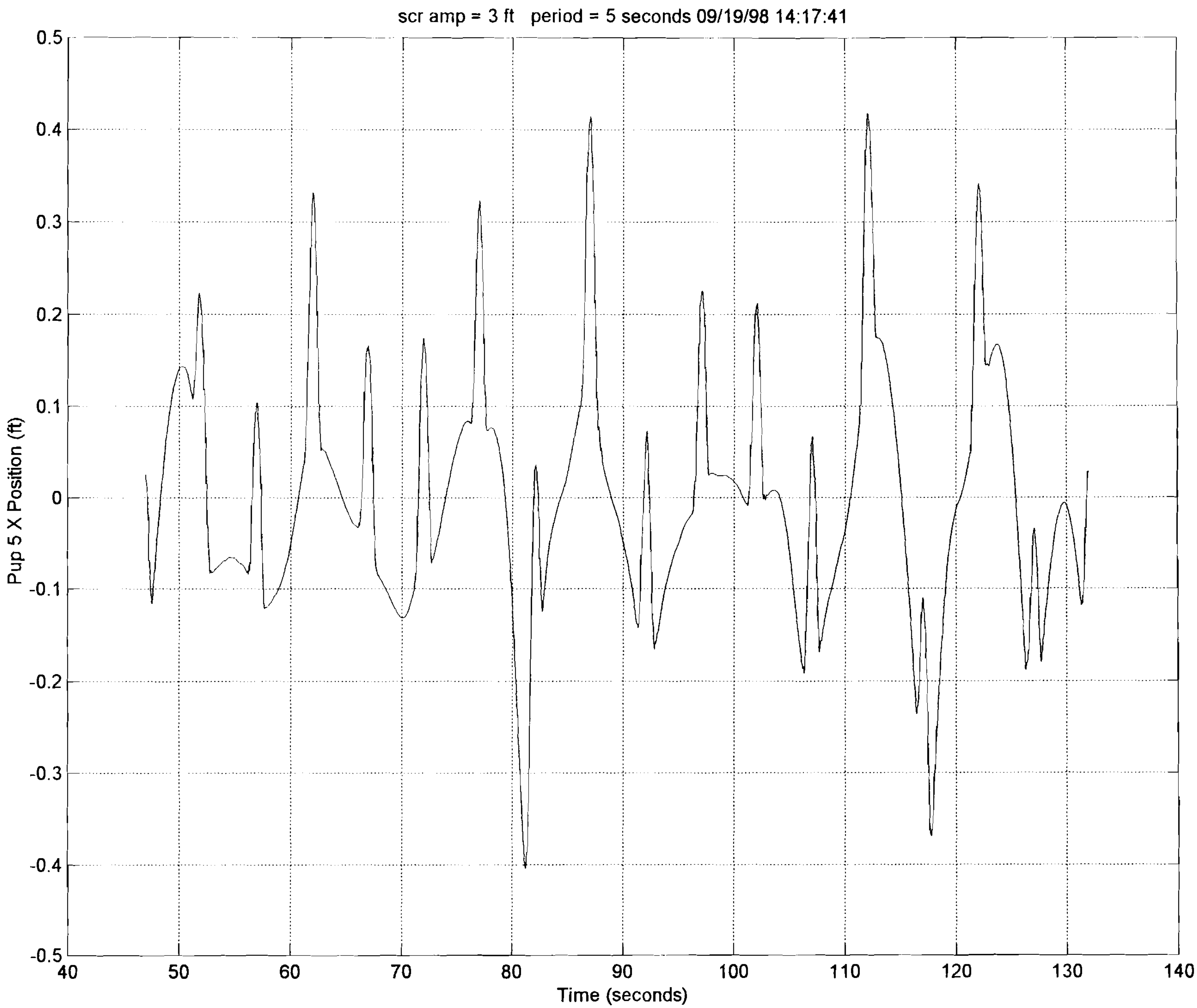


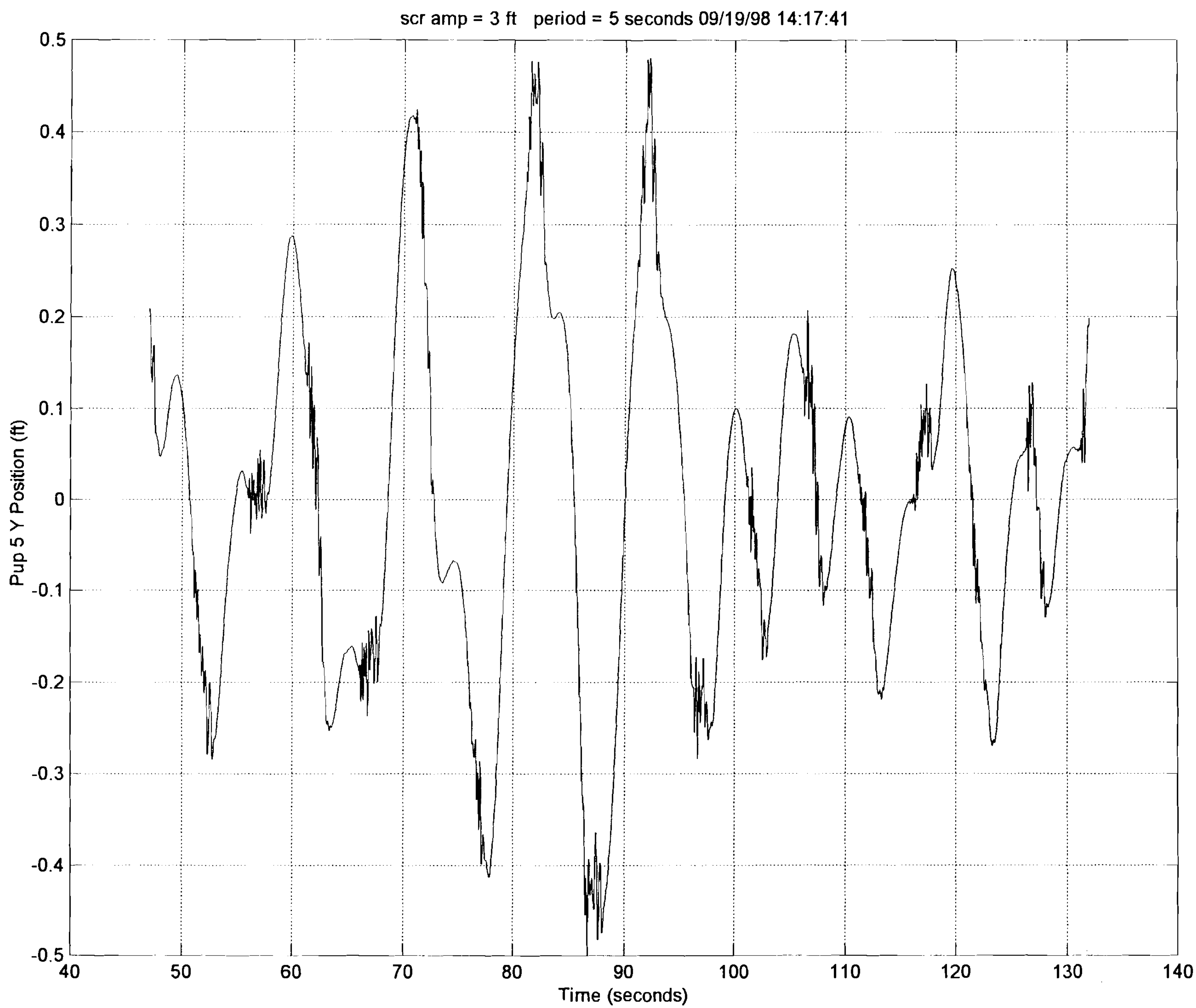
scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 3 X Position (ft)
6
4
2
0
-2
-4
-6
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

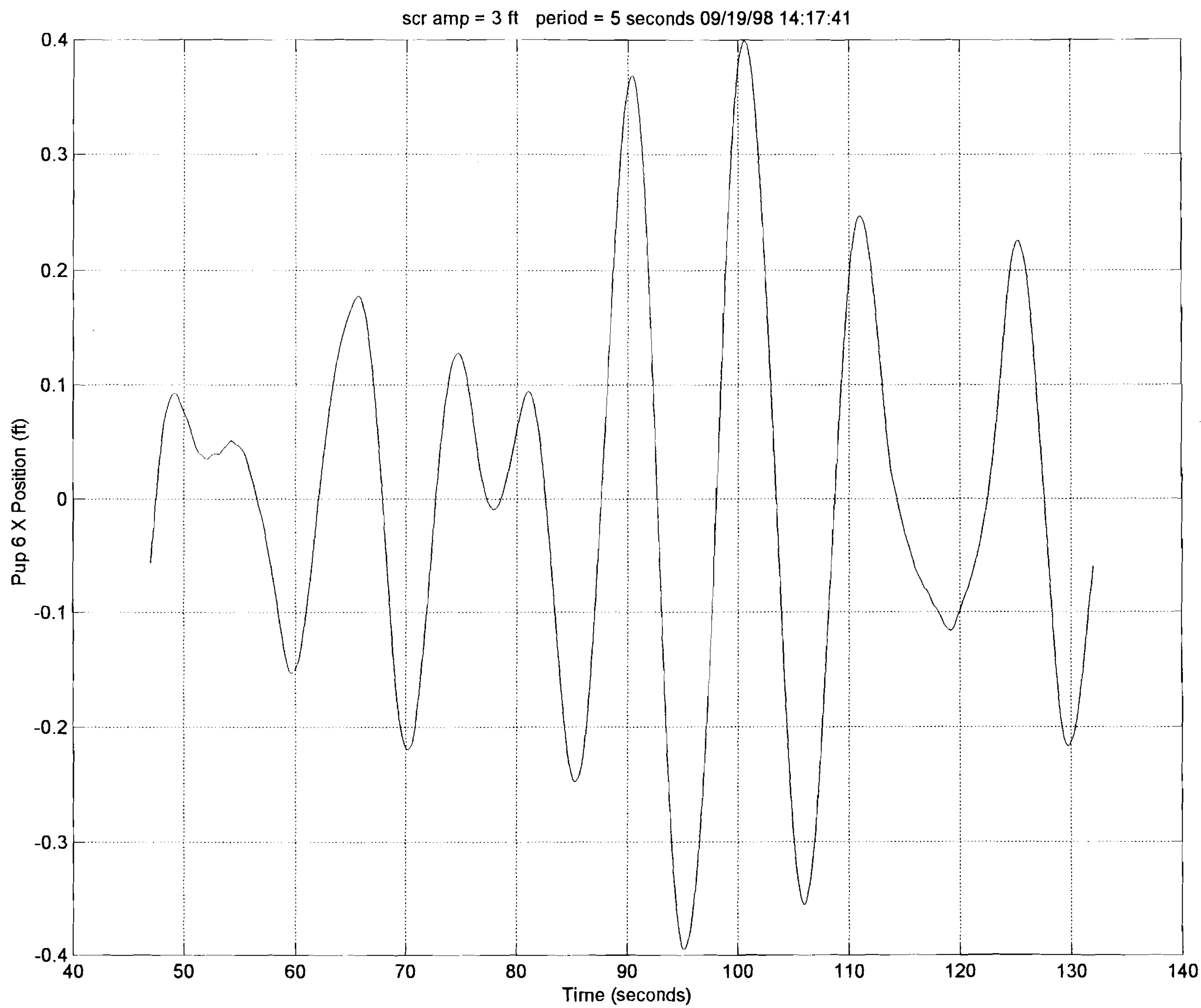

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 3 Y Position (ft)
Time (seconds)

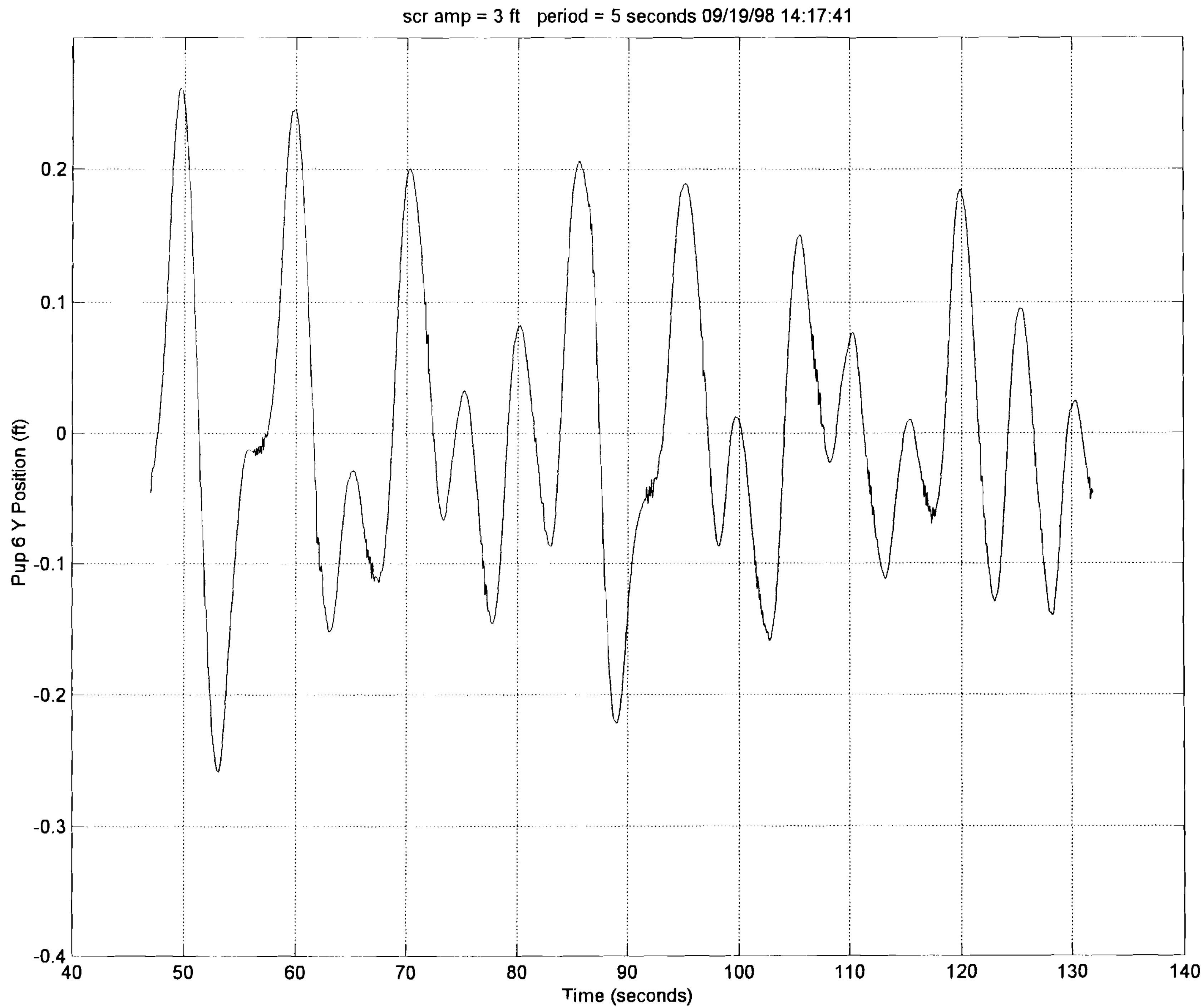

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 4 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
40
50
60
70
80
90
100
110
120
130
140

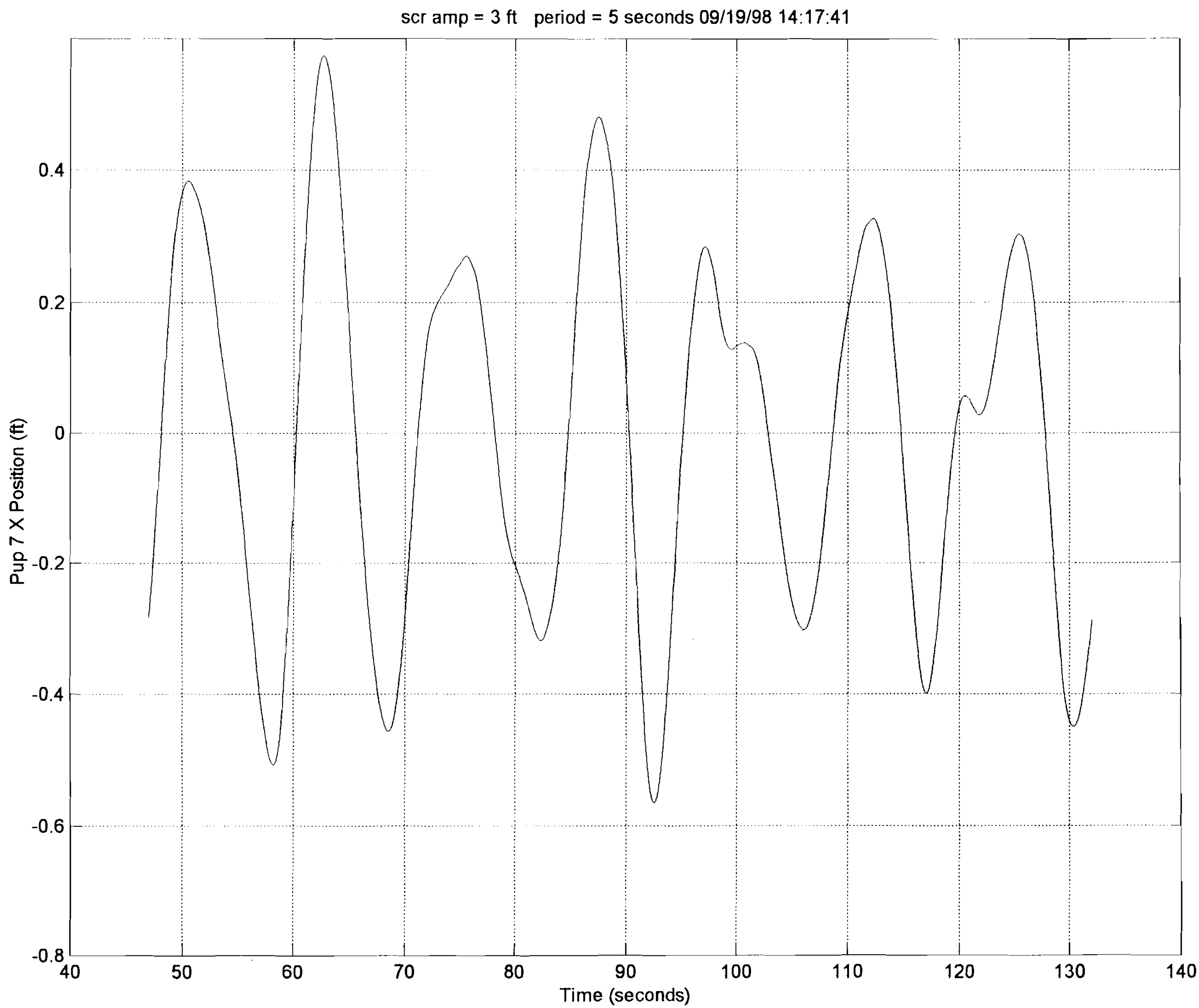

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 4 Y Position (ft)
0.5
0
-0.5
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)


scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 5 X Position (ft)
Time (seconds)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
40
50
60
70
80
90
100
110
120
130
140

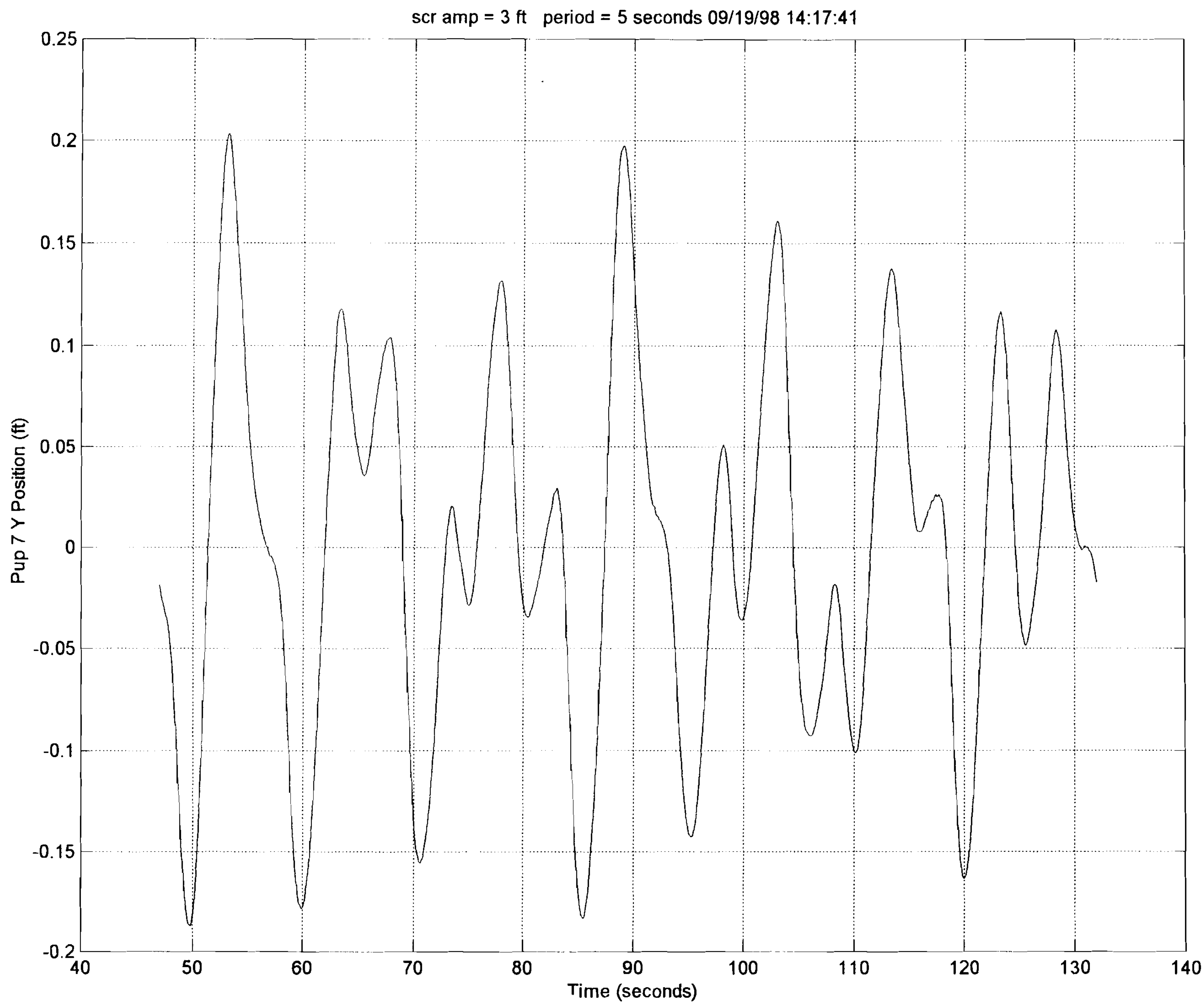

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 5 Y Position (ft)
Time (seconds)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
40
50
60
70
80
90
100
110
120
130
140

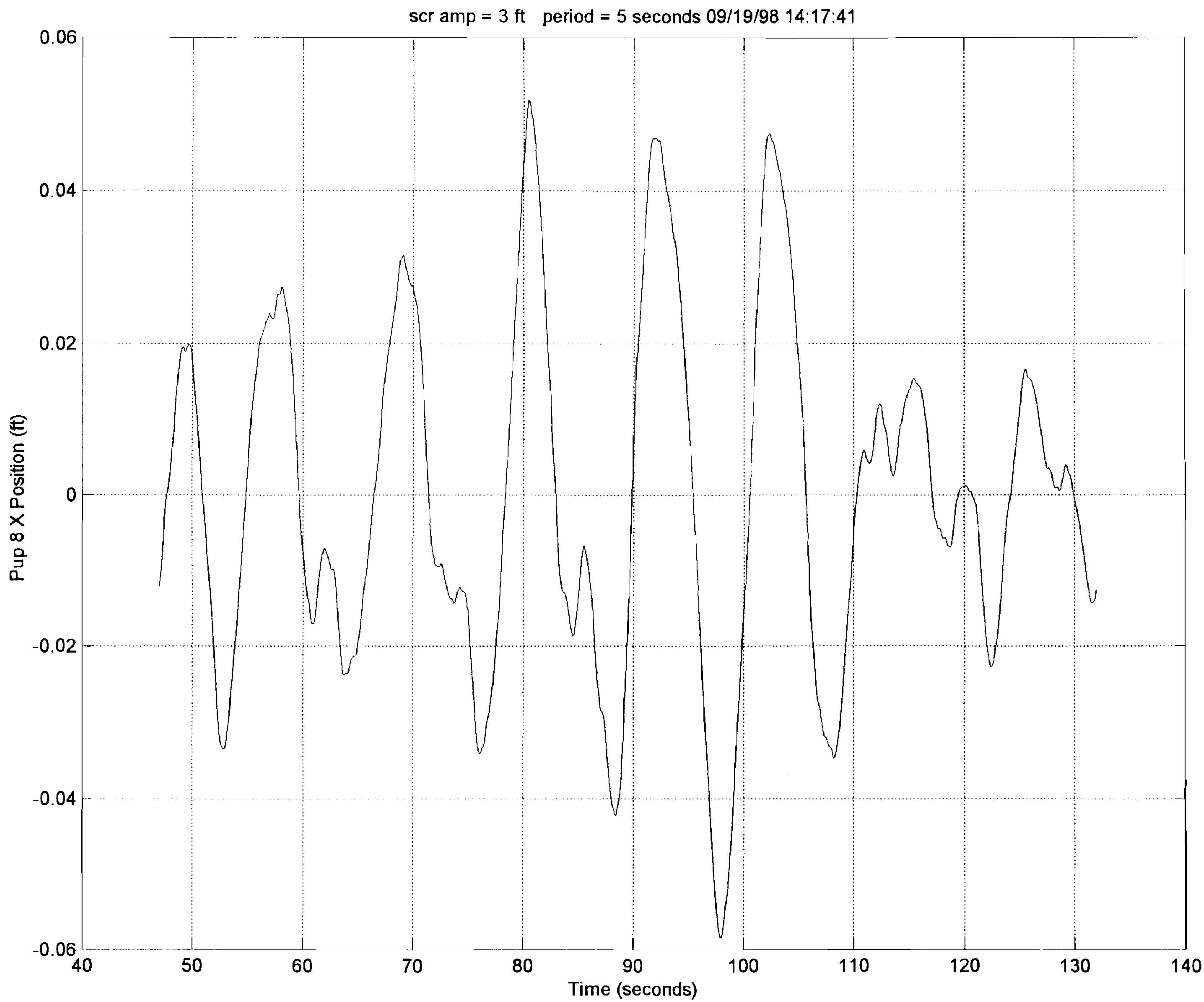

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 6 X Position (ft)
Time (seconds)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
40
50
60
70
80
90
100
110
120
130
140

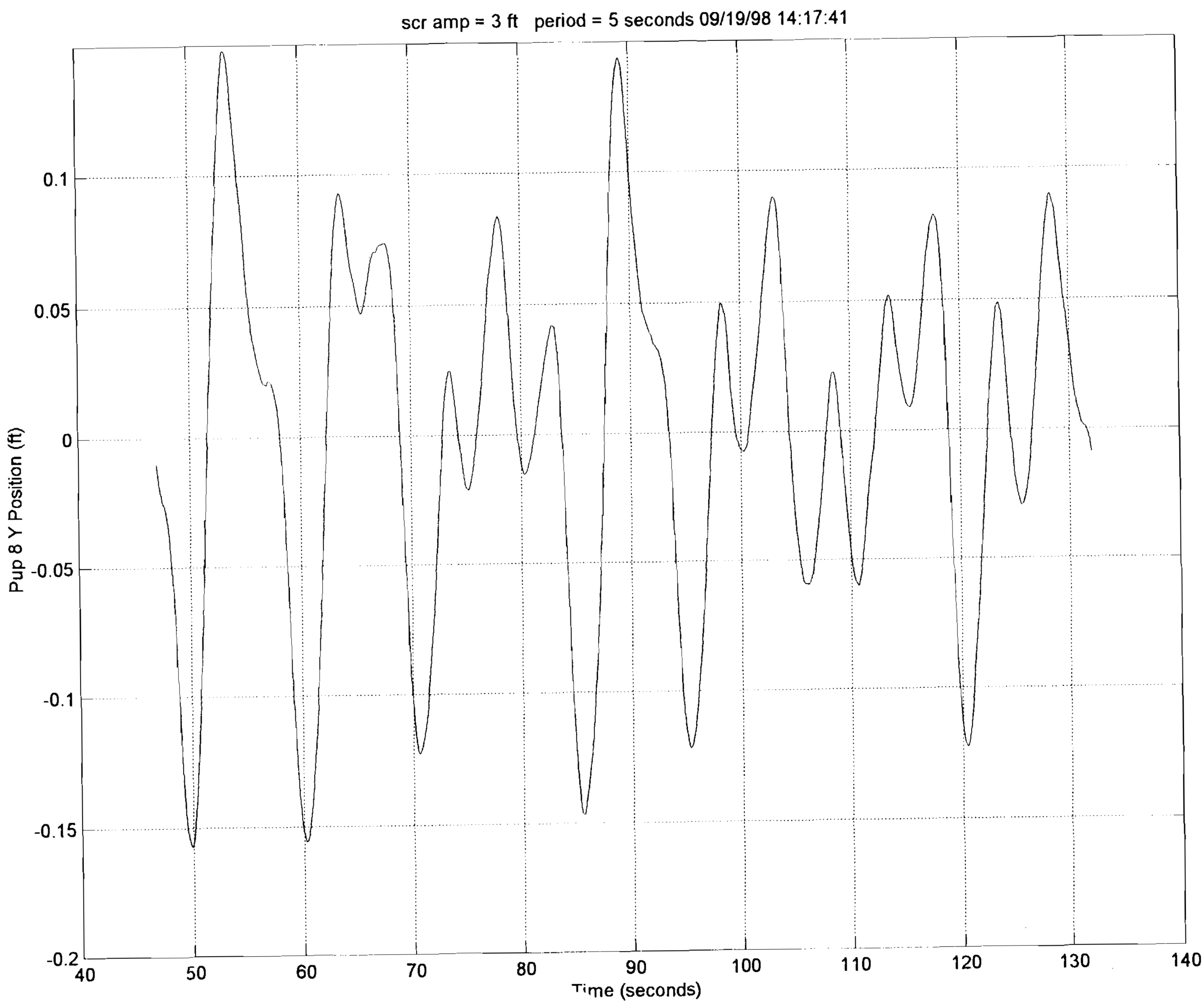

scr amp = 3 ft   period = 5 seconds 09/19/98 14:17:41
Pup 6 Y Position (ft)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

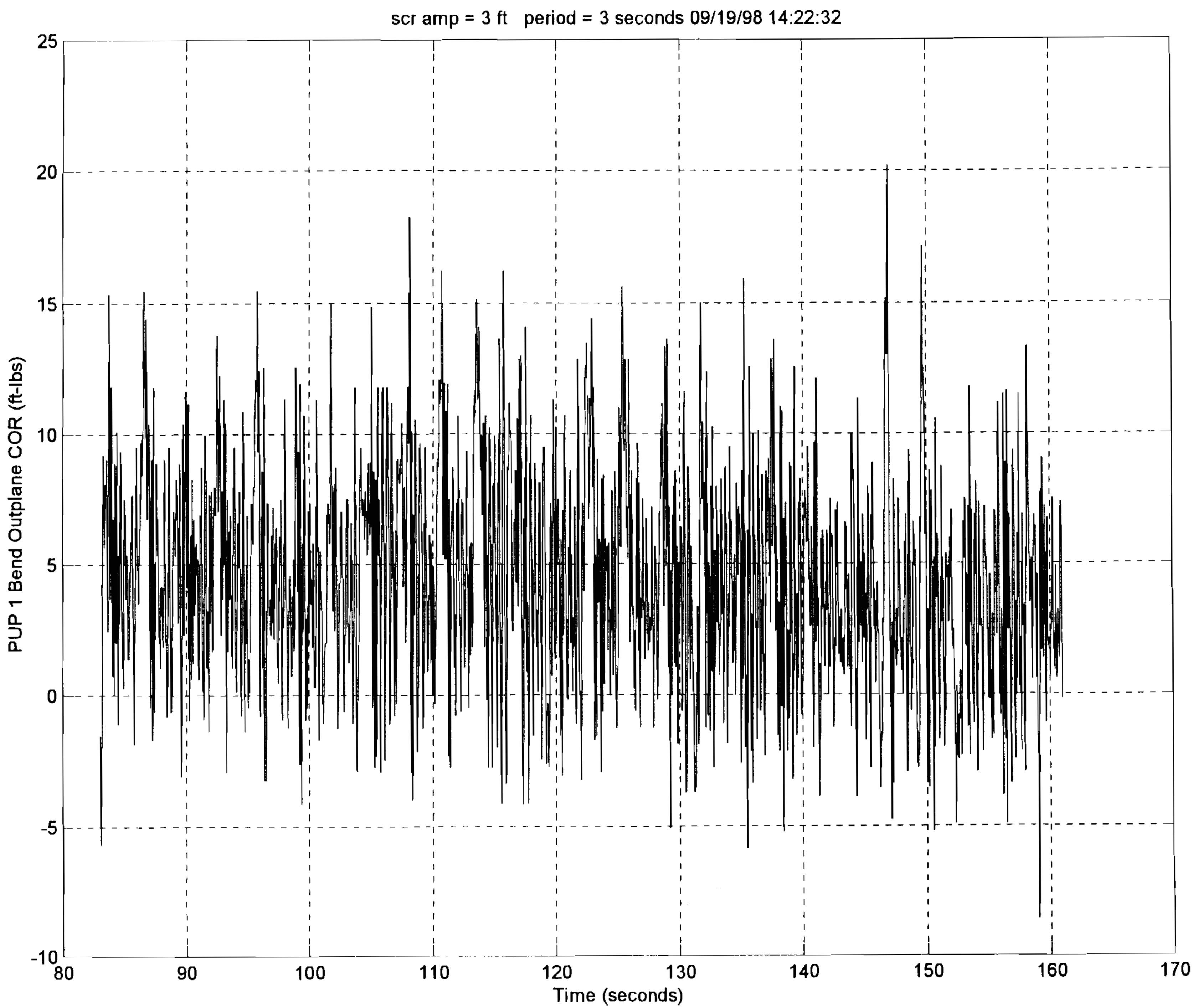


scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 7 X Position (ft)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

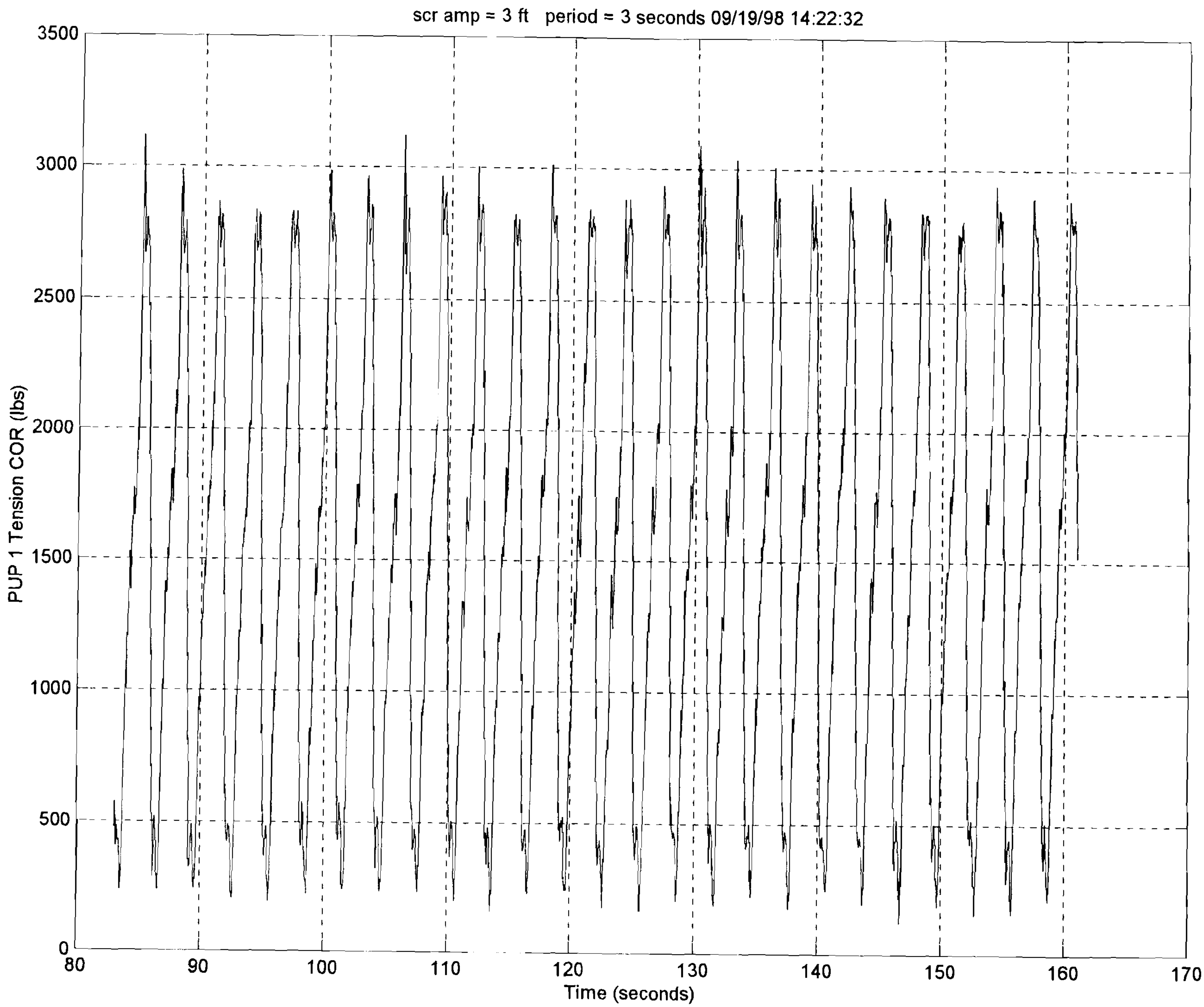

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 7 Y Position (ft)
Time (seconds)
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
40
50
60
70
80
90
100
110
120
130
140

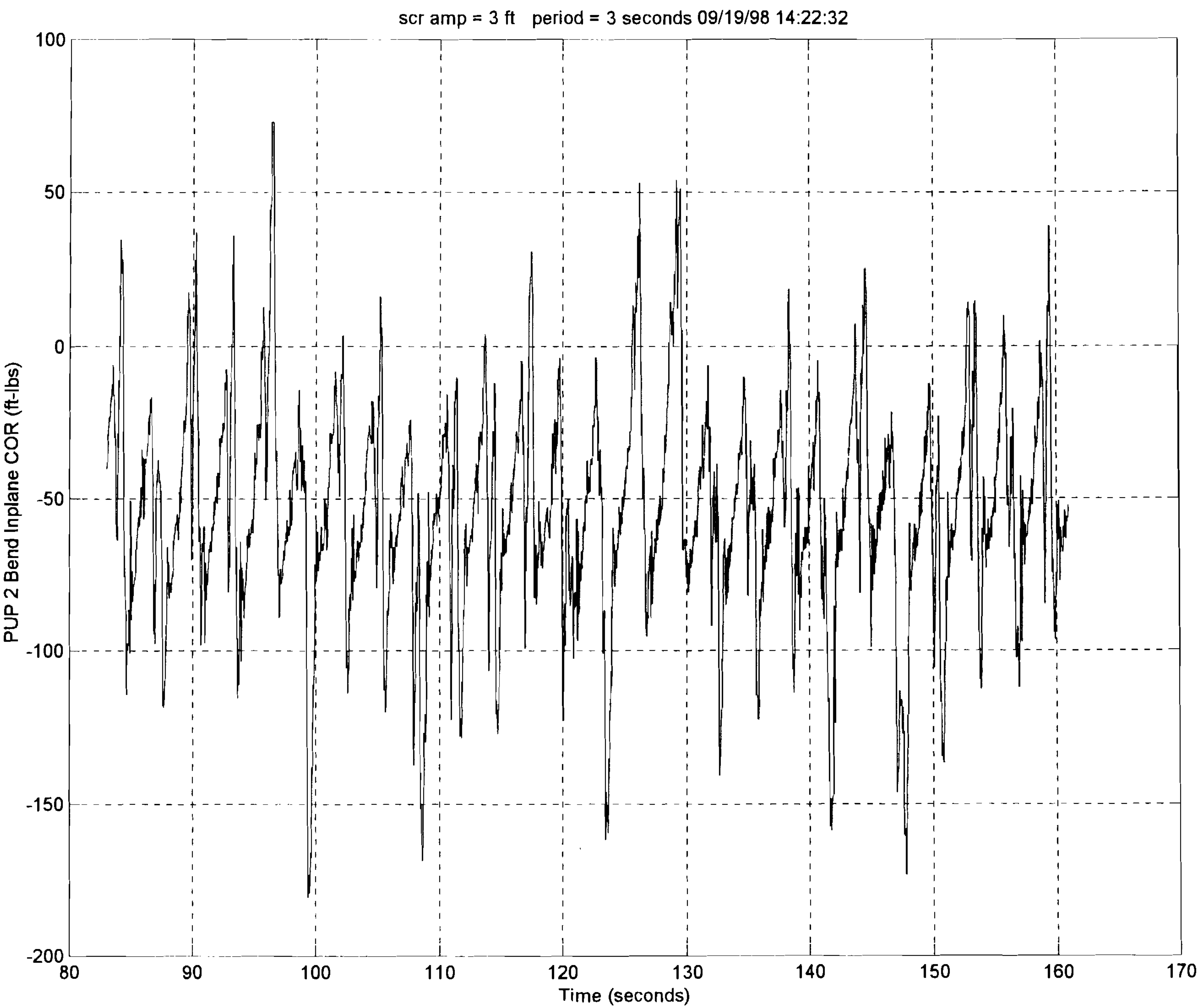

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 8 X Position (ft)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

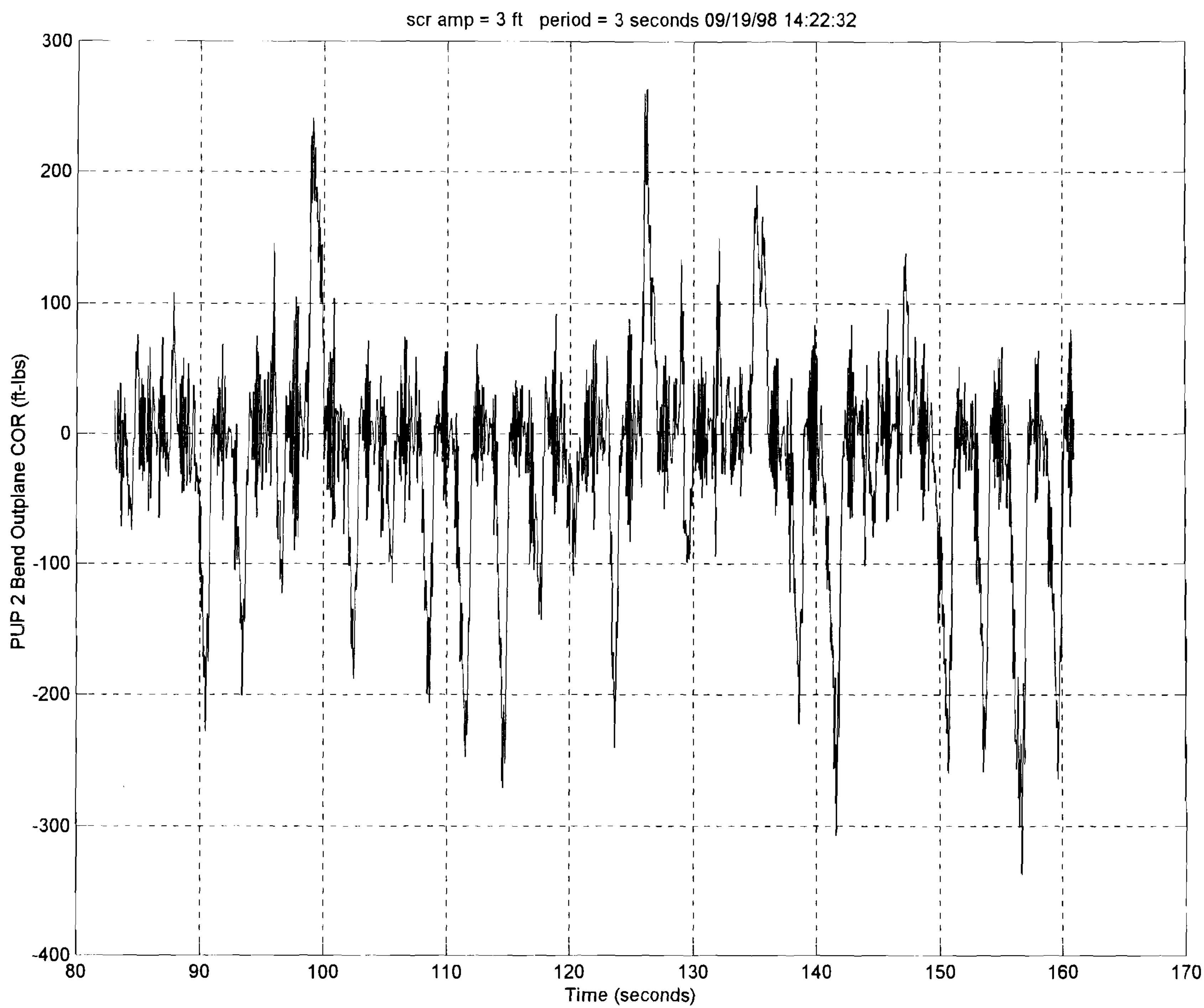

scr amp = 3 ft period = 5 seconds 09/19/98 14:17:41
Pup 8 Y Position (ft)
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
40
50
60
70
80
90
100
110
120
130
140
Time (seconds)

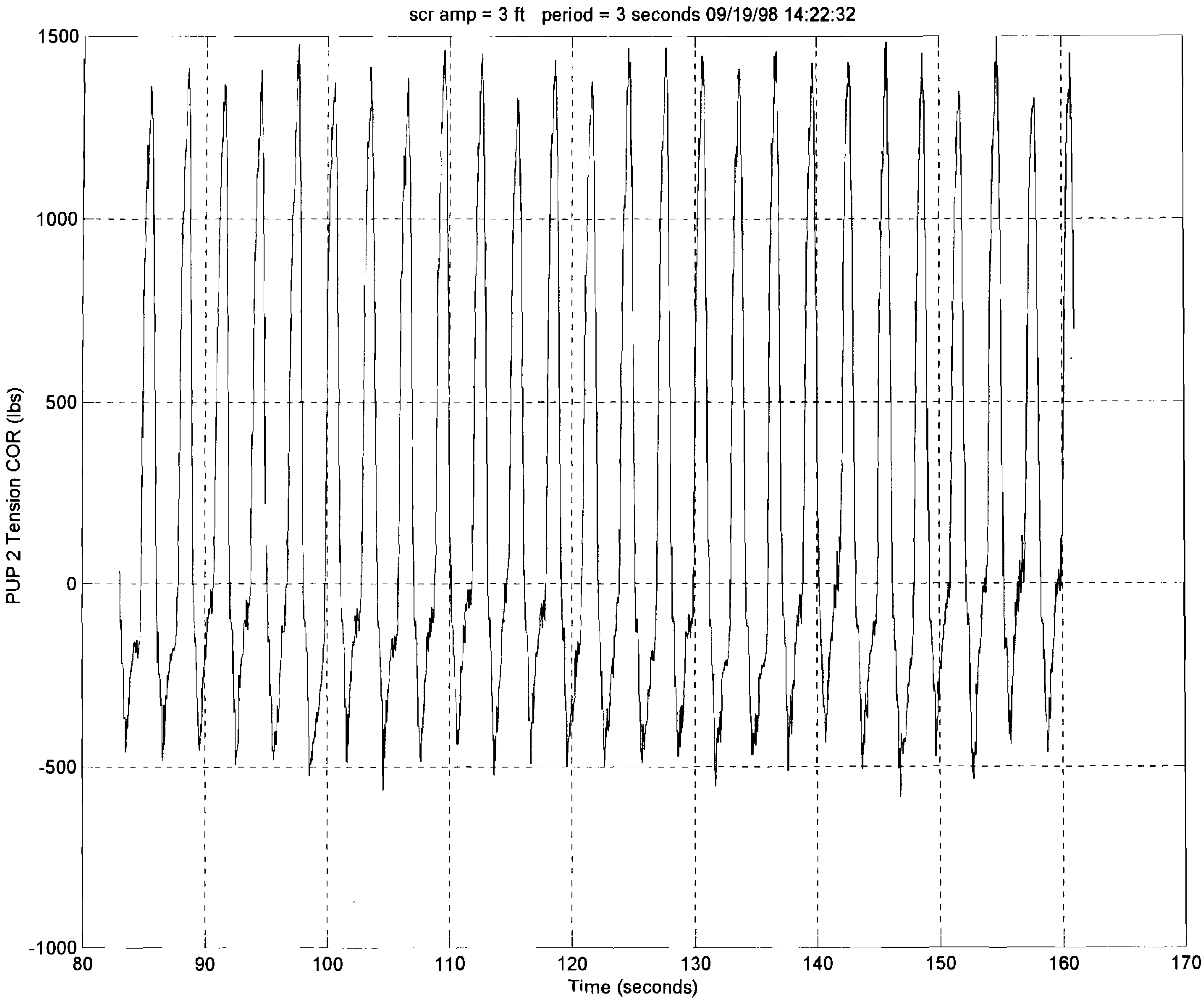


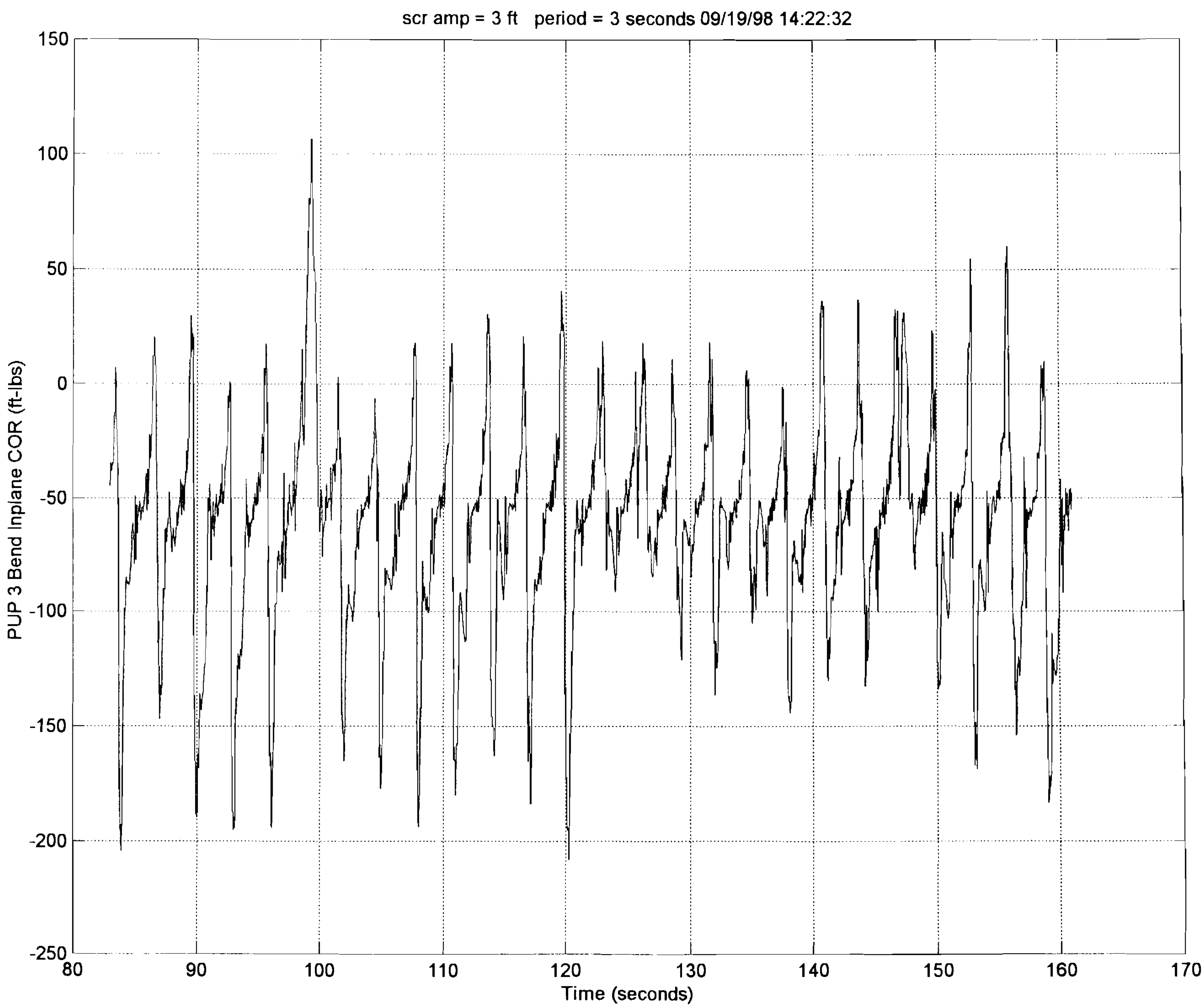
scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 1 Bend Outplane COR (ft-lbs)
25
20
15
10
5
0
-5
-10
80
90
100
110
120
130
140
150
160
170
Time (seconds)

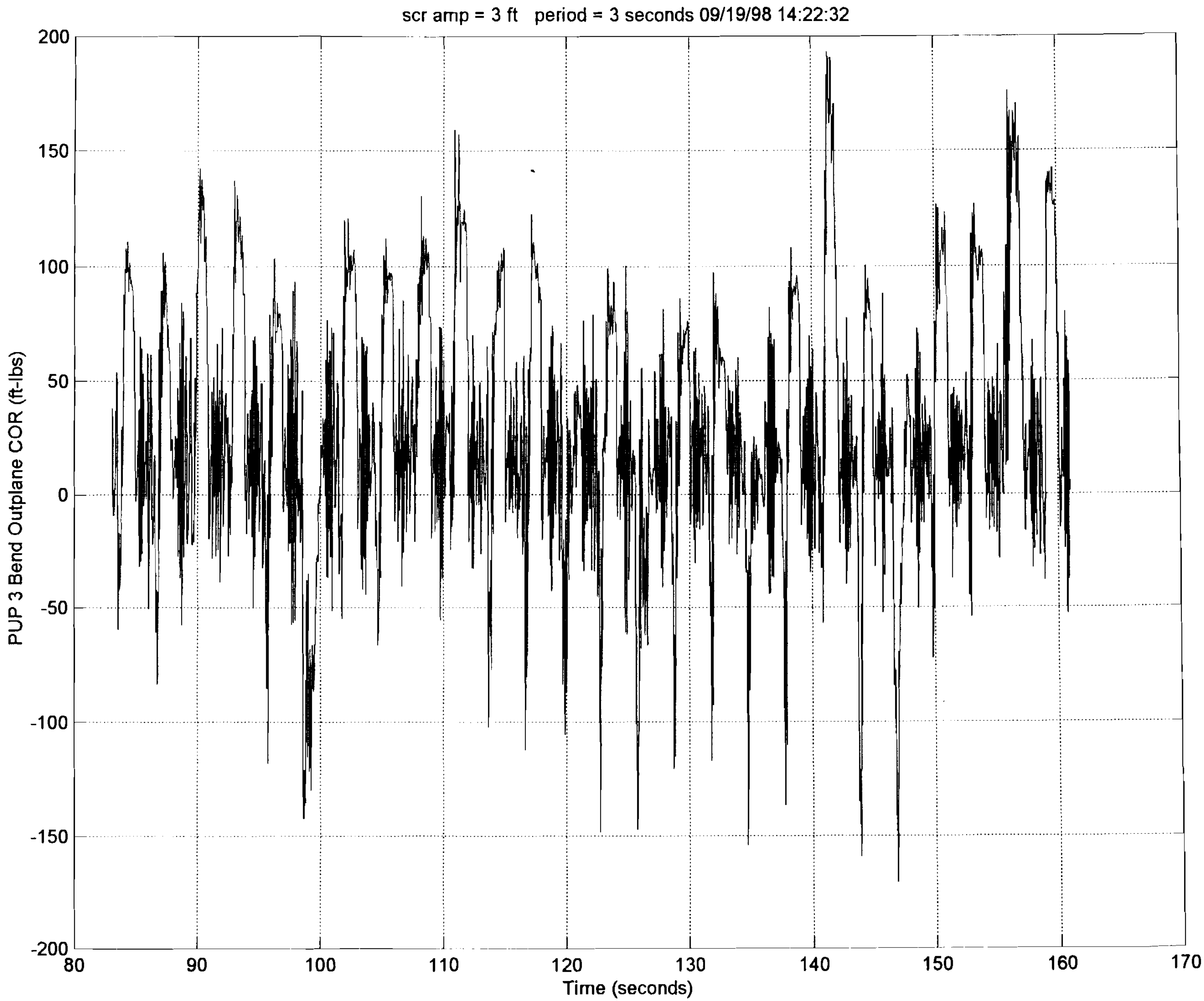

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 1 Tension COR (lbs)
0
500
1000
1500
2000
2500
3000
3500
80
90
100
110
120
130
140
150
160
170
Time (seconds)

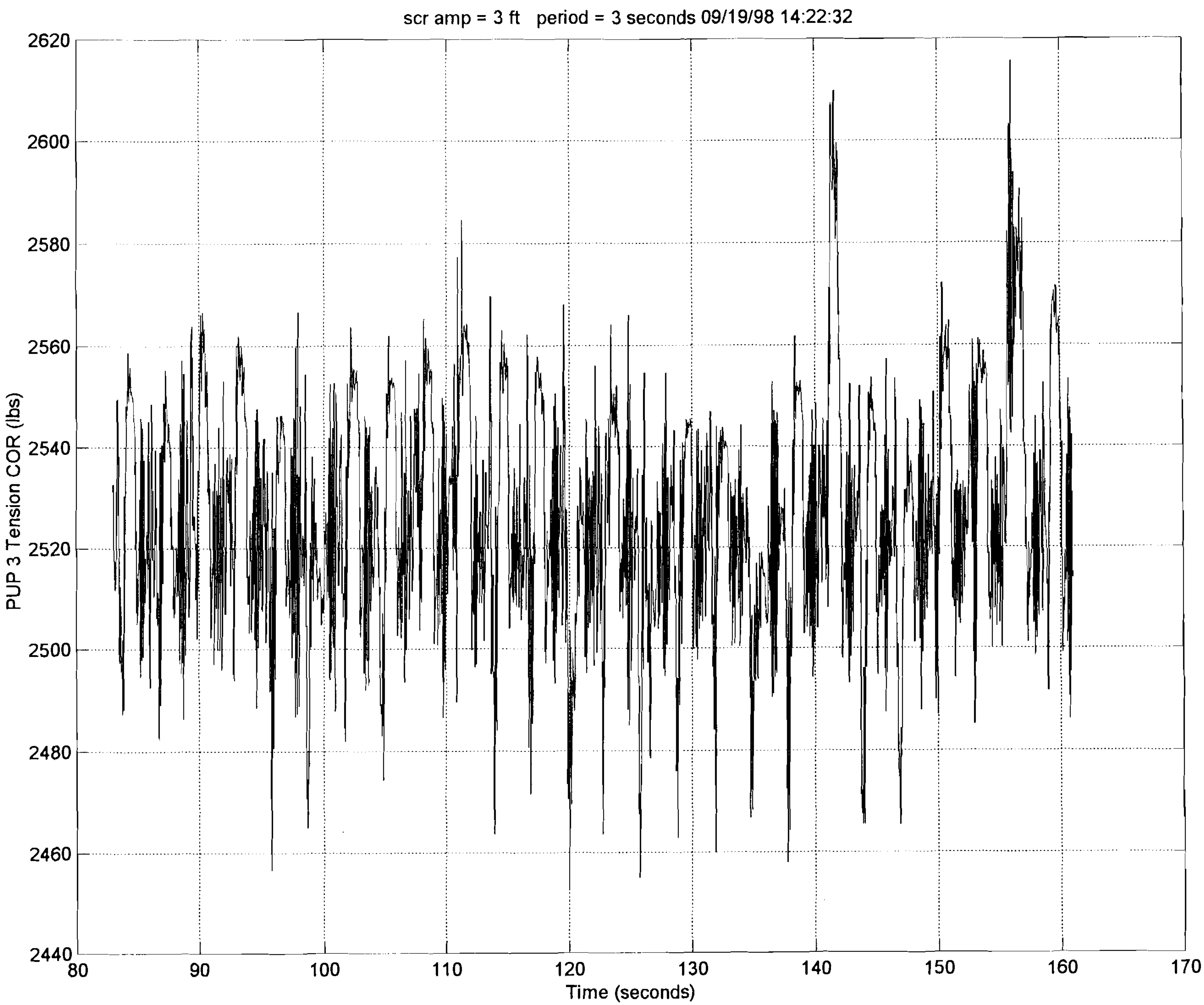

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 2 Bend Inplane COR (ft-lbs)
100
50
0
-50
-100
-150
-200
80
90
100
110
120
130
140
150
160
170
Time (seconds)

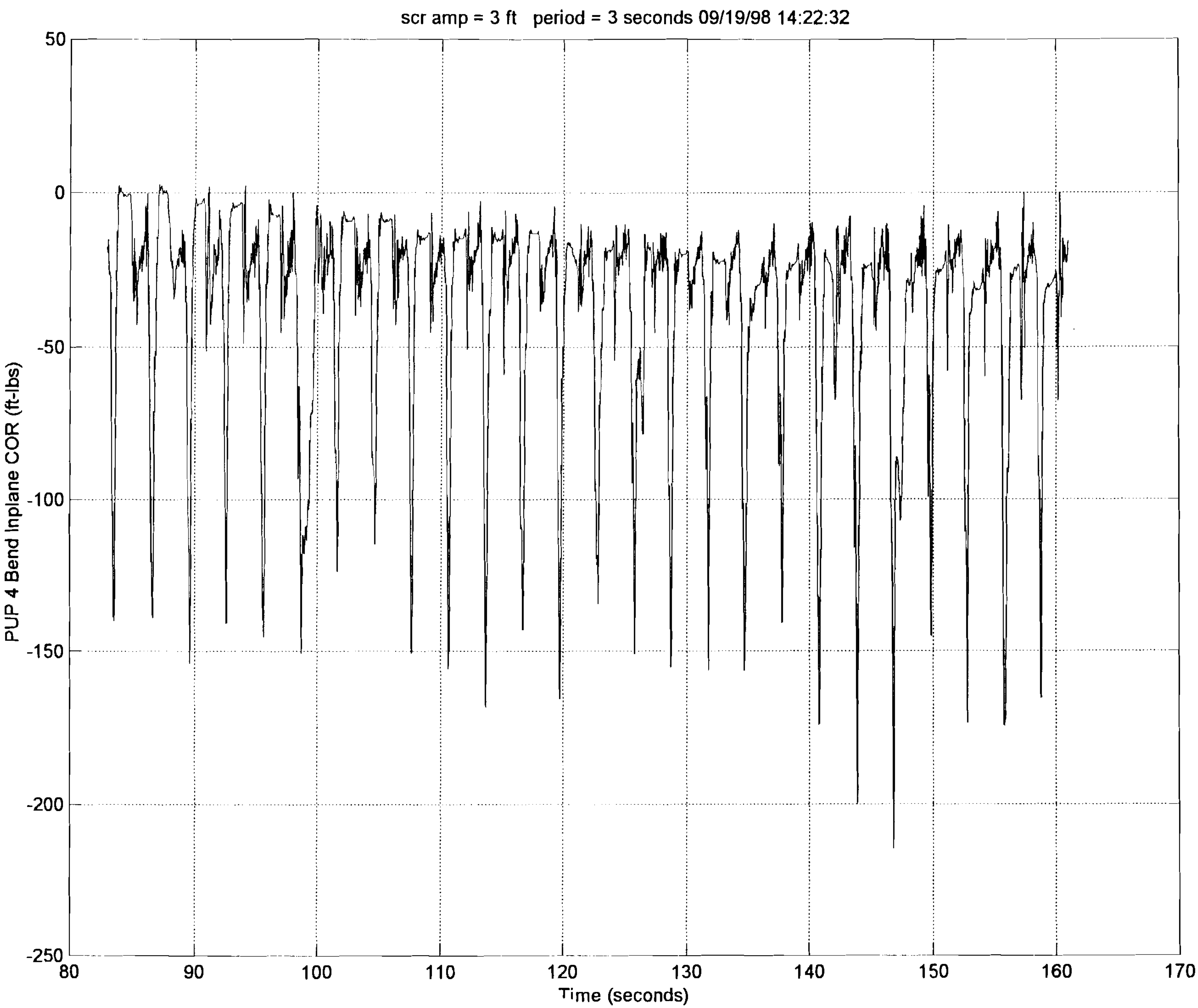

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 2 Bend Outplane COR (ft-lbs)
300
200
100
0
-100
-200
-300
-400
80
90
100
110
120
130
140
150
160
170
Time (seconds)

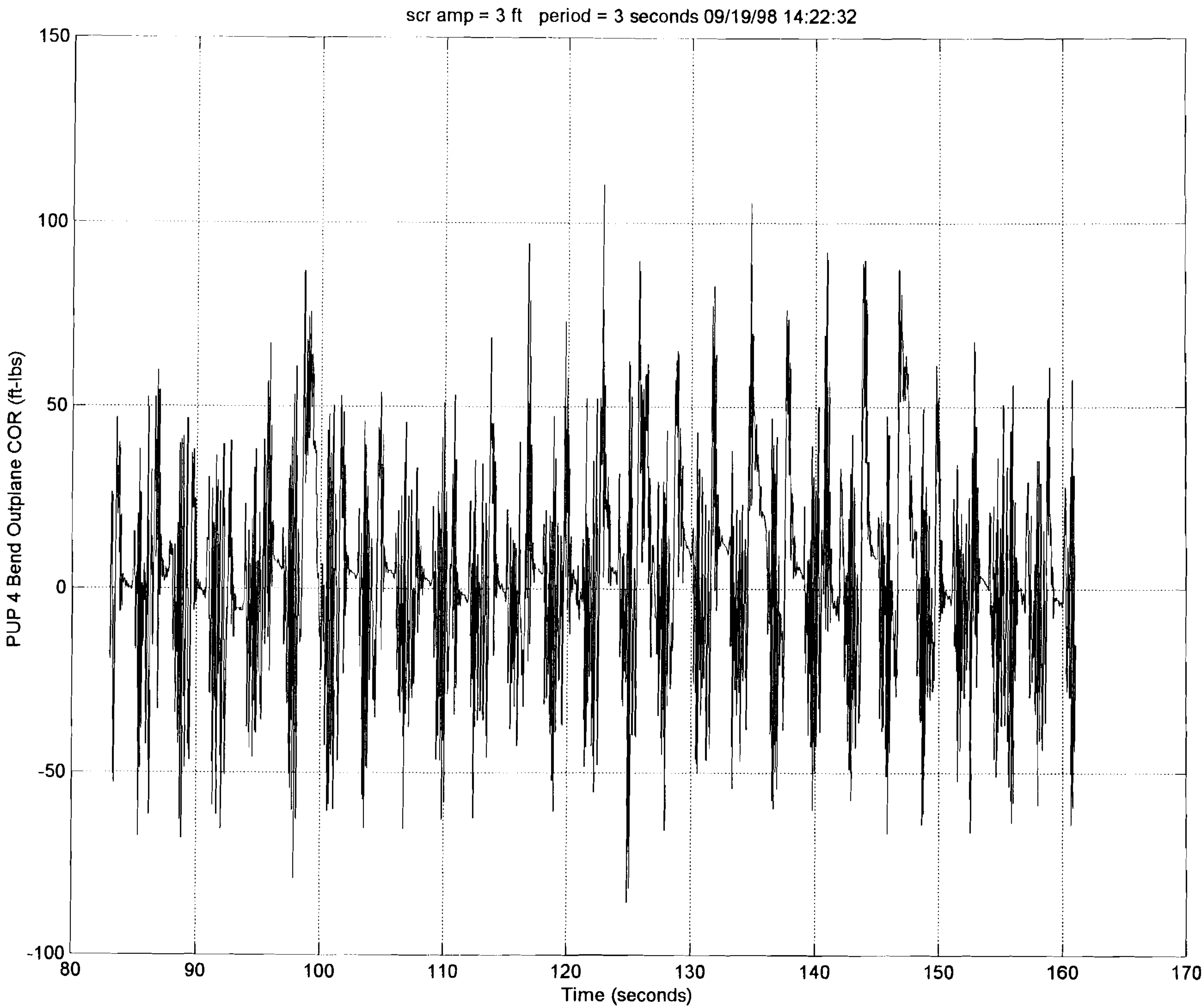

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
1500
1000
500
0
-500
-1000
PUP 2 Tension COR (lbs)
80
90
100
110
120
130
140
150
160
170
Time (seconds)

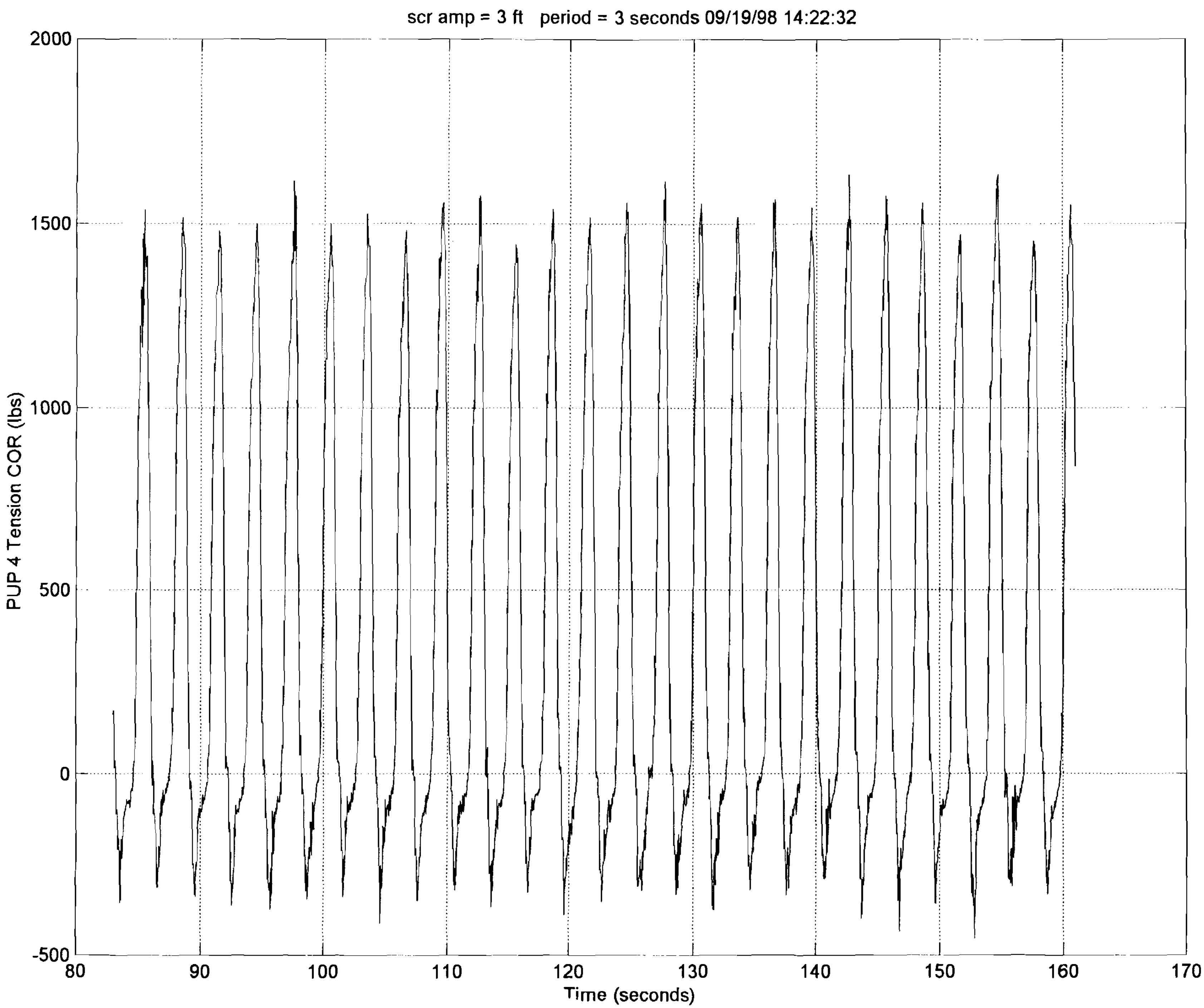

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 3 Bend Inplane COR (ft-lbs)
Time (seconds)
150
100
50
0
-50
-100
-150
-200
-250
80
90
100
110
120
130
140
150
160
170

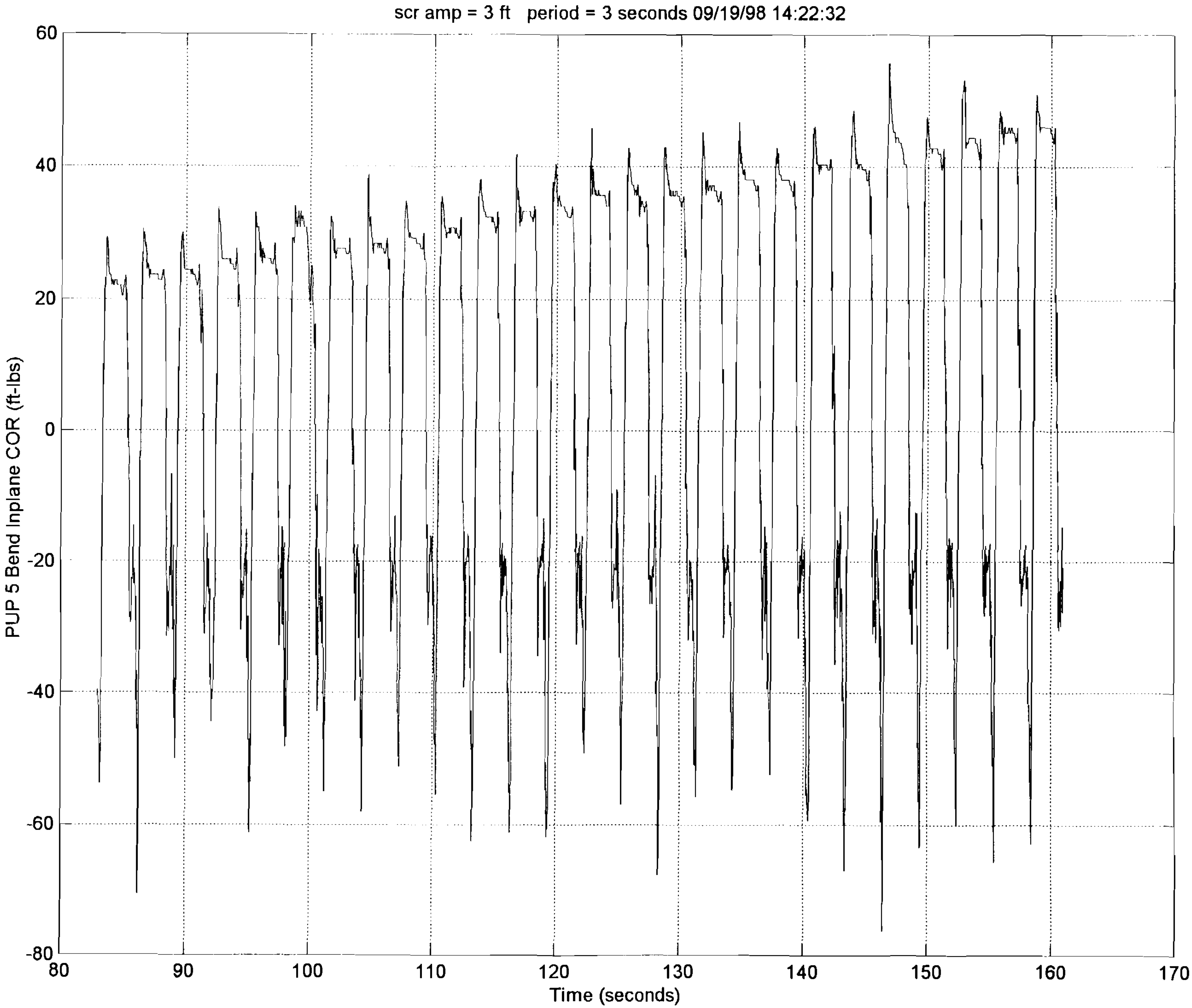

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 3 Bend Outplane COR (ft-lbs)
200
150
100
50
0
-50
-100
-150
-200
80
90
100
110
120
130
140
150
160
170
Time (seconds)

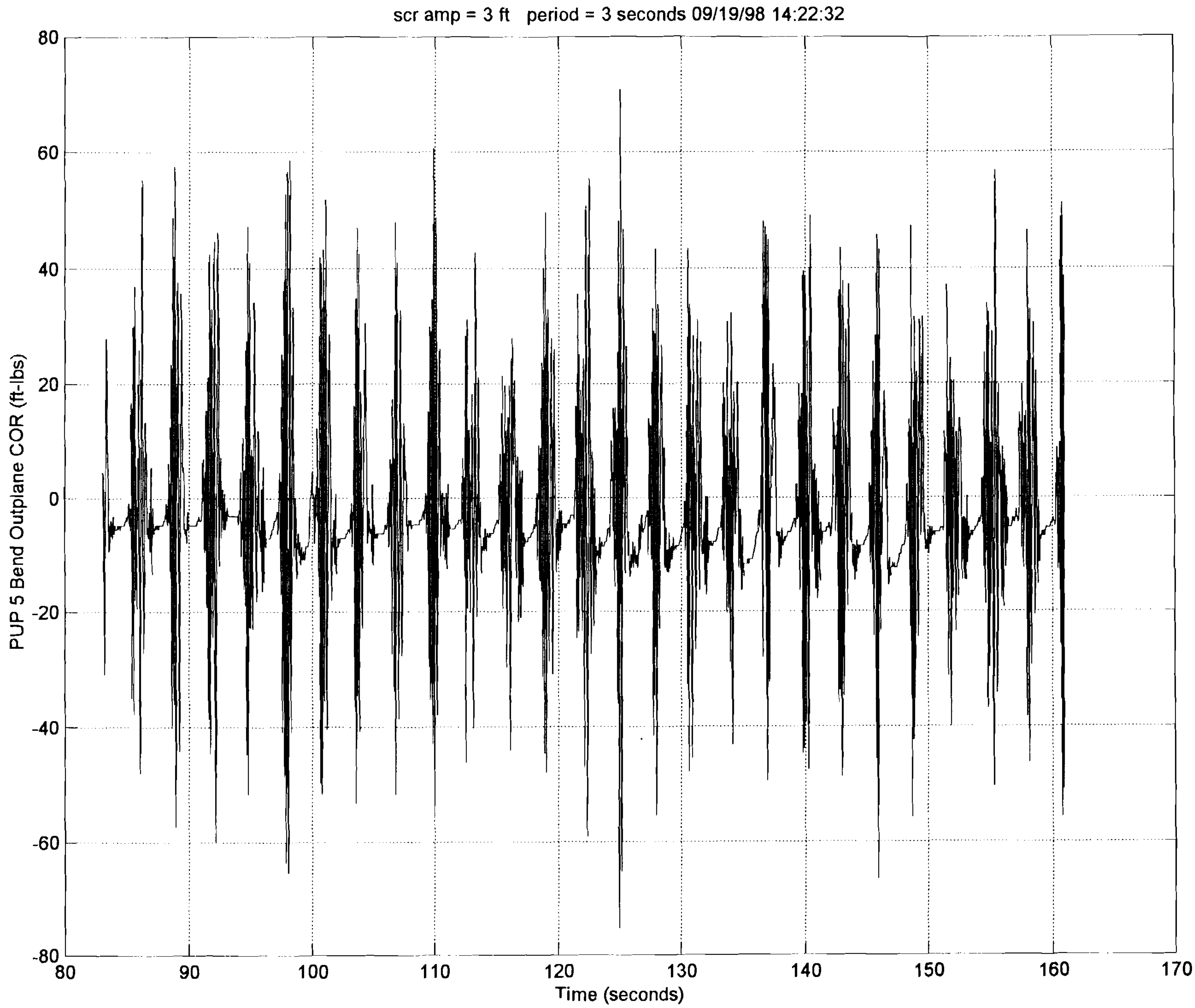

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 3 Tension COR (lbs)
2620
2600
2580
2560
2540
2520
2500
2480
2460
2440
80
90
100
110
120
130
140
150
160
170
Time (seconds)

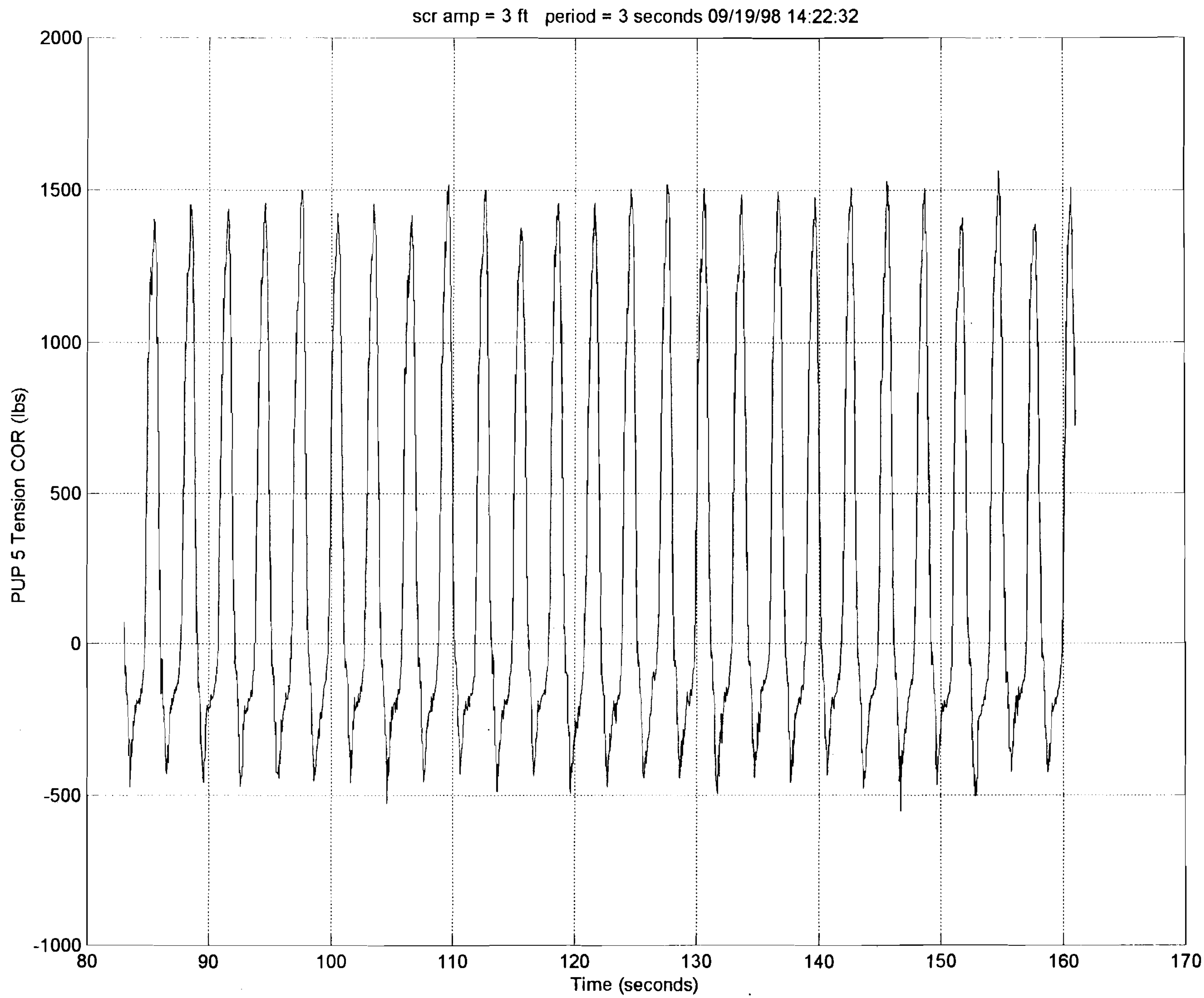

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 4 Bend Inplane COR (ft-lbs)
Time (seconds)
50
0
-50
-100
-150
-200
-250
80
90
100
110
120
130
140
150
160
170

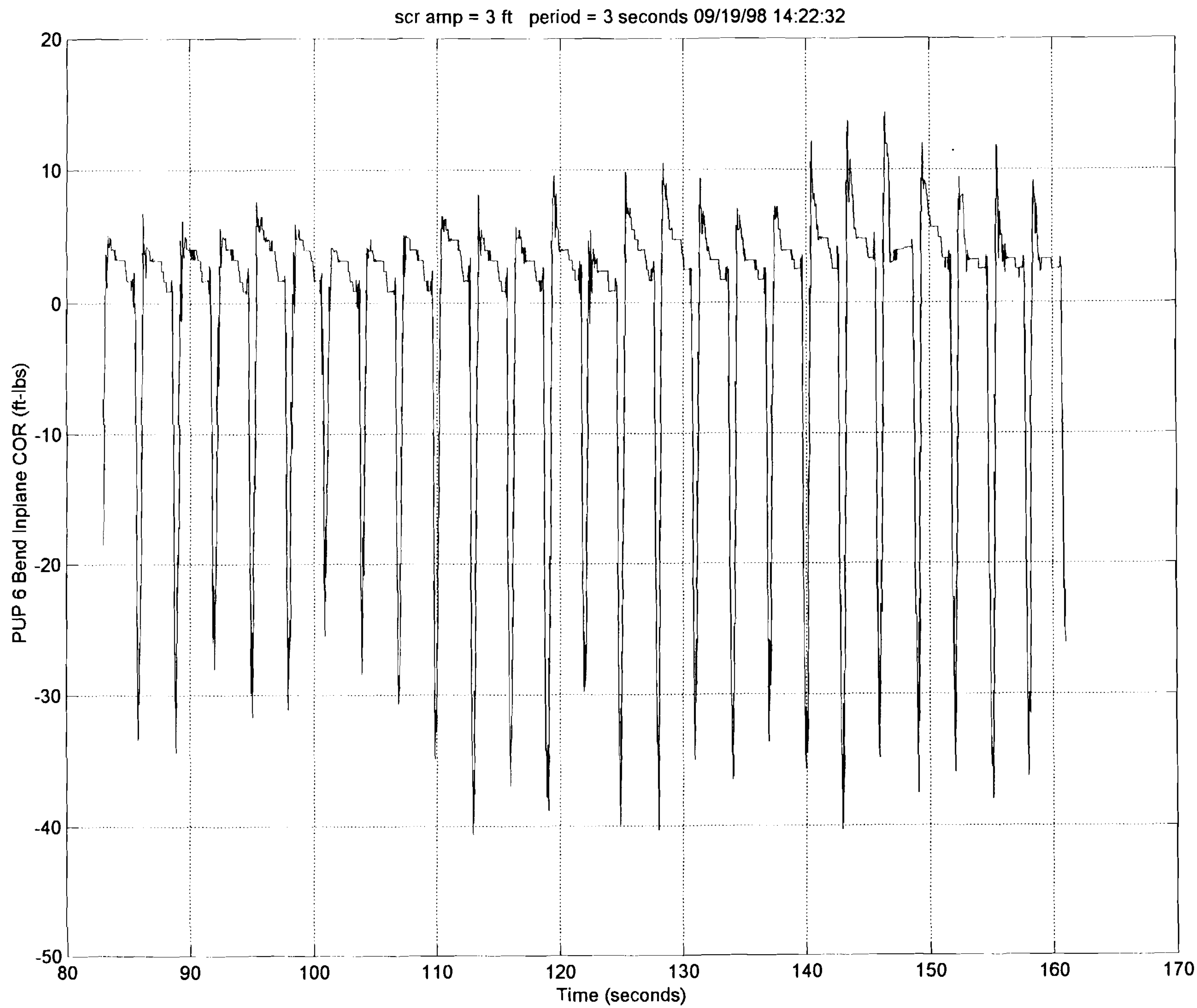

scr amp = 3 ft   period = 3 seconds 09/19/98 14:22:32
150
100
50
0
-50
-100
80
90
100
110
120
130
140
150
160
170
PUP 4 Bend Outplane COR (ft-lbs)
Time (seconds)

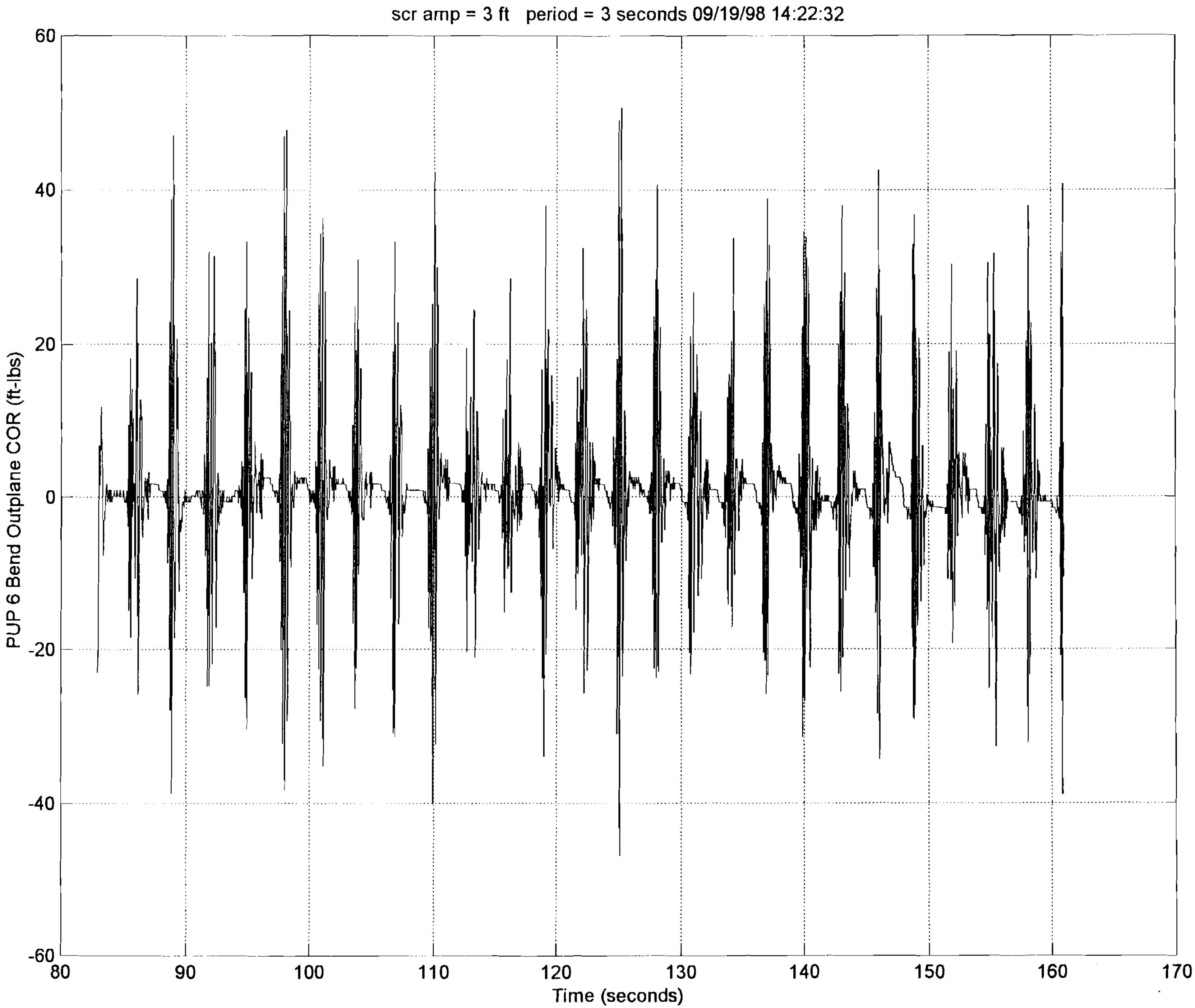

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 4 Tension COR (lbs)
2000
1500
1000
500
0
-500
80
90
100
110
120
130
140
150
160
170
Time (seconds)

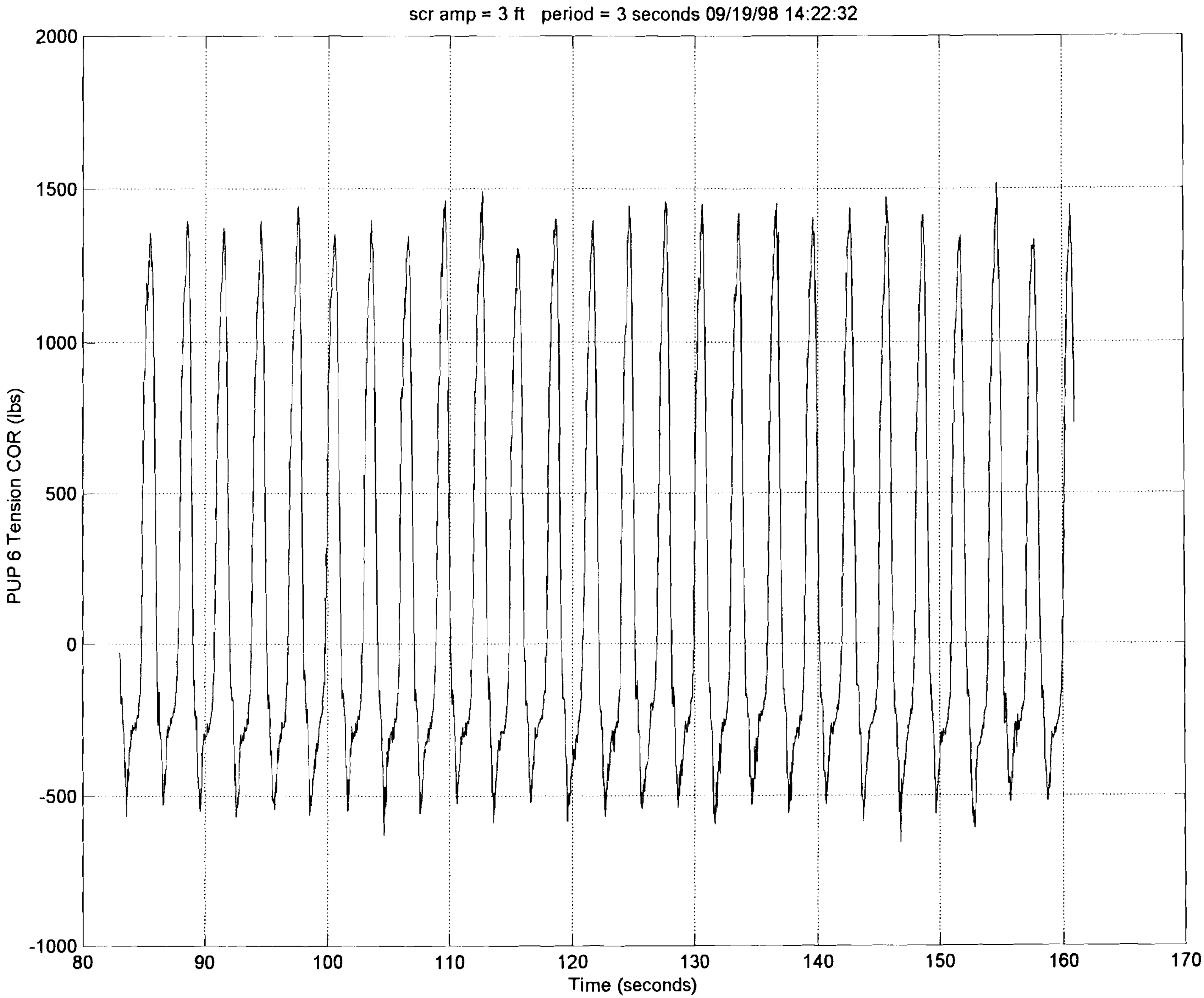

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 5 Bend Inplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
-80
80
90
100
110
120
130
140
150
160
170
Time (seconds)


scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 5 Bend Outplane COR (ft-lbs)
80
60
40
20
0
-20
-40
-60
-80
80
90
100
110
120
130
140
150
160
170
Time (seconds)

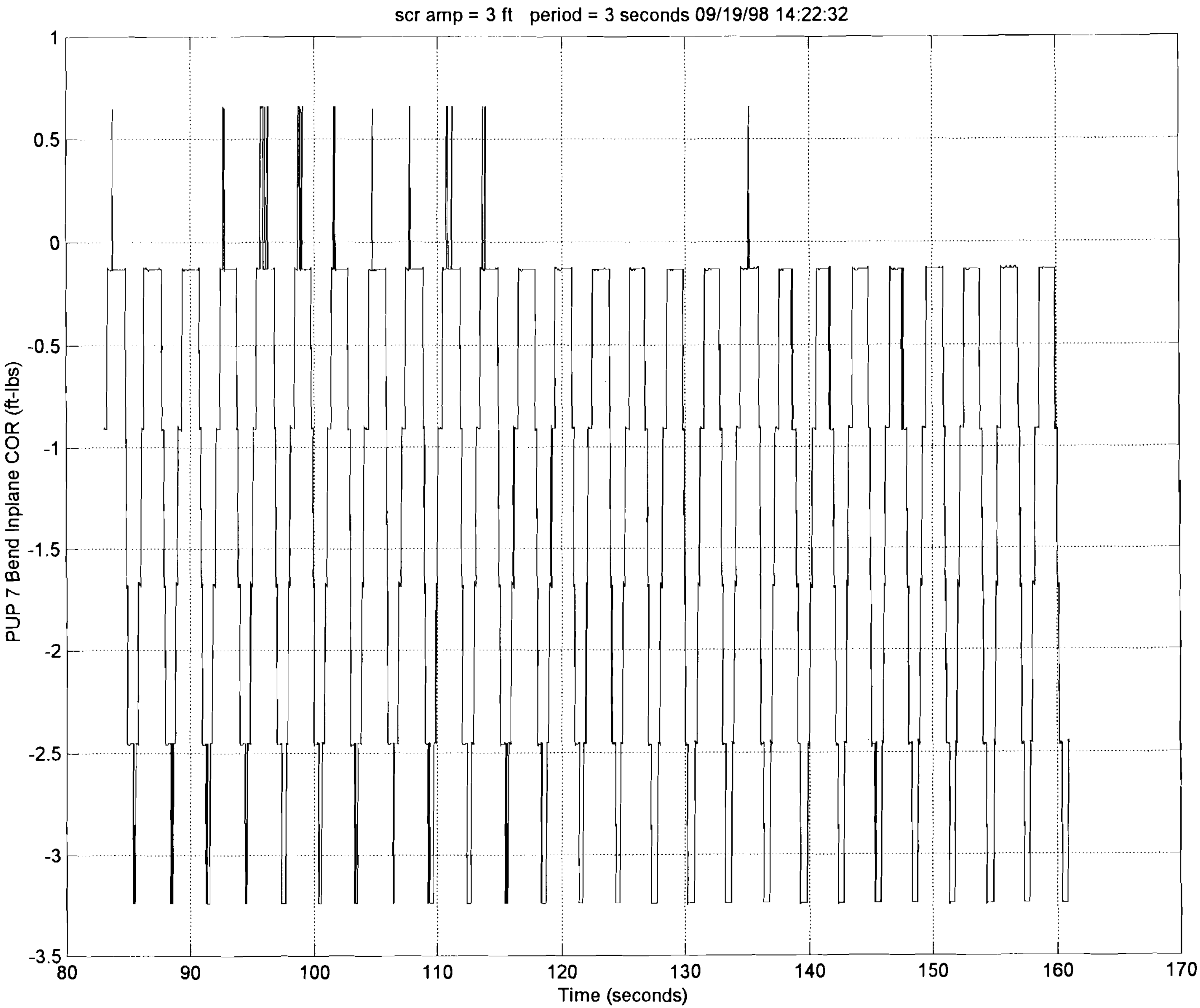

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 5 Tension COR (lbs)
2000
1500
1000
500
0
-500
-1000
80
90
100
110
120
130
140
150
160
170
Time (seconds)

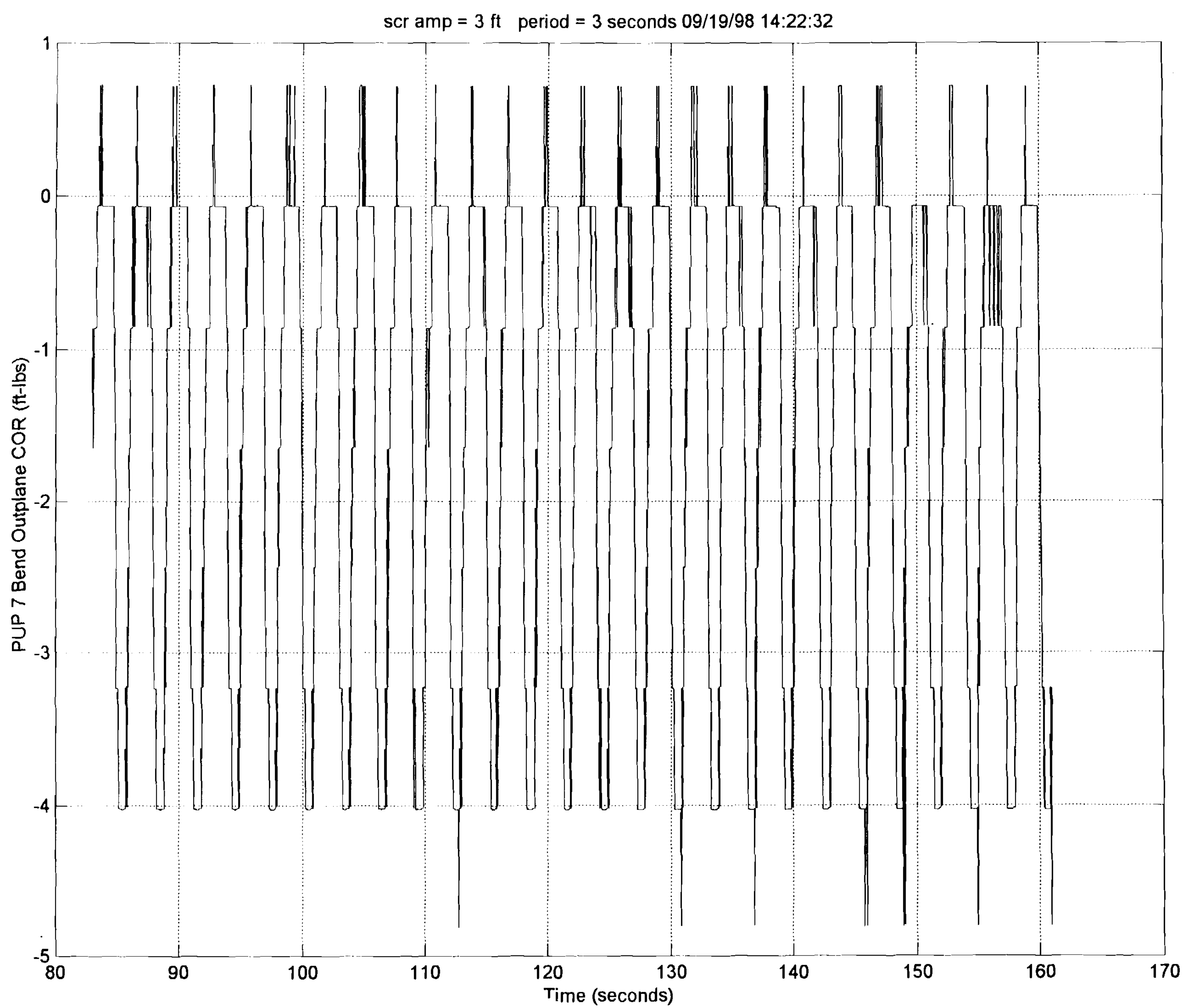

scr amp = 3 ft   period = 3 seconds 09/19/98 14:22:32
20
10
0
-10
-20
-30
-40
-50
PUP 6 Bend Inplane COR (ft-lbs)
80
90
100
110
120
130
140
150
160
170
Time (seconds)

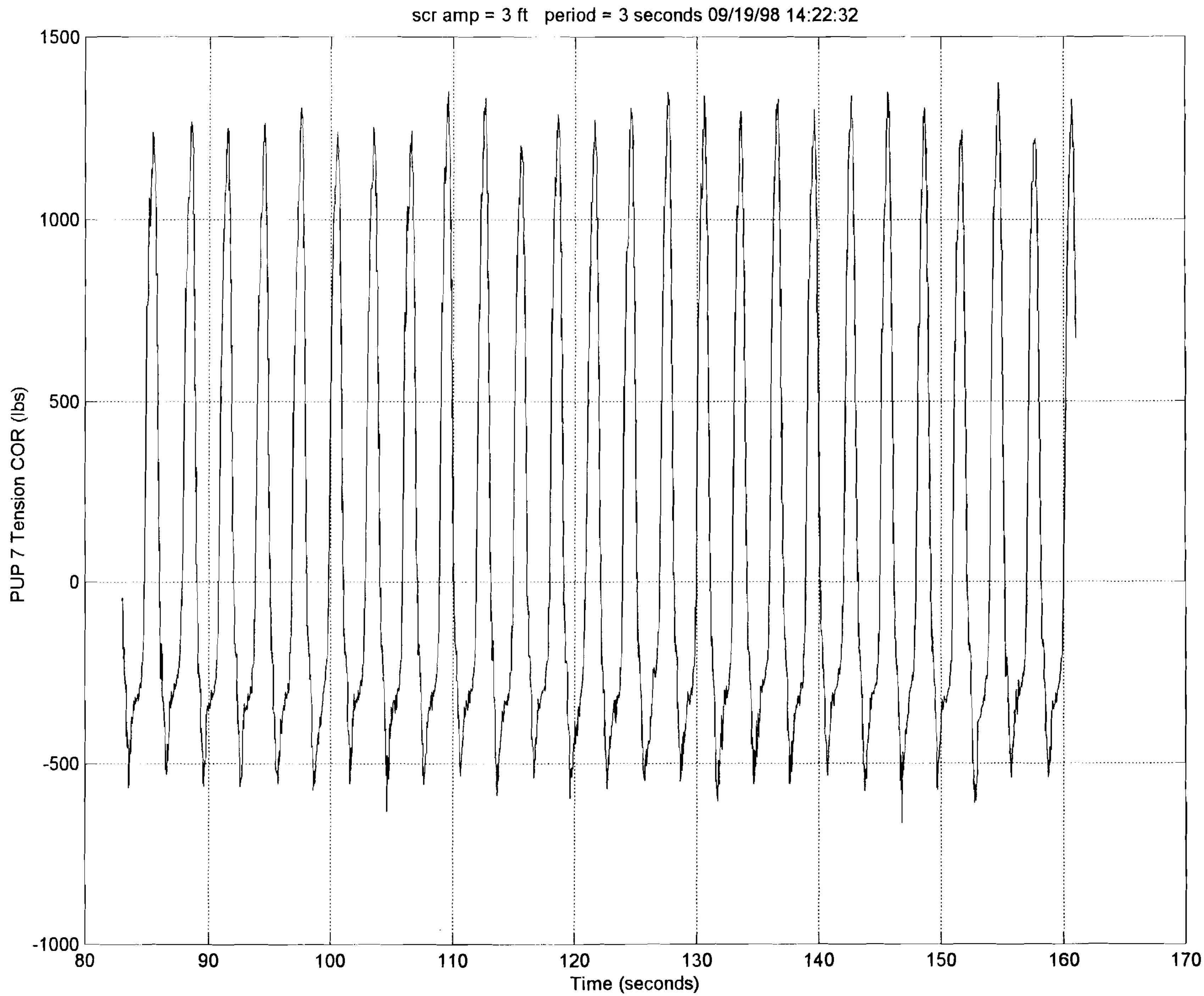

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 6 Bend Outplane COR (ft-lbs)
Time (seconds)
60
40
20
0
-20
-40
-60
80
90
100
110
120
130
140
150
160
170

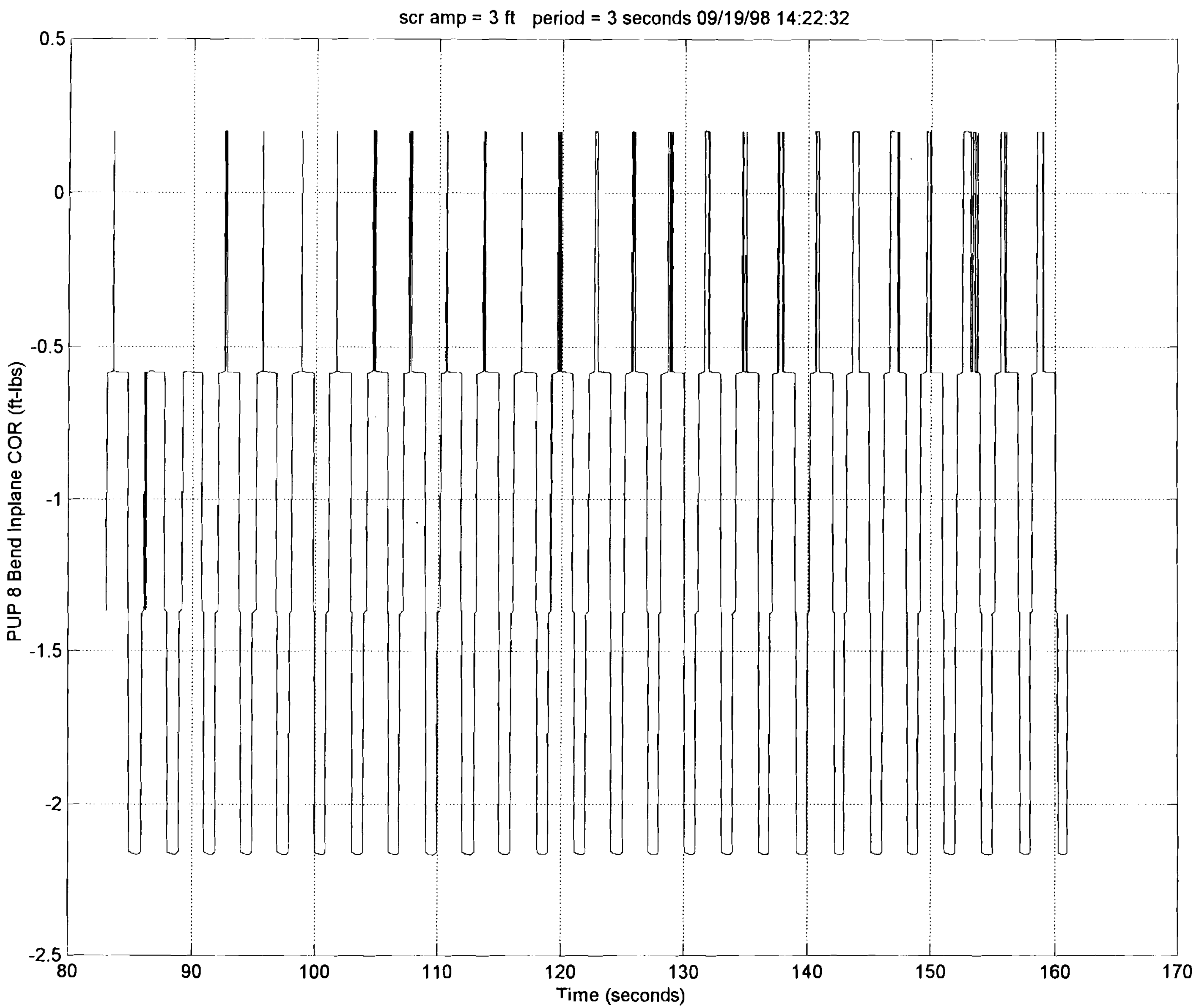


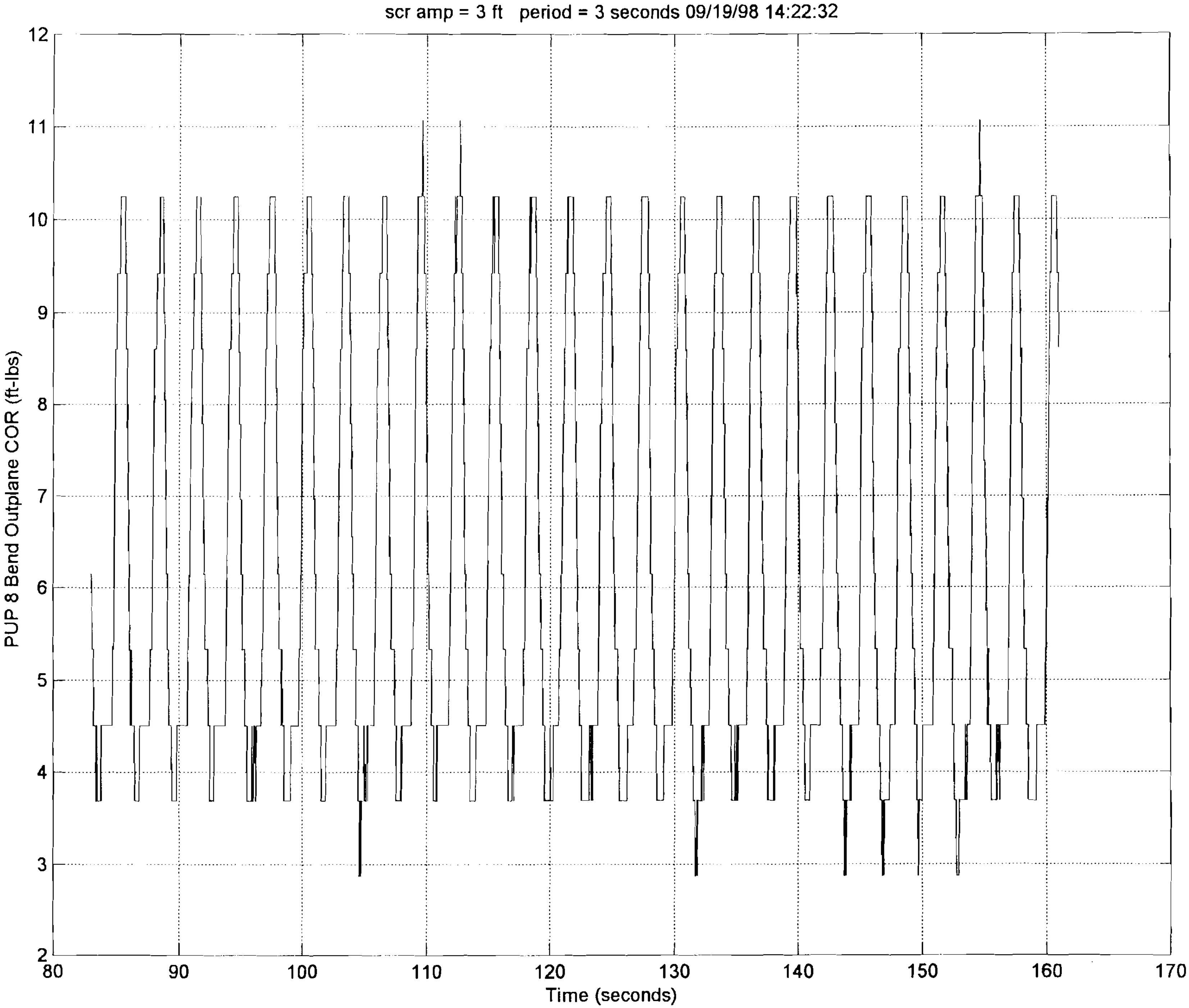
scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 6 Tension COR (lbs)
Time (seconds)
2000
1500
1000
500
0
-500
-1000
80
90
100
110
120
130
140
150
160
170

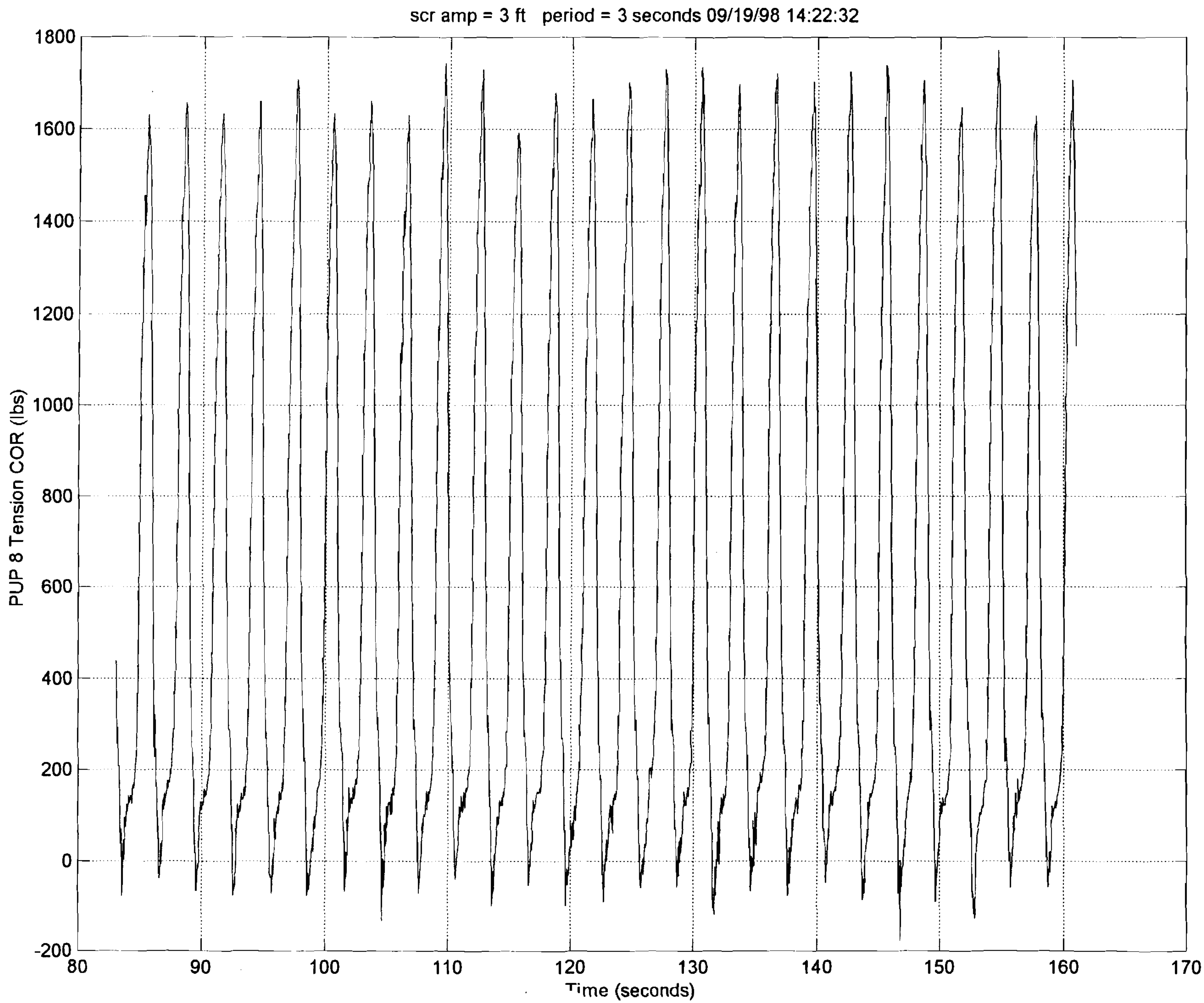

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 7 Bend Inplane COR (ft-lbs)
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
80
90
100
110
120
130
140
150
160
170
Time (seconds)

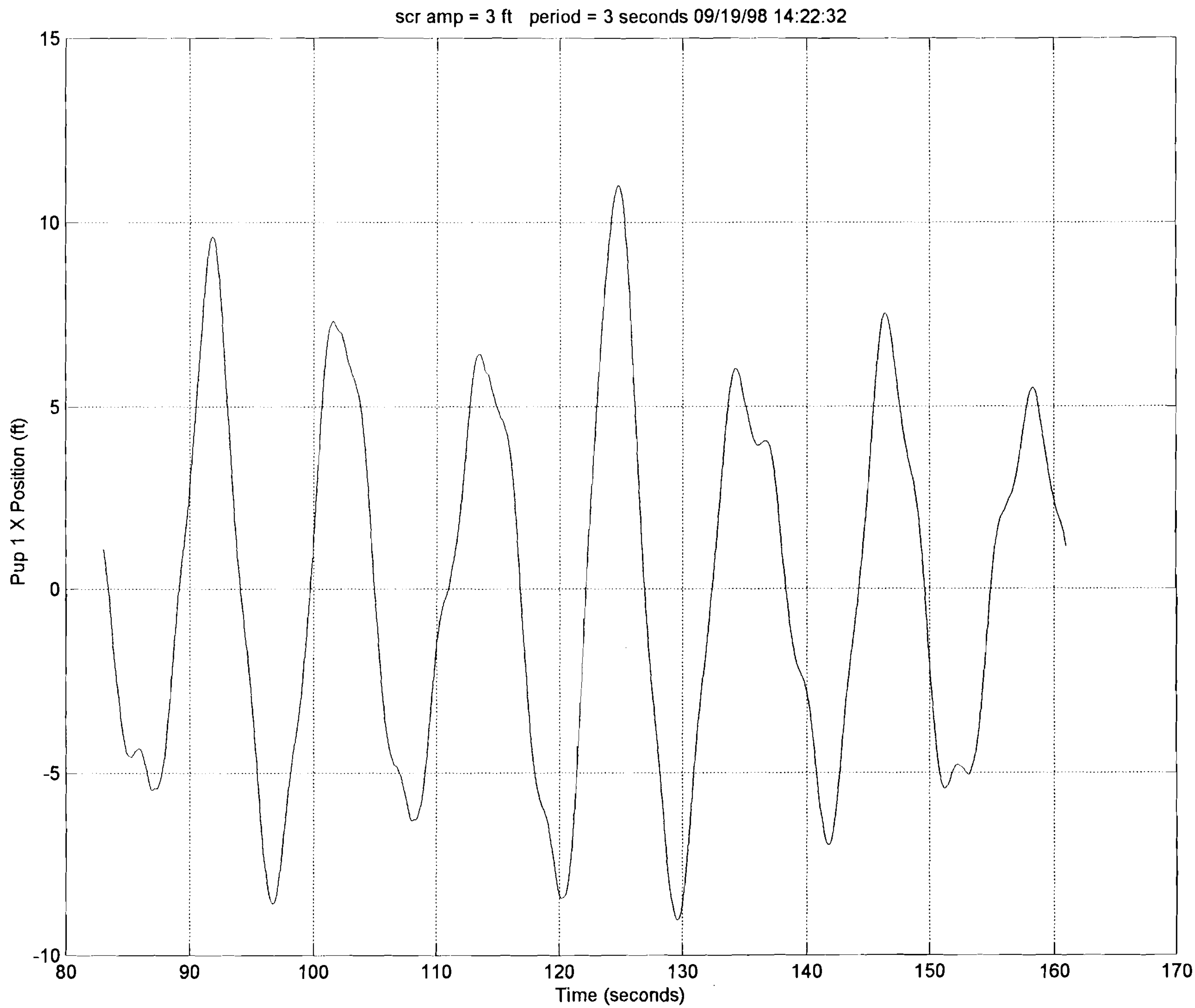

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 7 Bend Outplane COR (ft-lbs)
Time (seconds)
1
0
-1
-2
-3
-4
-5
80
90
100
110
120
130
140
150
160
170

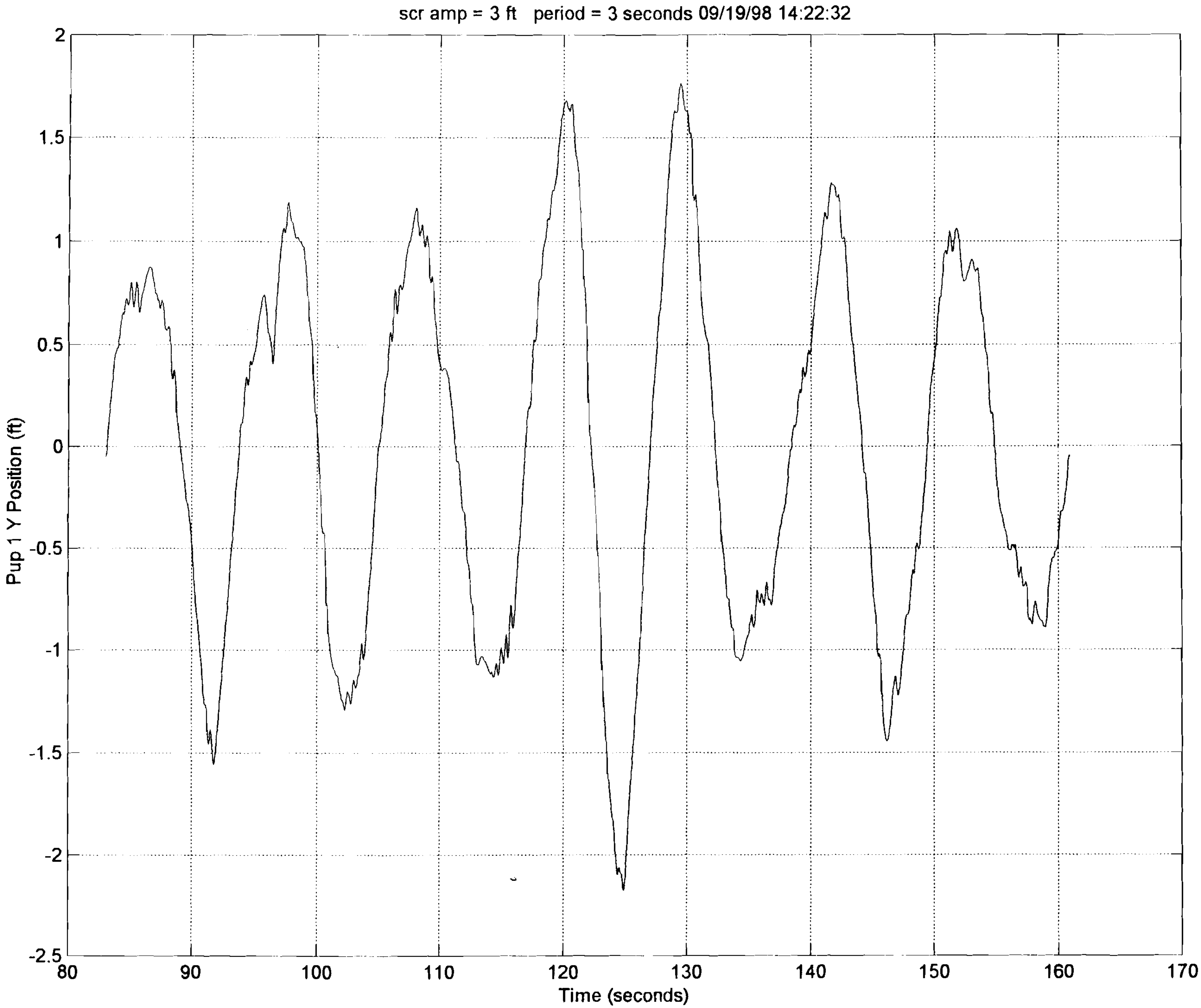

scr amp = 3 ft   period = 3 seconds 09/19/98 14:22:32
PUP 7 Tension COR (lbs)
Time (seconds)
1500
1000
500
0
-500
-1000
80
90
100
110
120
130
140
150
160
170

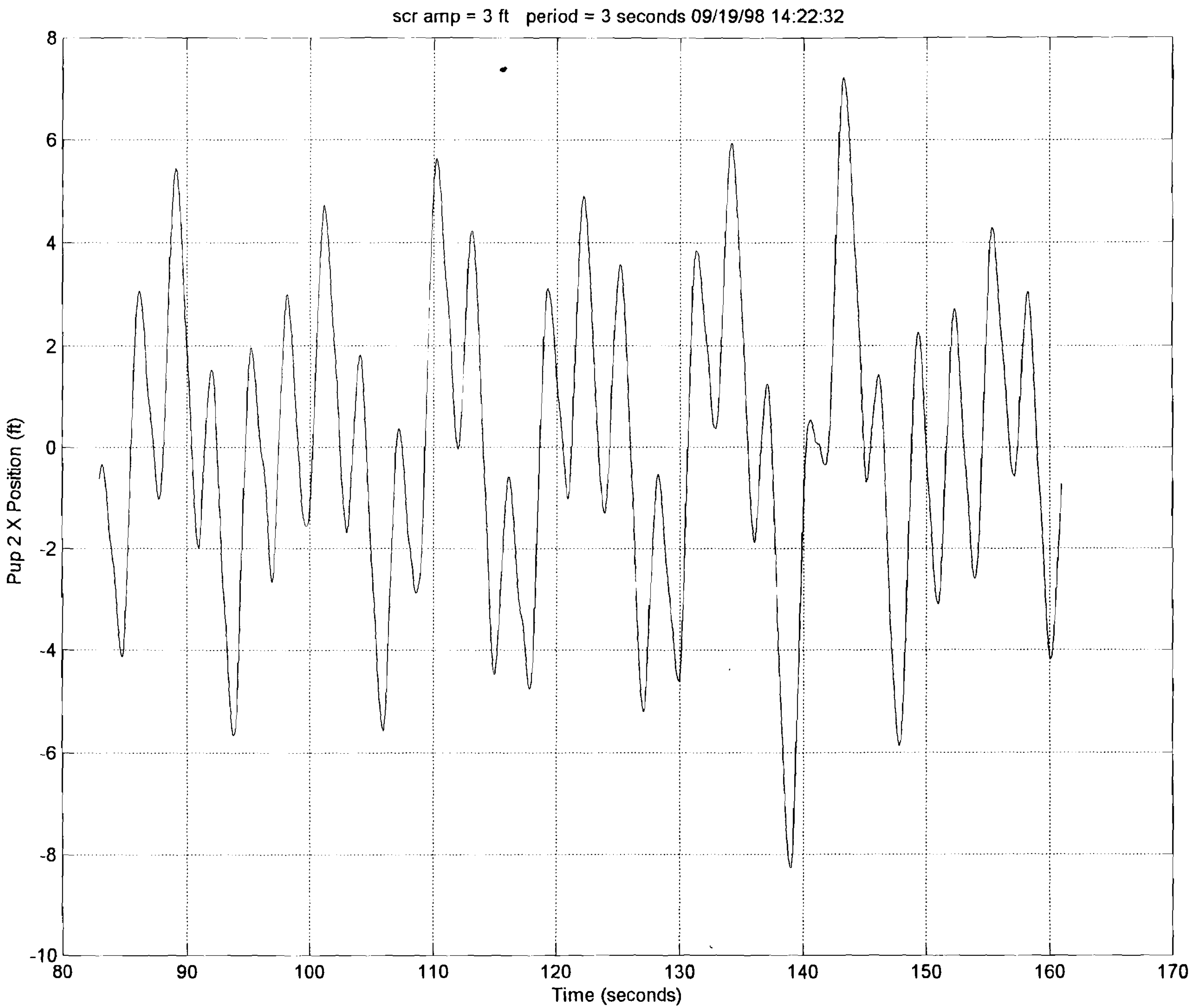

scr amp = 3 ft   period = 3 seconds 09/19/98 14:22:32
PUP 8 Bend Inplane COR (ft-lbs)
0.5
0
-0.5
-1
-1.5
-2
-2.5
80
90
100
110
120
130
140
150
160
170
Time (seconds)

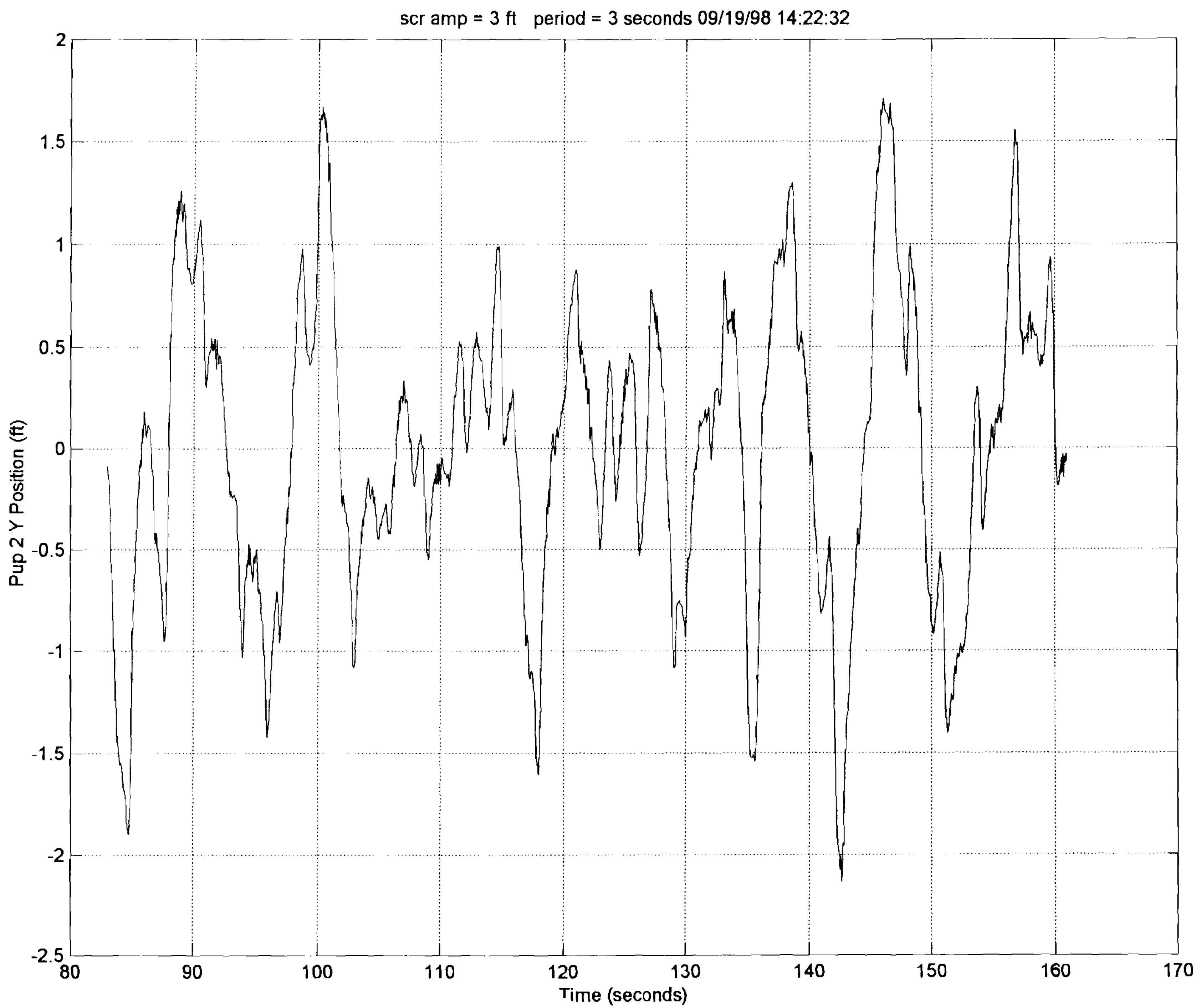

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 8 Bend Outplane COR (ft-lbs)
Time (seconds)
2
3
4
5
6
7
8
9
10
11
12
80
90
100
110
120
130
140
150
160
170

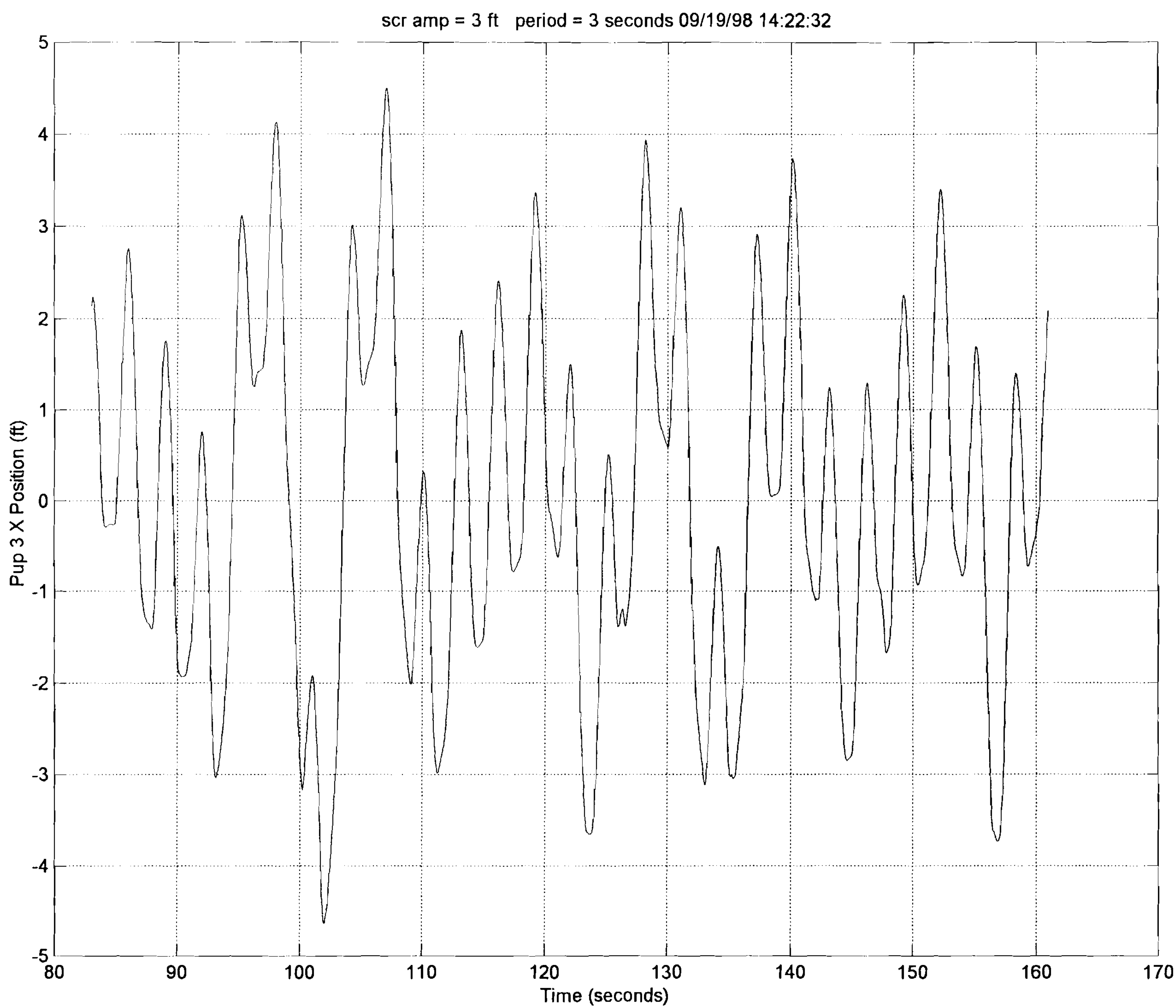

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
PUP 8 Tension COR (lbs)
1800
1600
1400
1200
1000
800
600
400
200
0
-200
80
90
100
110
120
130
140
150
160
170
Time (seconds)

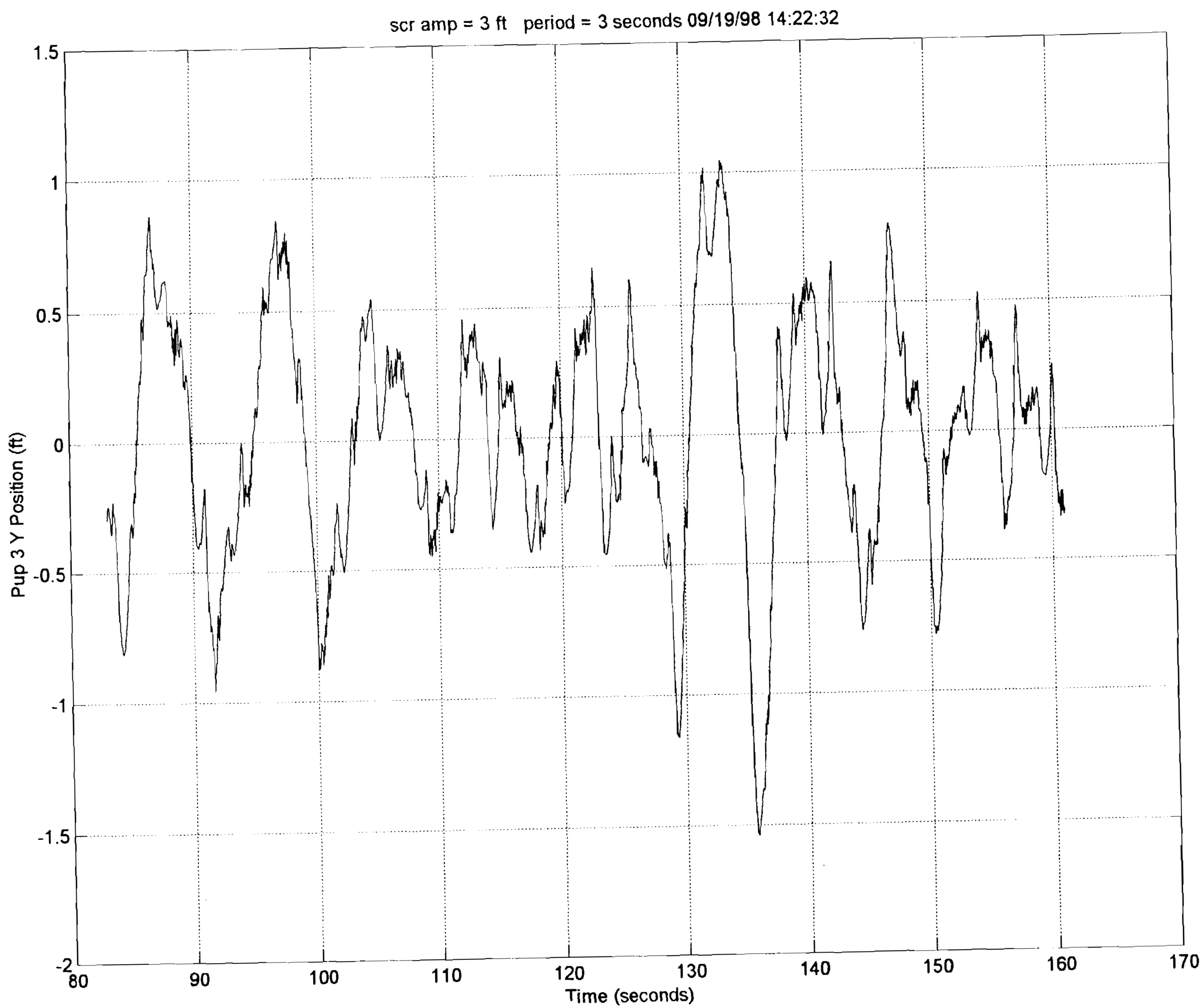

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 1 X Position (ft)
15
10
5
0
-5
-10
80
90
100
110
120
130
140
150
160
170
Time (seconds)

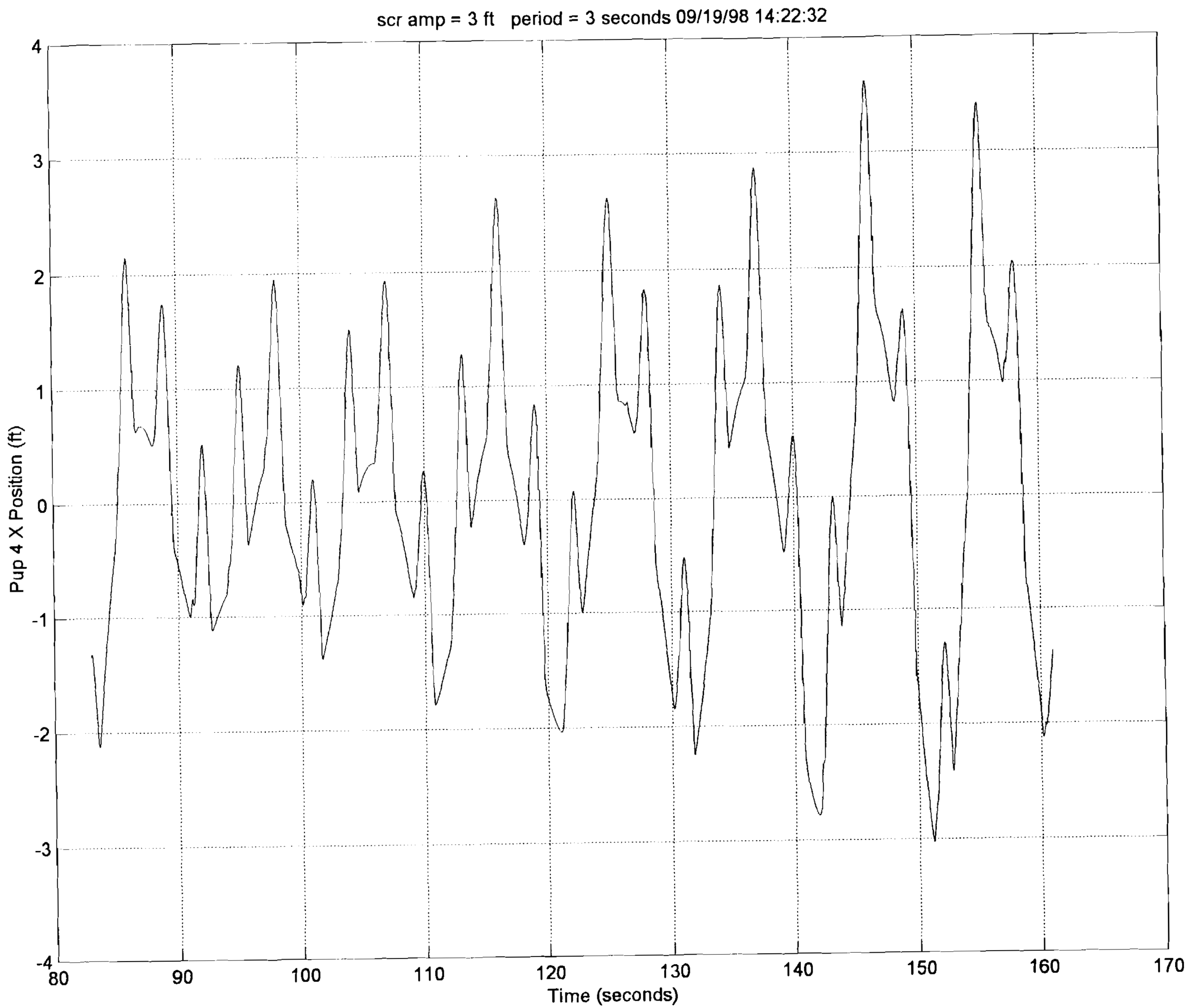

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 1 Y Position (ft)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
80
90
100
110
120
130
140
150
160
170
Time (seconds)

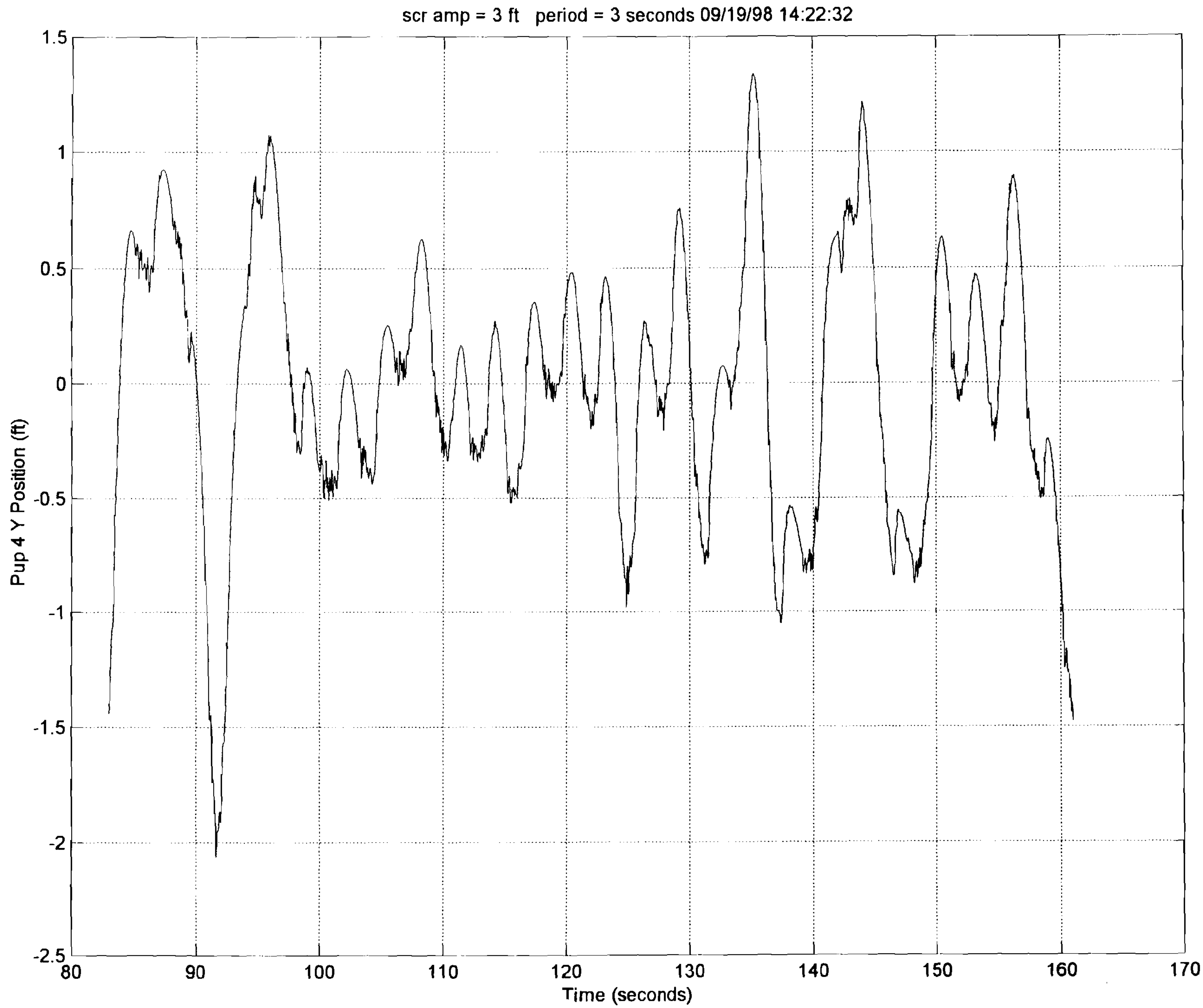

scr amp = 3 ft   period = 3 seconds 09/19/98 14:22:32
Pup 2 X Position (ft)
Time (seconds)
8
6
4
2
0
-2
-4
-6
-8
-10
80
90
100
110
120
130
140
150
160
170


scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 2 Y Position (ft)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
80
90
100
110
120
130
140
150
160
170
Time (seconds)

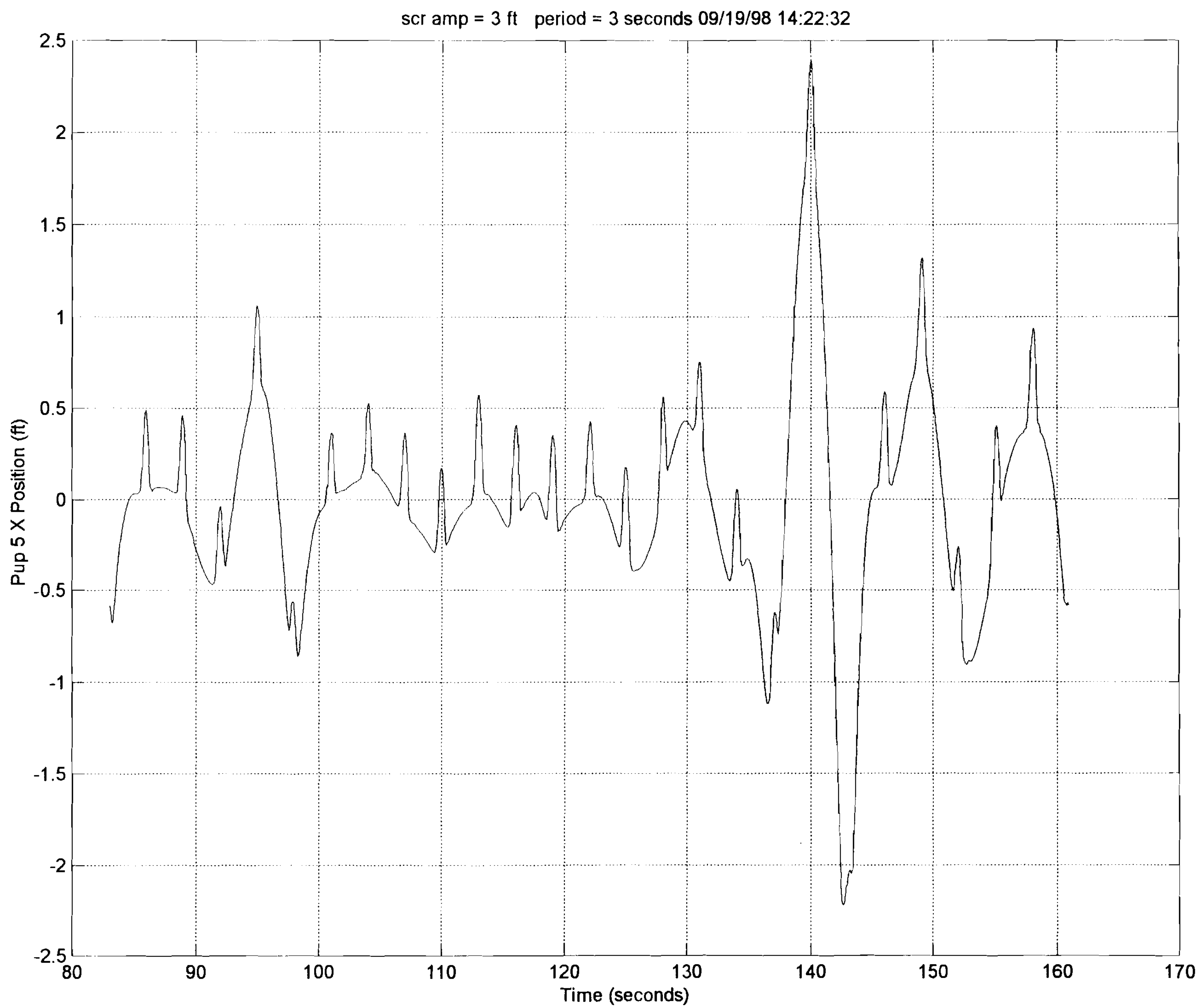

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 3 X Position (ft)
Time (seconds)
5
4
3
2
1
0
-1
-2
-3
-4
-5
80
90
100
110
120
130
140
150
160
170

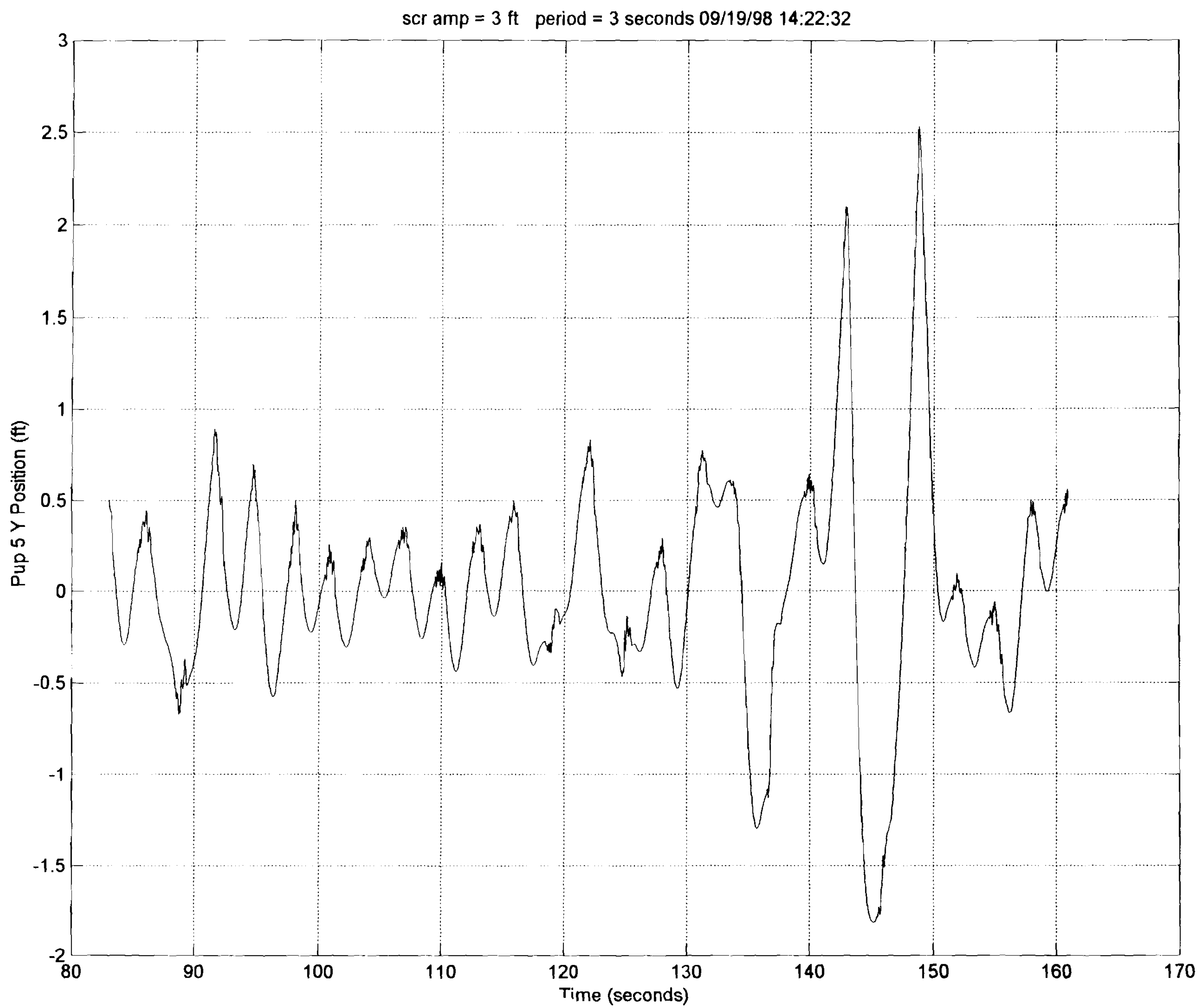

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 3 Y Position (ft)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
80
90
100
110
120
130
140
150
160
170
Time (seconds)

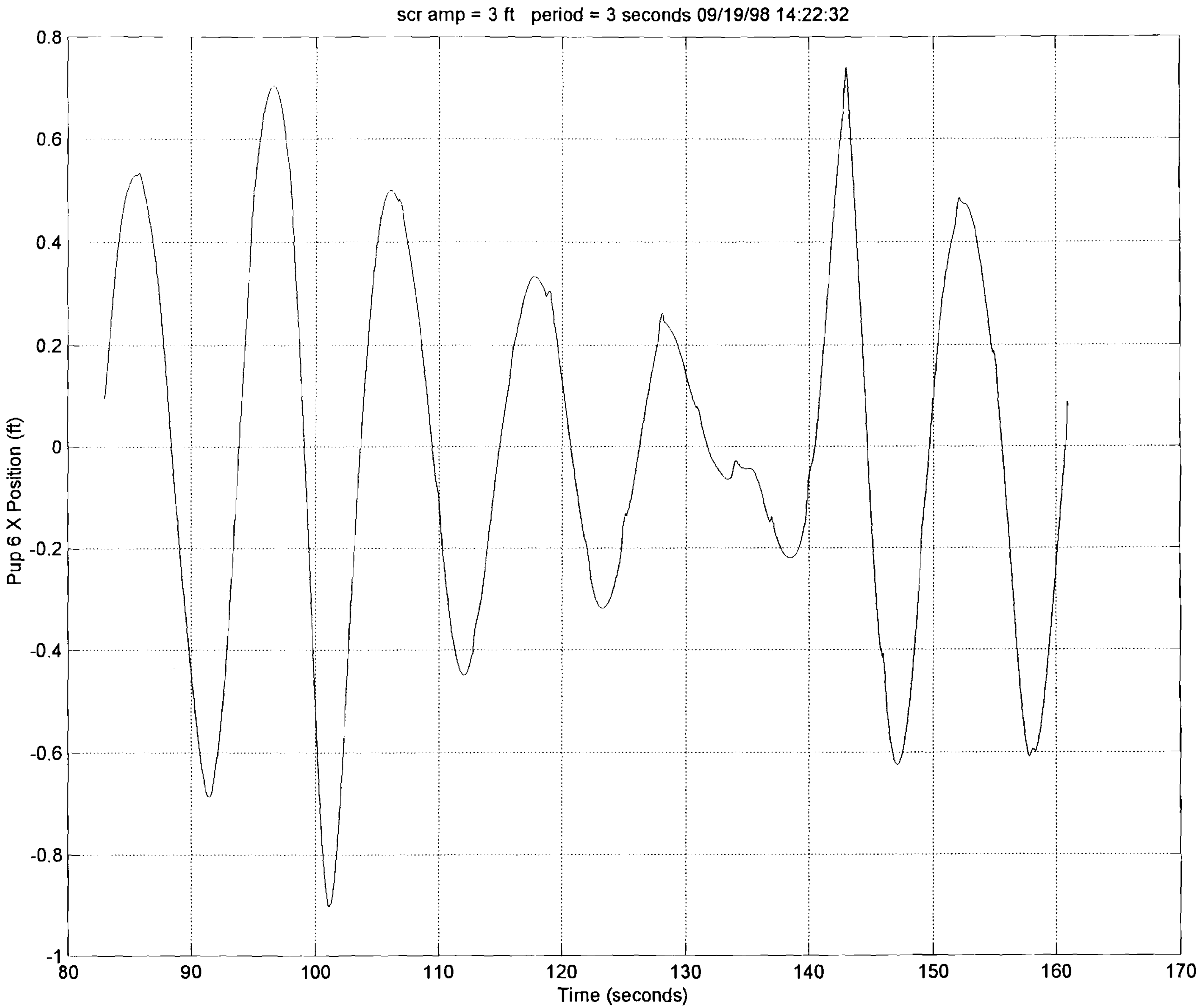

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 4 X Position (ft)
4
3
2
1
0
-1
-2
-3
-4
80
90
100
110
120
130
140
150
160
170
Time (seconds)



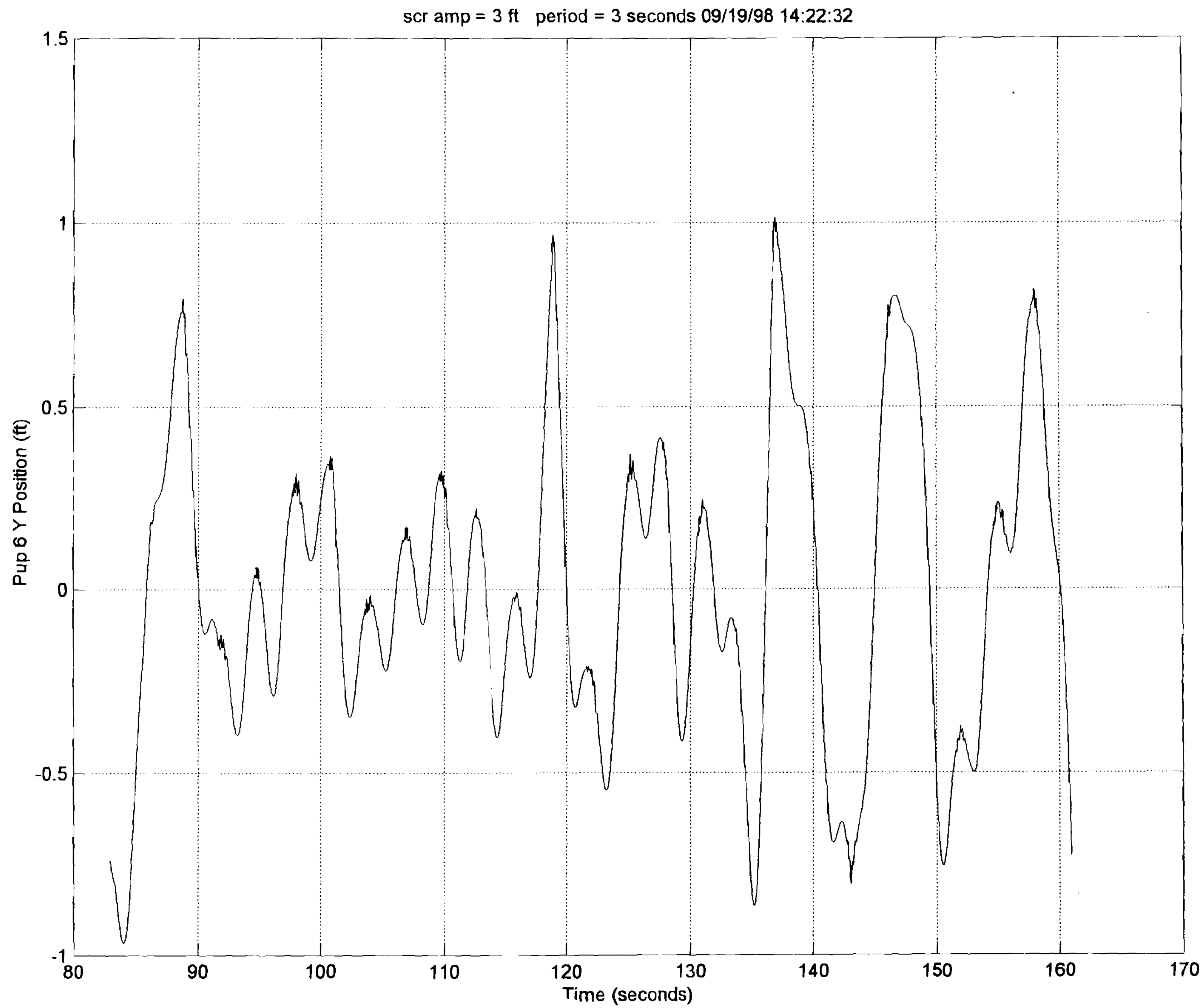
scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 4 Y Position (ft)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
80
90
100
110
120
130
140
150
160
170
Time (seconds)

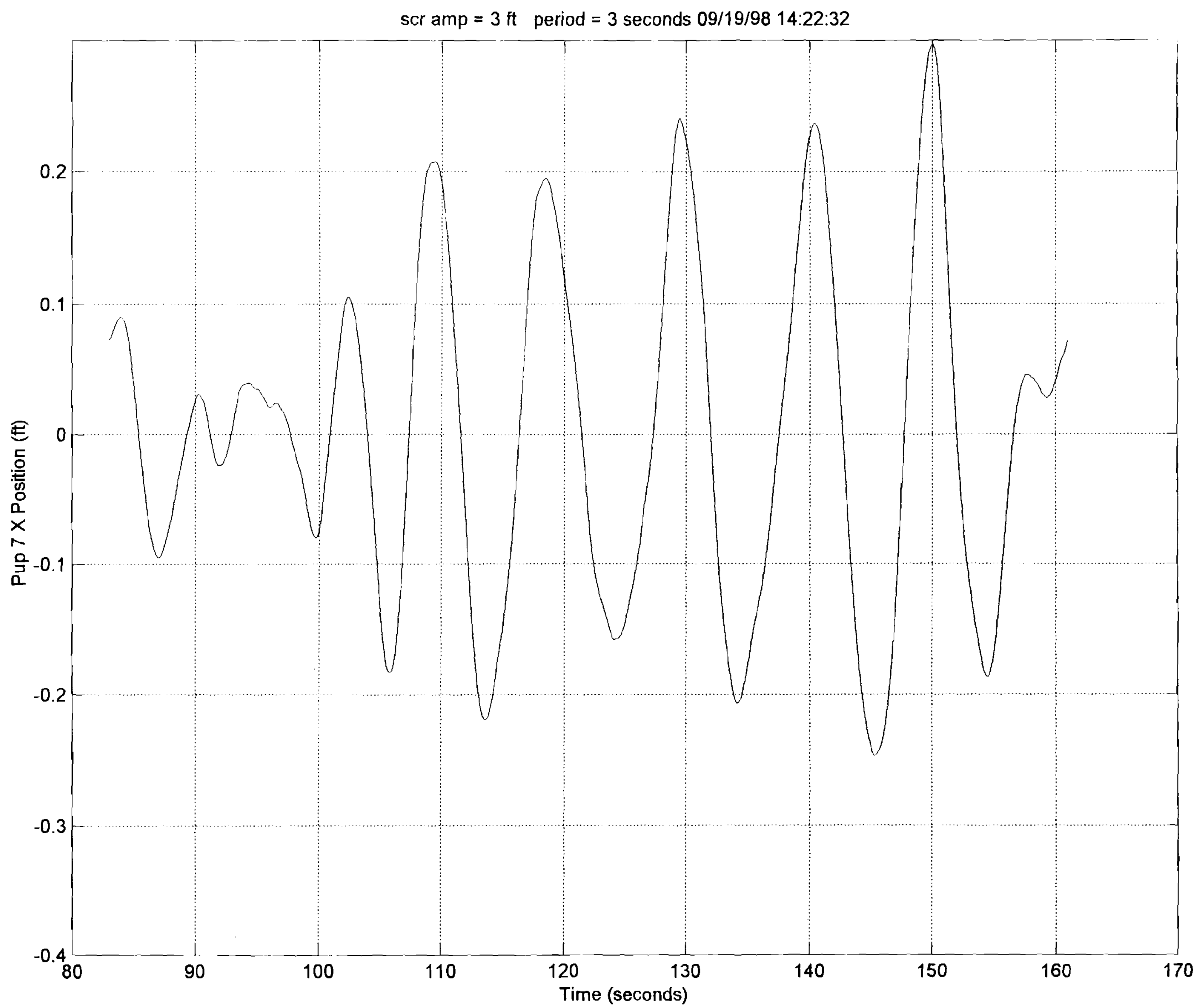

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 5 X Position (ft)
Time (seconds)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
80
90
100
110
120
130
140
150
160
170


scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 5 Y Position (ft)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
80
90
100
110
120
130
140
150
160
170
Time (seconds)

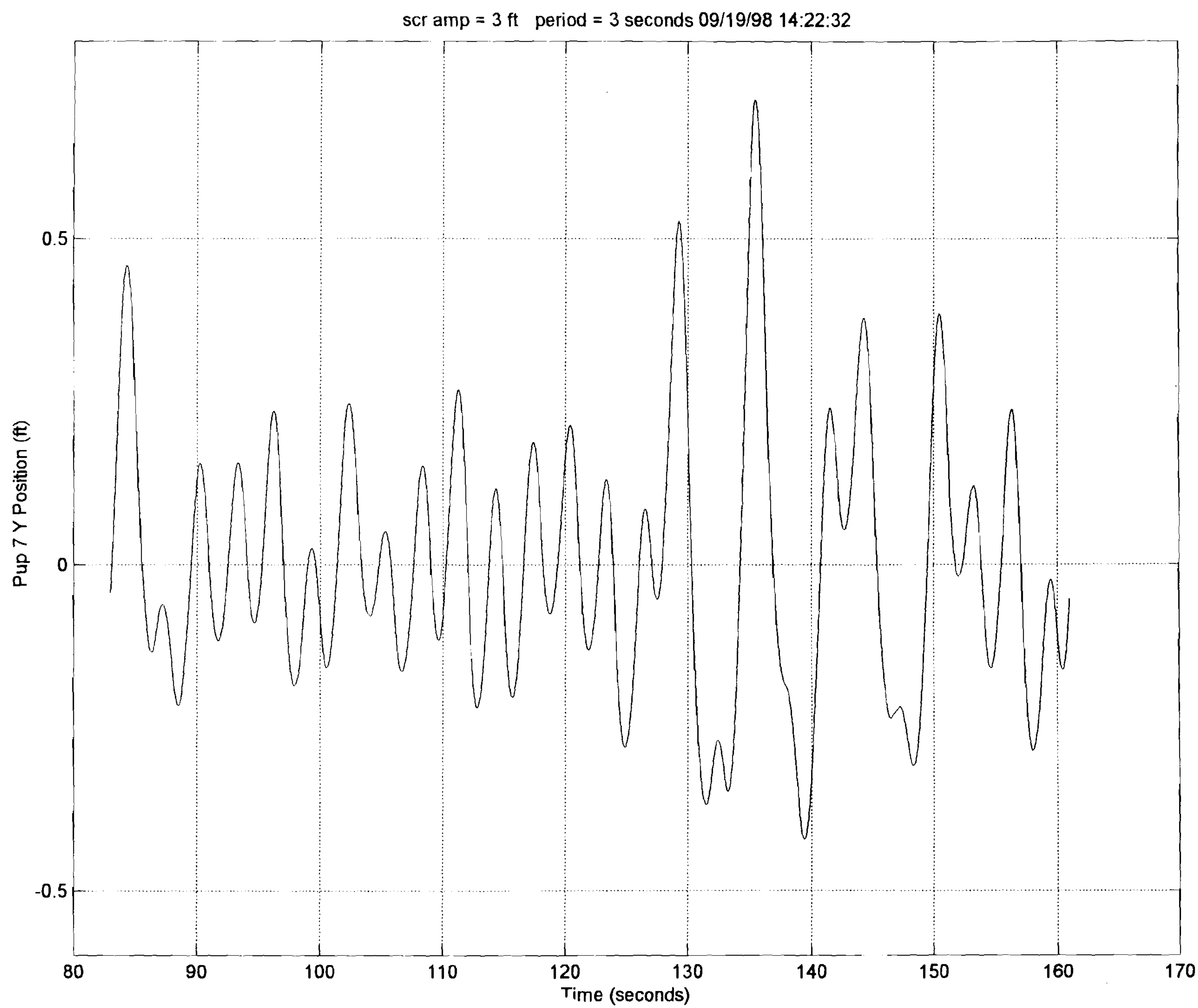


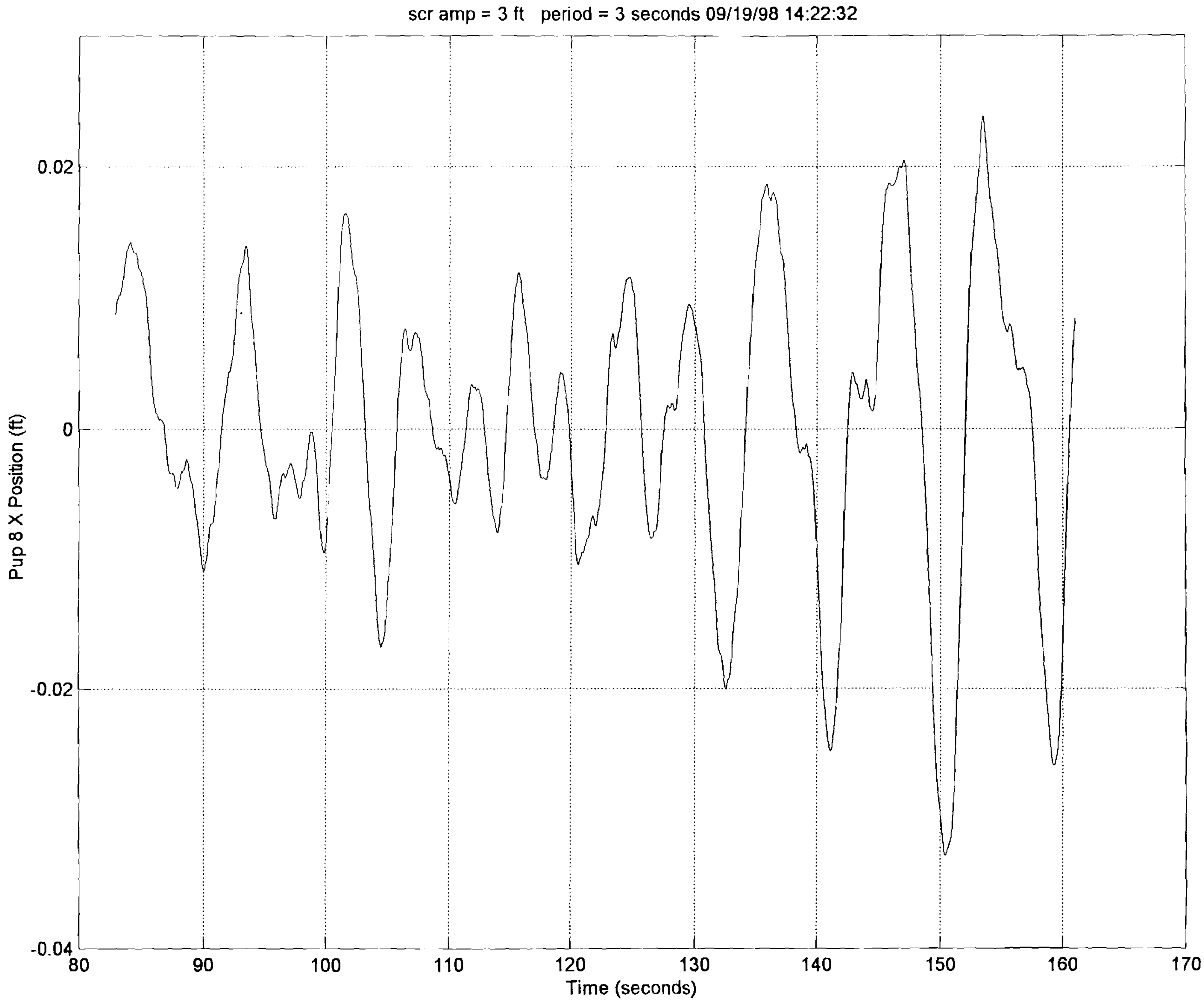
scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 6 X Position (ft)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
80
90
100
110
120
130
140
150
160
170
Time (seconds)

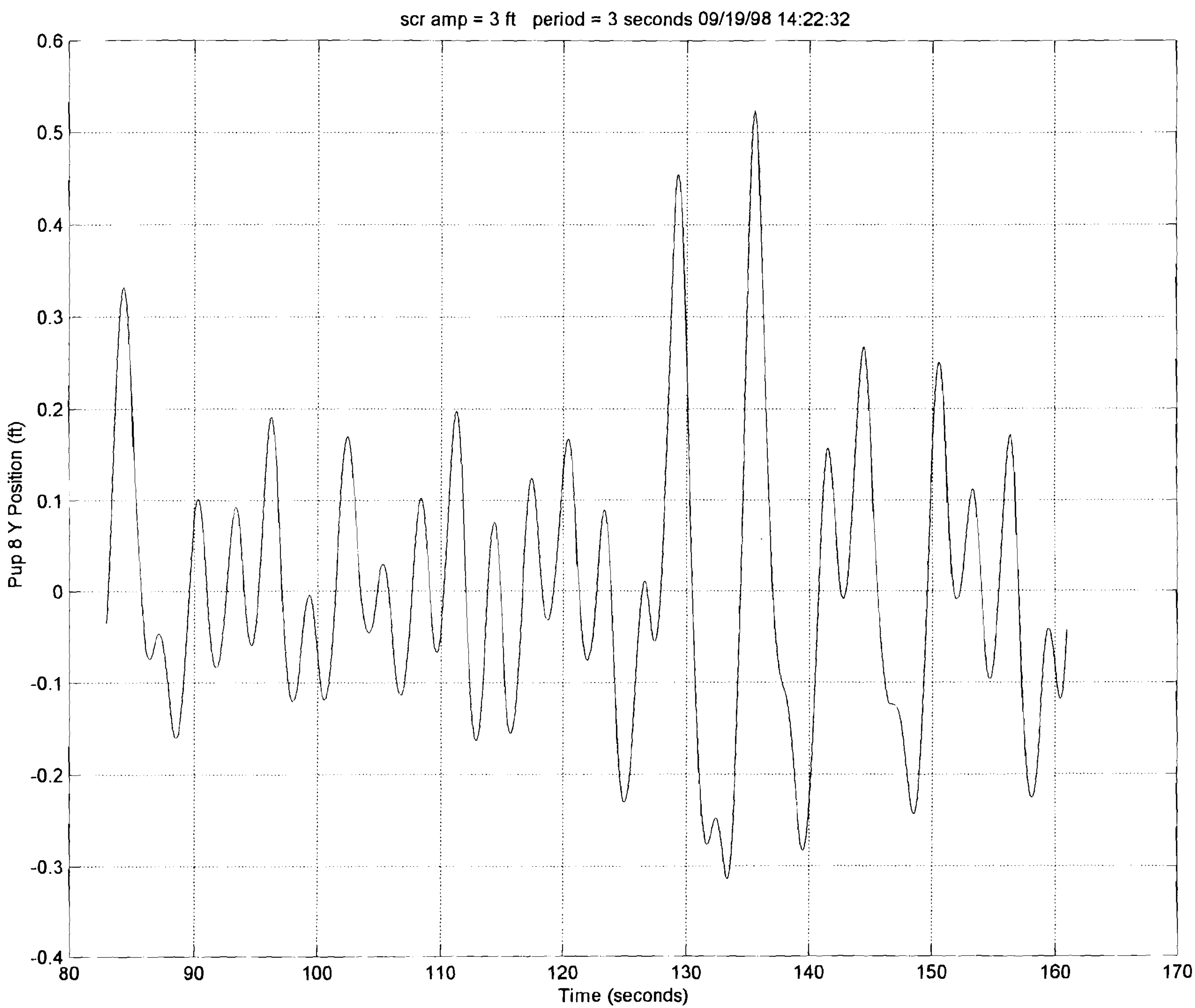

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 6 Y Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
80
90
100
110
120
130
140
150
160
170

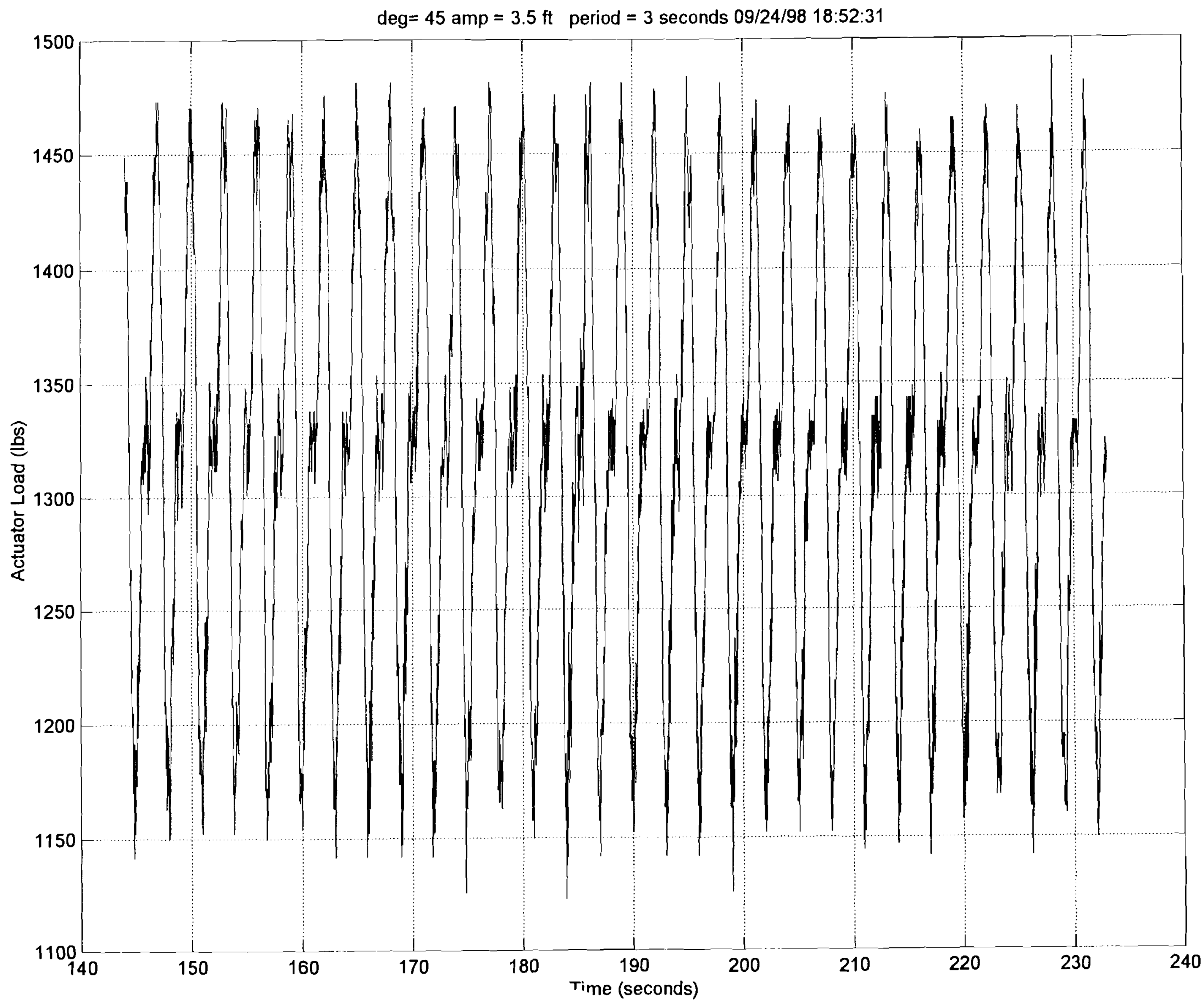


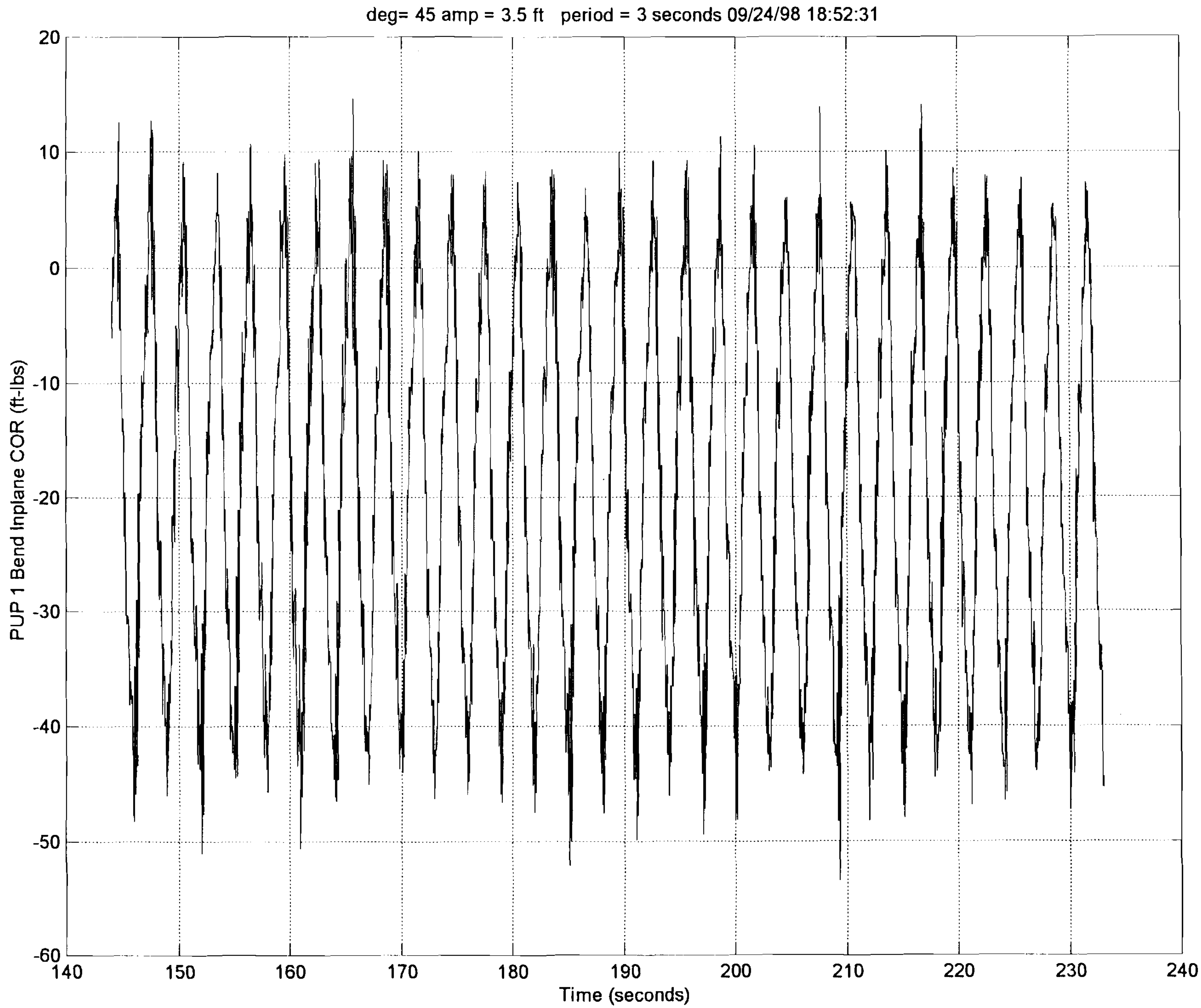
scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 7 X Position (ft)
Time (seconds)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
80
90
100
110
120
130
140
150
160
170

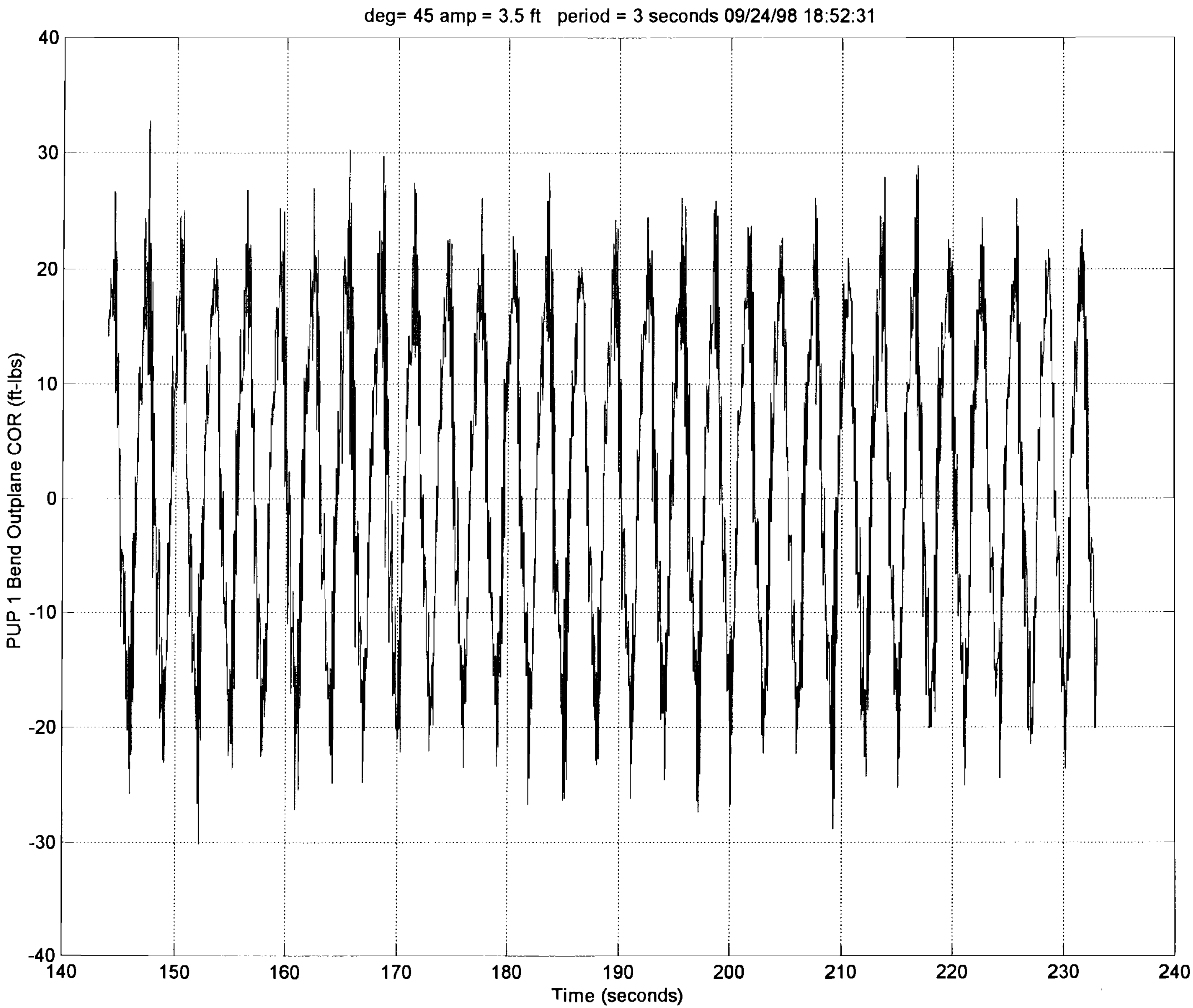

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 7 Y Position (ft)
0.5
0
-0.5
80
90
100
110
120
130
140
150
160
170
Time (seconds)

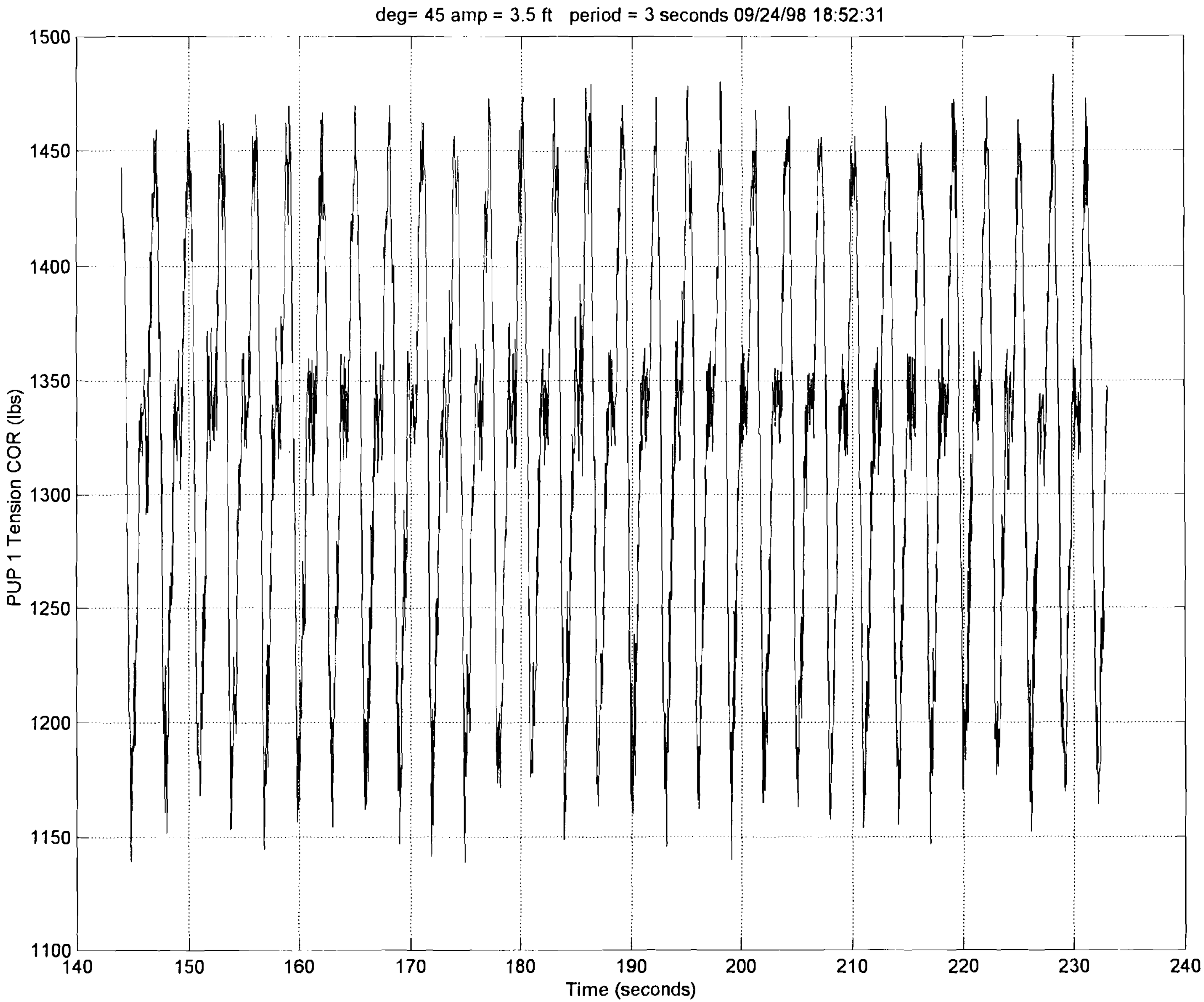

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 8 X Position (ft)
0.02
0
-0.02
-0.04
80
90
100
110
120
130
140
150
160
170
Time (seconds)

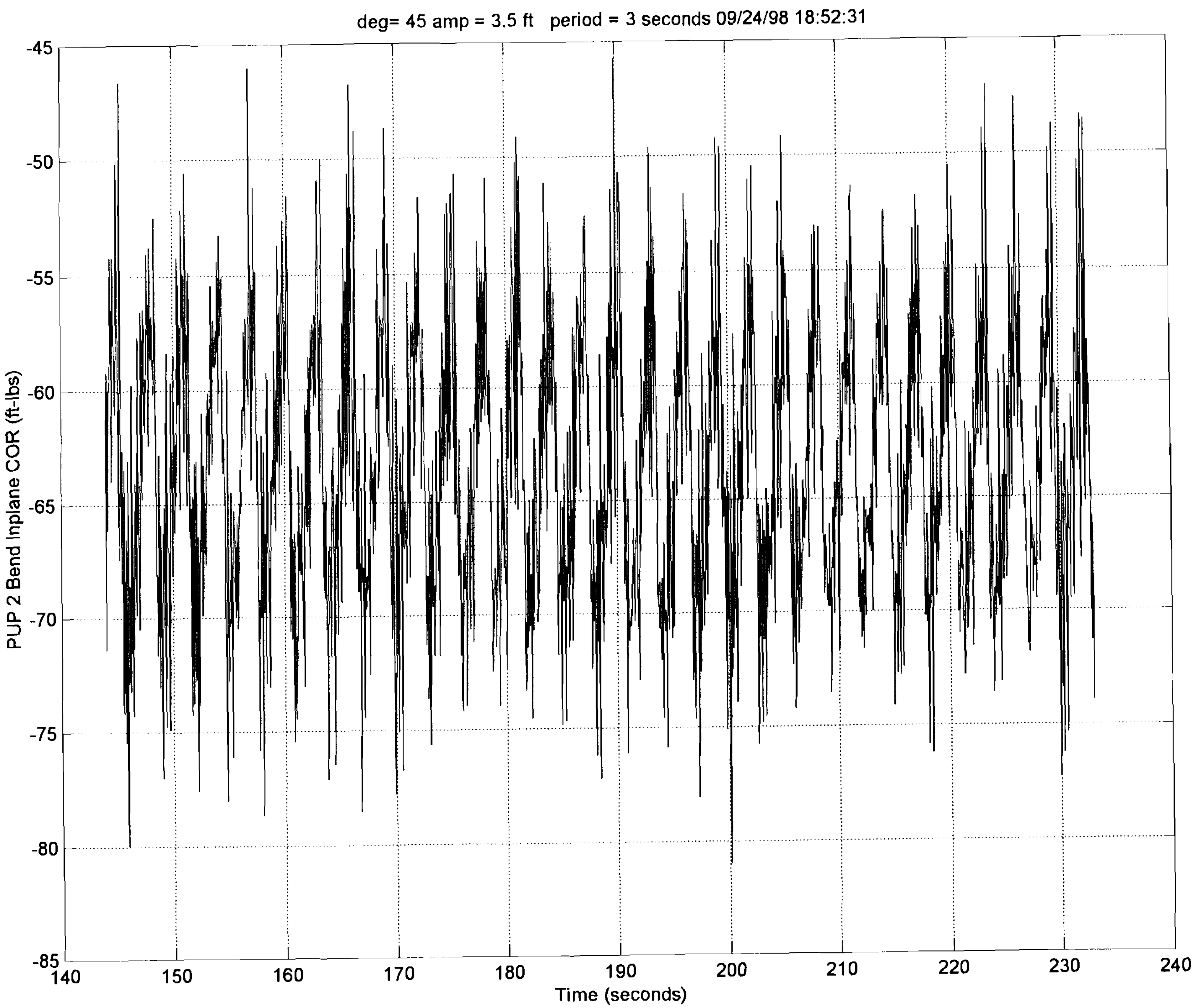

scr amp = 3 ft period = 3 seconds 09/19/98 14:22:32
Pup 8 Y Position (ft)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
80
90
100
110
120
130
140
150
160
170
Time (seconds)

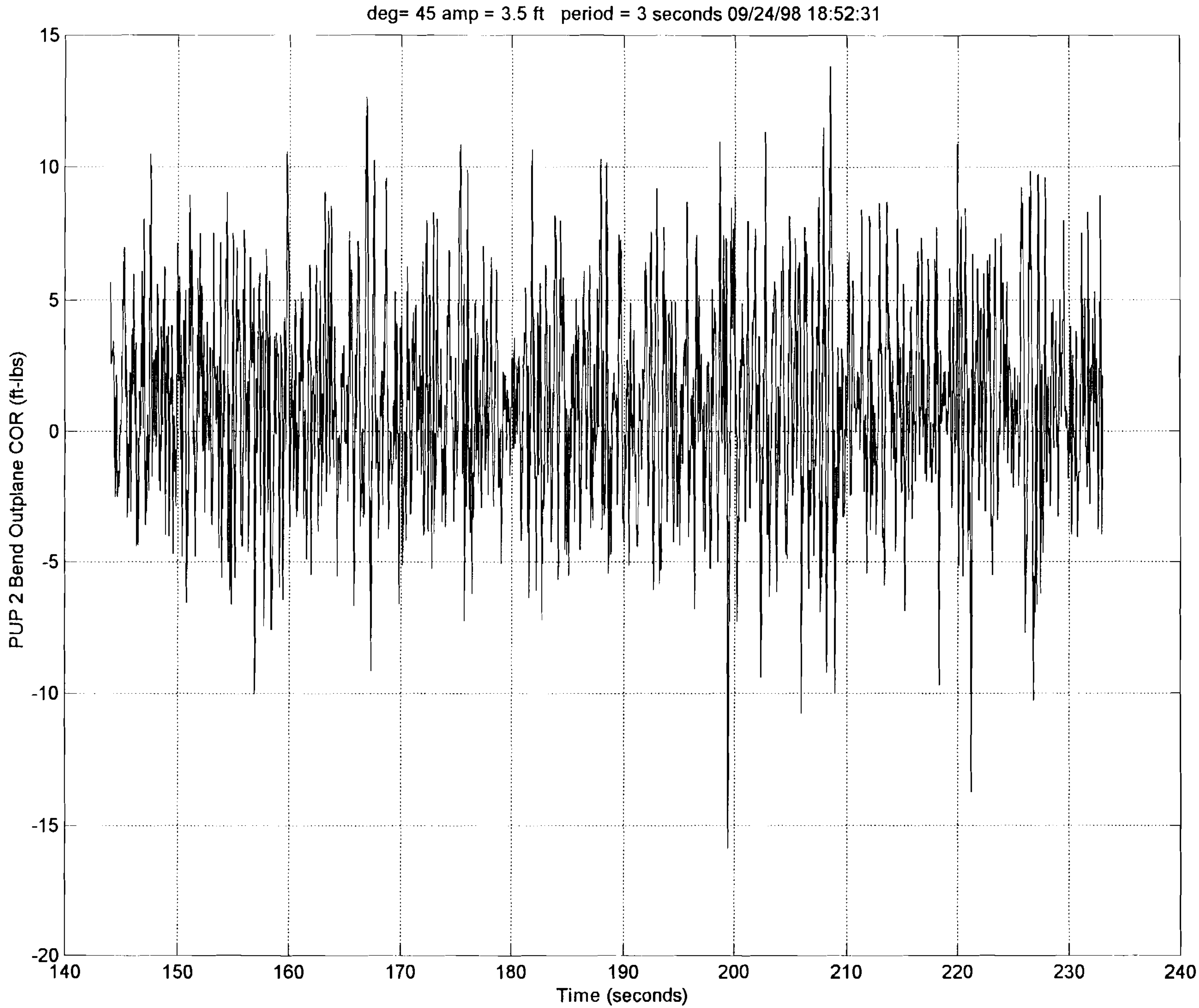

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Actuator Load (lbs)
1500
1450
1400
1350
1300
1250
1200
1150
1100
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 1 Bend Inplane COR (ft-lbs)
Time (seconds)
20
10
0
-10
-20
-30
-40
-50
-60
140
150
160
170
180
190
200
210
220
230
240

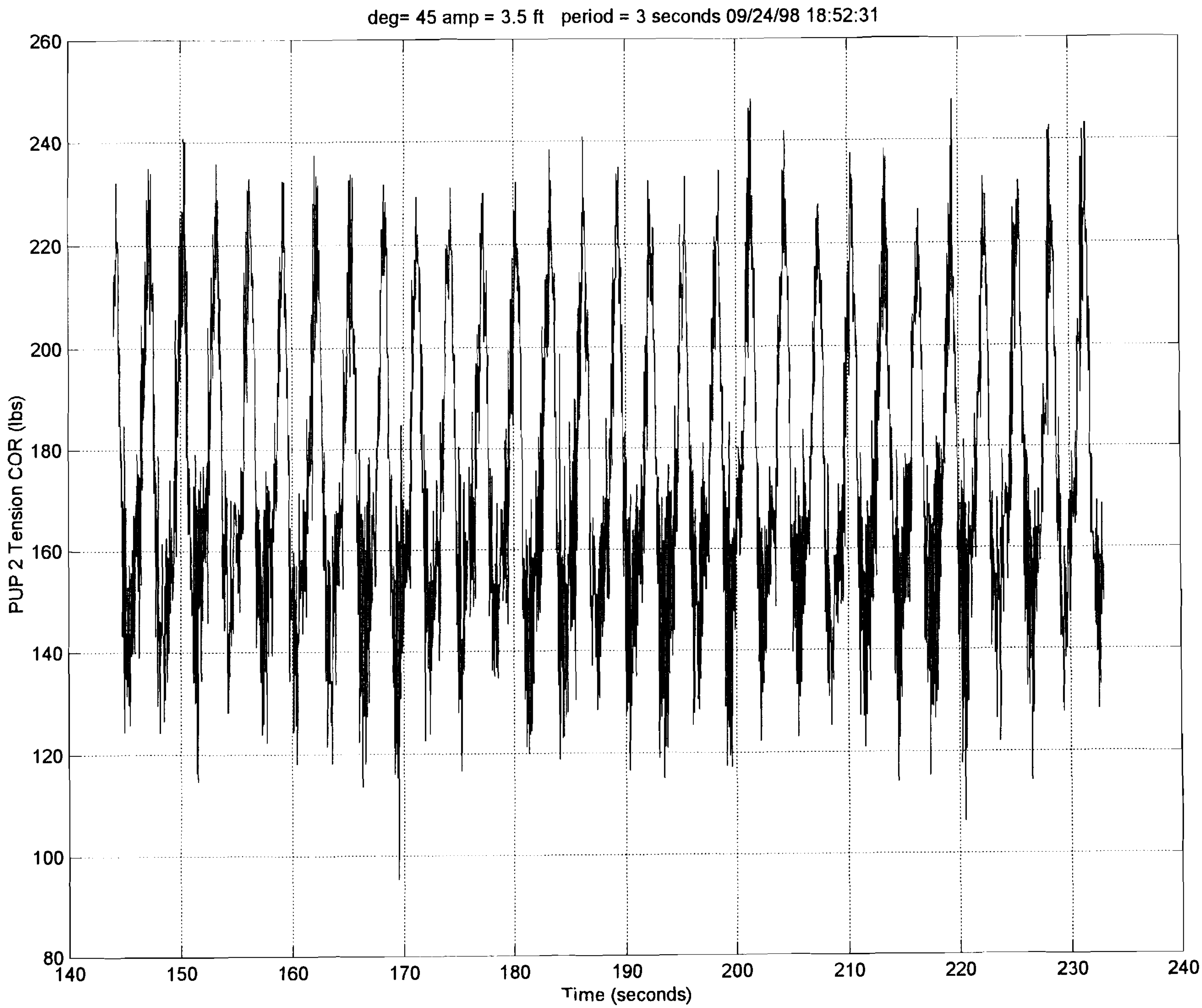

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 1 Bend Outplane COR (ft-lbs)
40
30
20
10
0
-10
-20
-30
-40
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

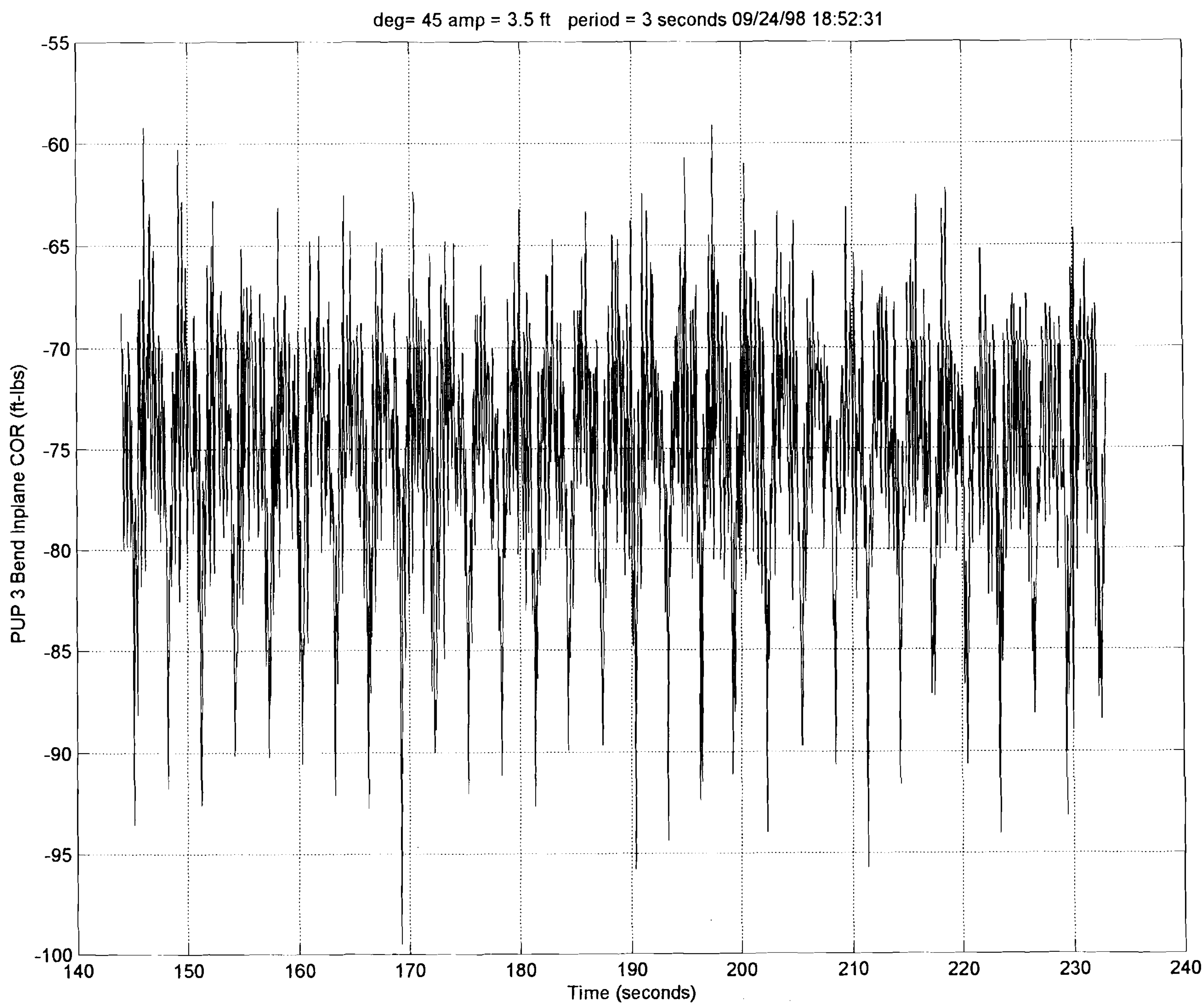

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 1 Tension COR (lbs)
1100
1150
1200
1250
1300
1350
1400
1450
1500
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

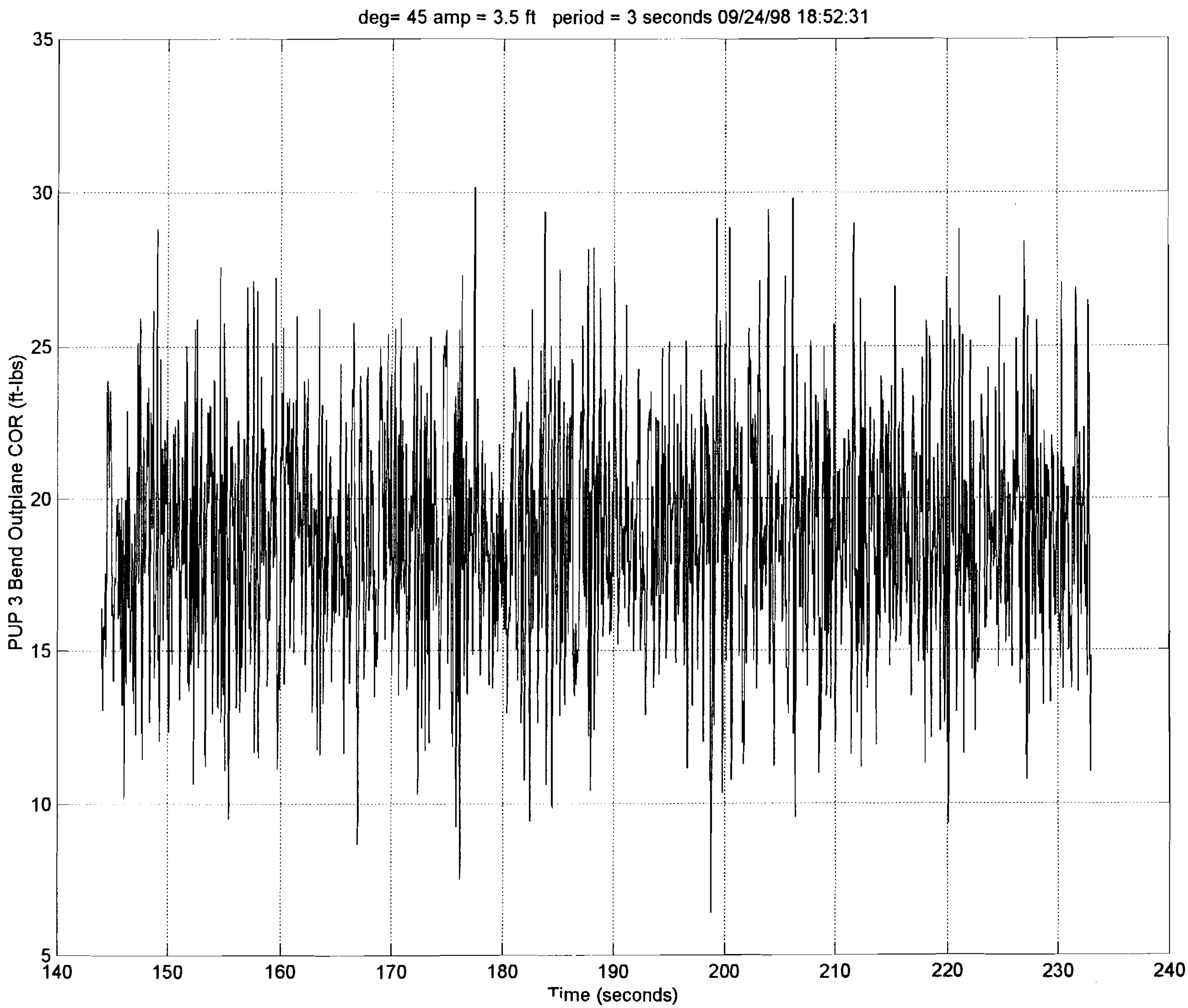

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 2 Bend Inplane COR (ft-lbs)
-45
-50
-55
-60
-65
-70
-75
-80
-85
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

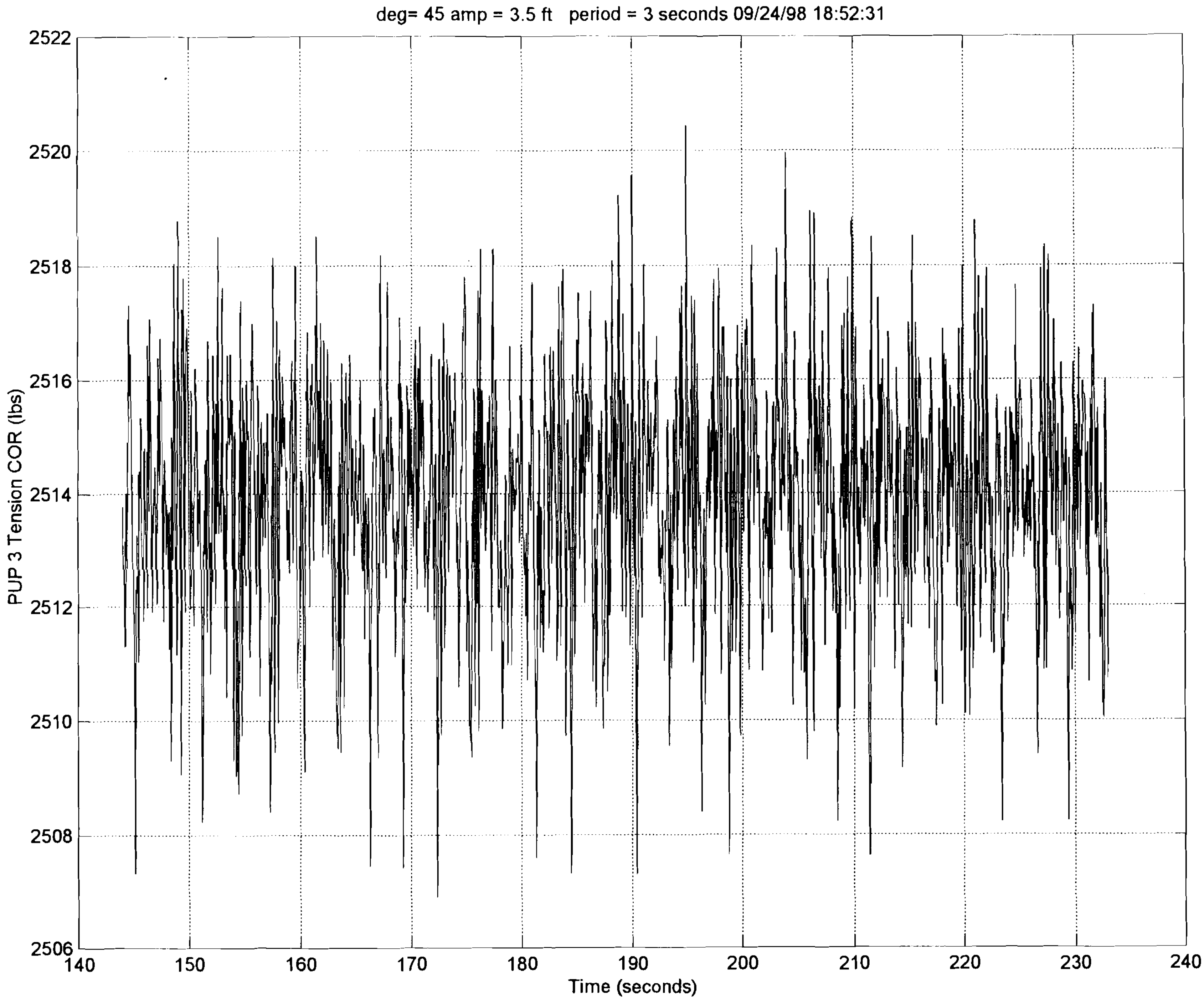


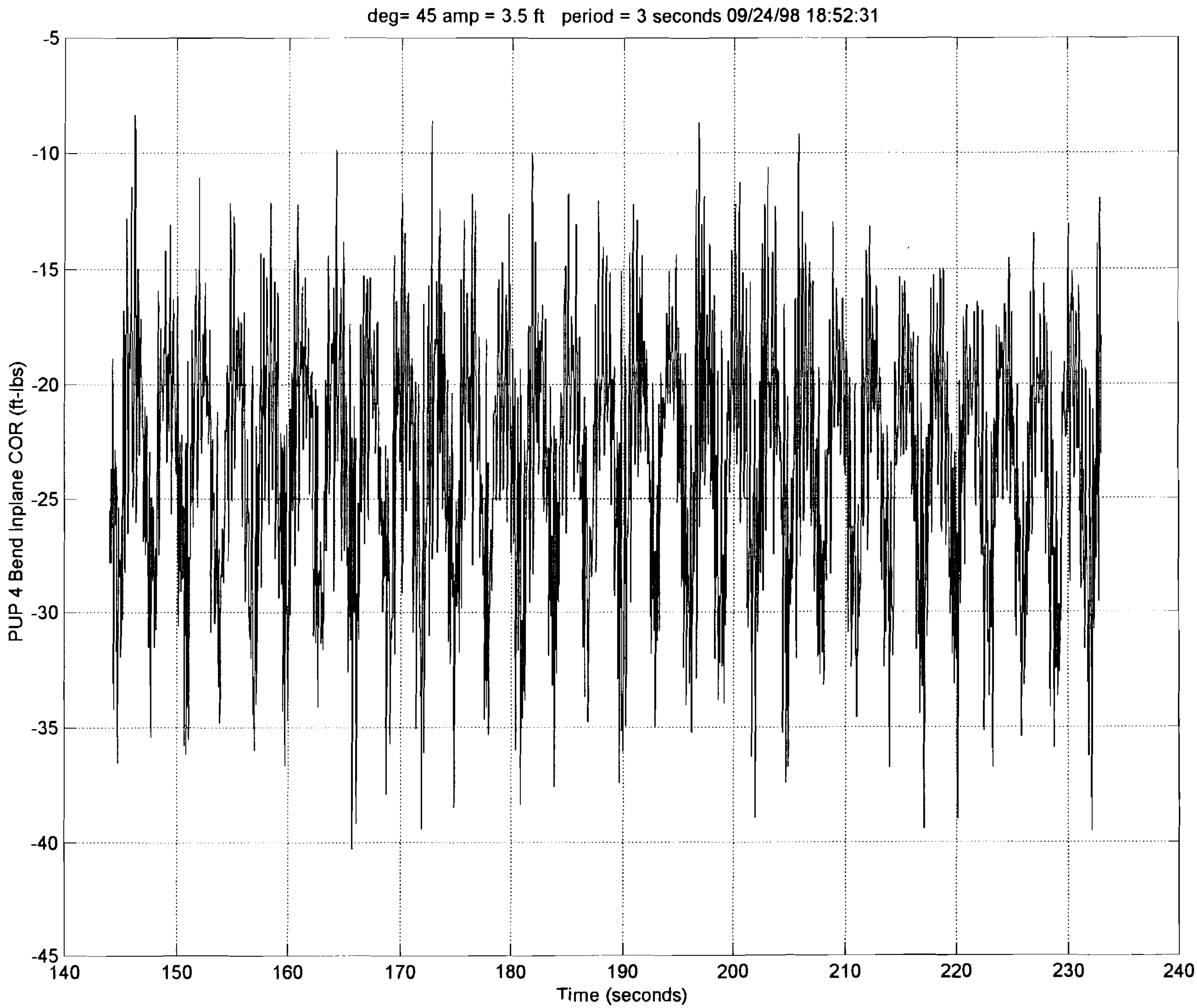
deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 2 Bend Outplane COR (ft-lbs)
Time (seconds)
15
10
5
0
-5
-10
-15
-20
140
150
160
170
180
190
200
210
220
230
240

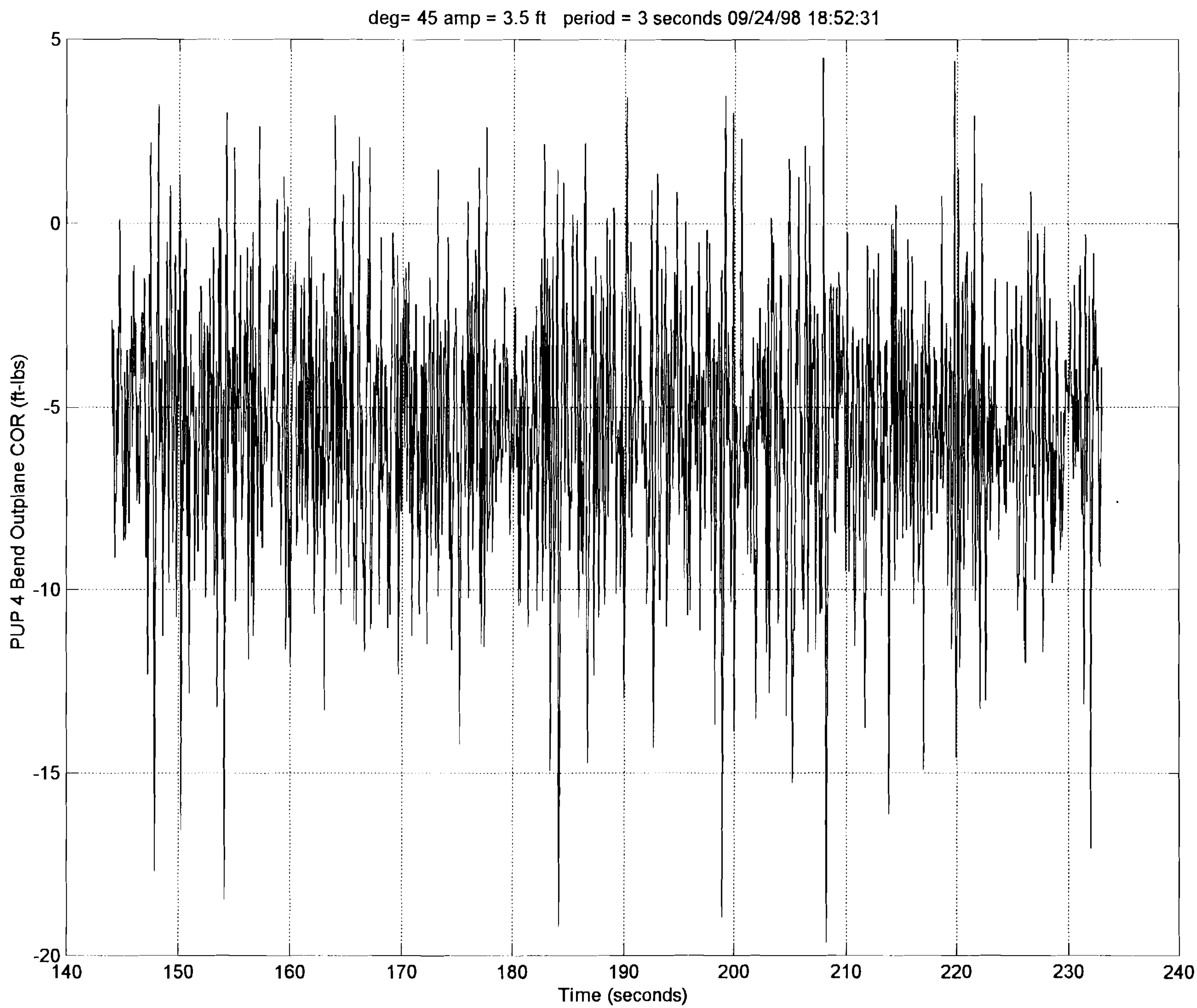

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 2 Tension COR (lbs)
260
240
220
200
180
160
140
120
100
80
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

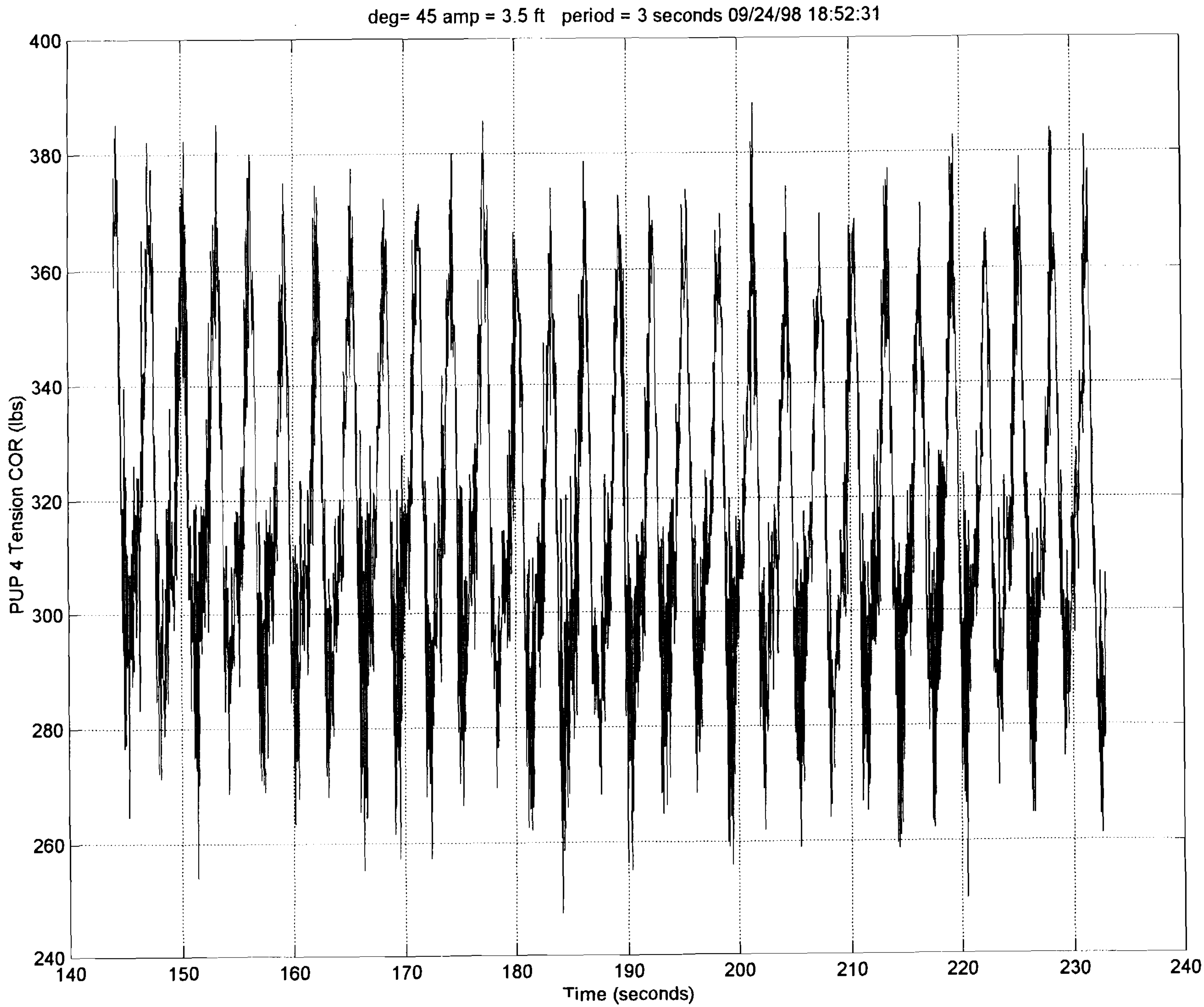

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 3 Bend Inplane COR (ft-lbs)
Time (seconds)
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
140
150
160
170
180
190
200
210
220
230
240

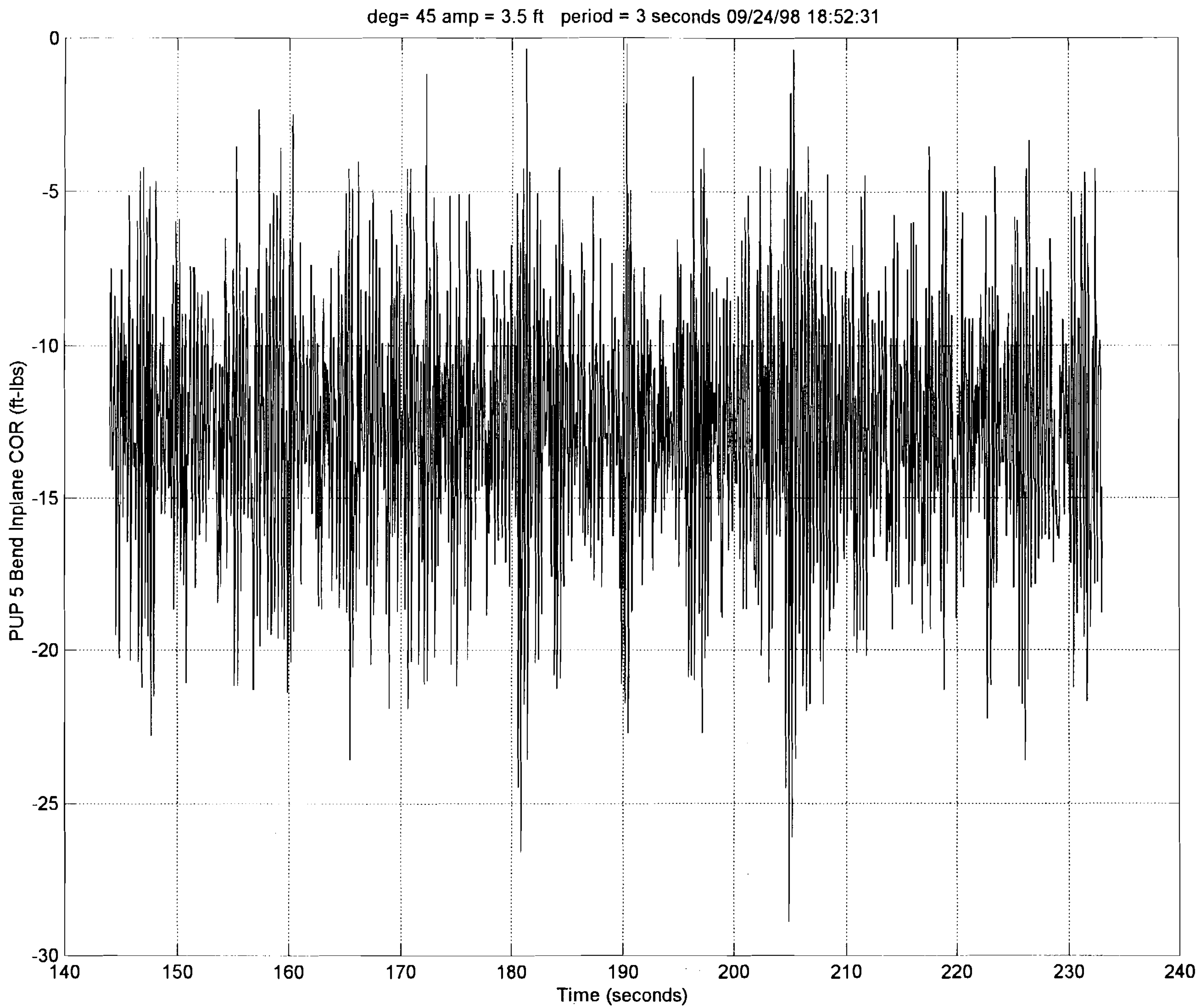

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 3 Bend Outplane COR (ft-lbs)
Time (seconds)
5
10
15
20
25
30
35
140
150
160
170
180
190
200
210
220
230
240


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 3 Tension COR (lbs)
2506
2508
2510
2512
2514
2516
2518
2520
2522
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

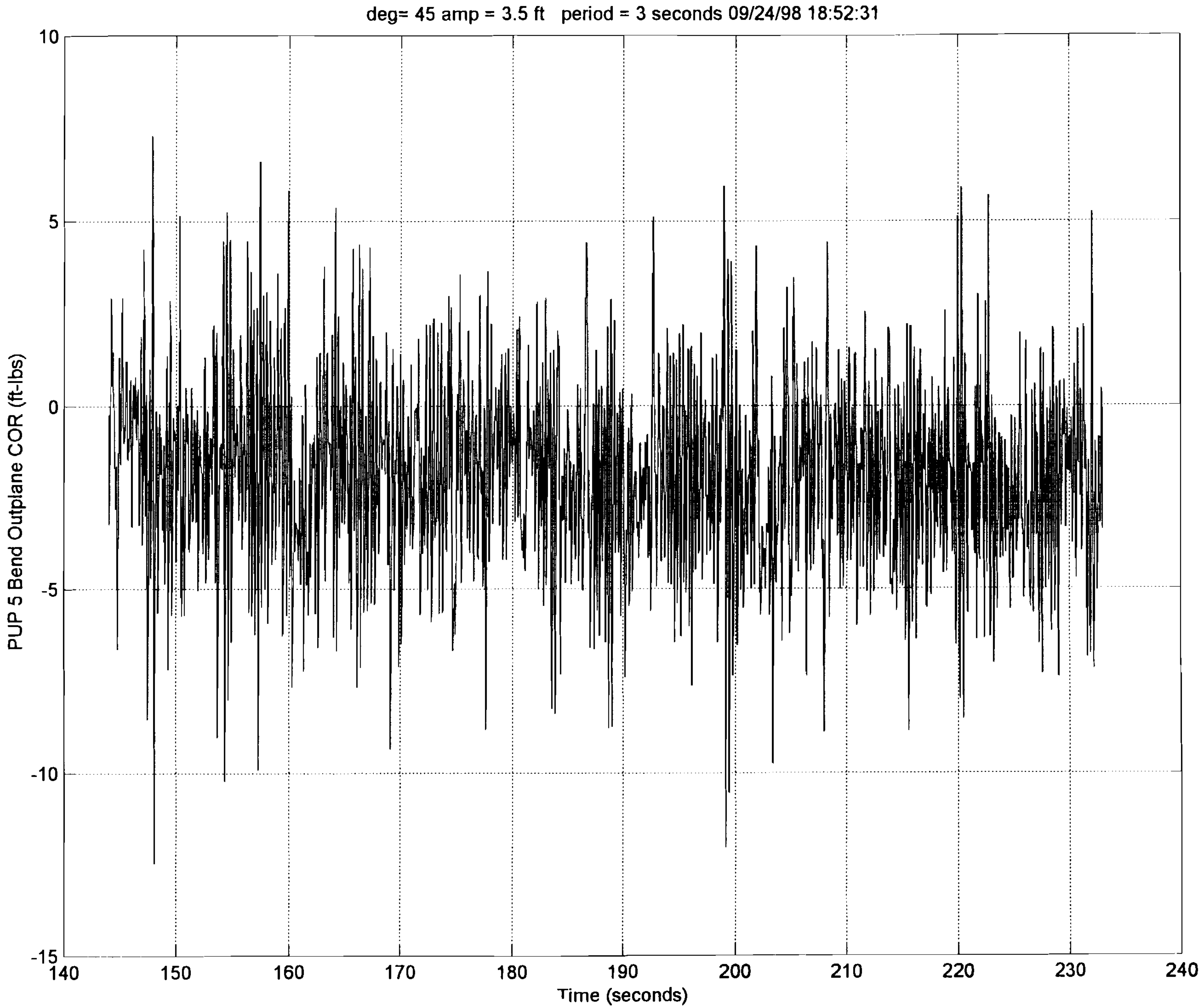

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 4 Bend Inplane COR (ft-lbs)
-5
-10
-15
-20
-25
-30
-35
-40
-45
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 4 Bend Outplane COR (ft-lbs)
Time (seconds)
5
0
-5
-10
-15
-20
140
150
160
170
180
190
200
210
220
230
240

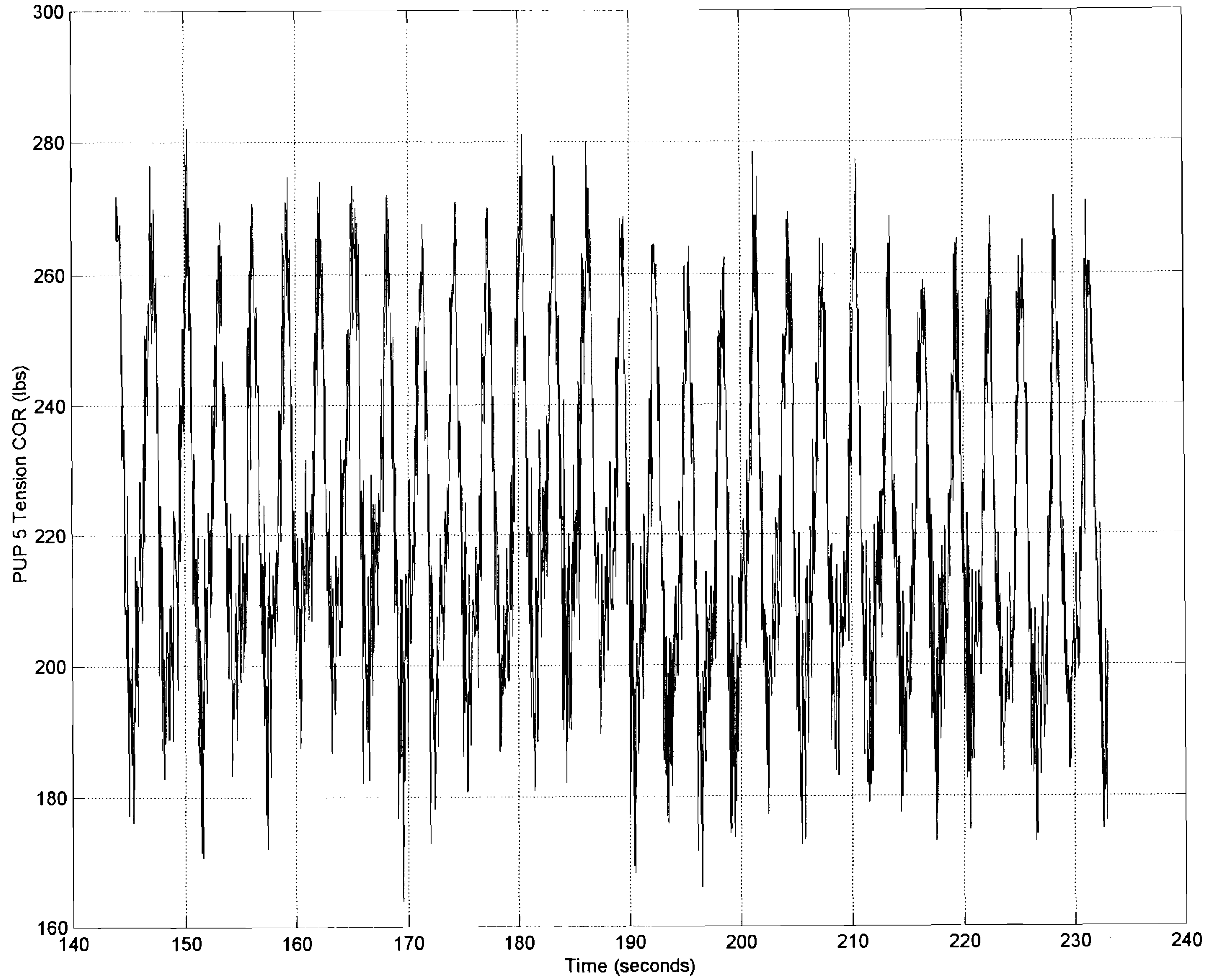

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 4 Tension COR (lbs)
400
380
360
340
320
300
280
260
240
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

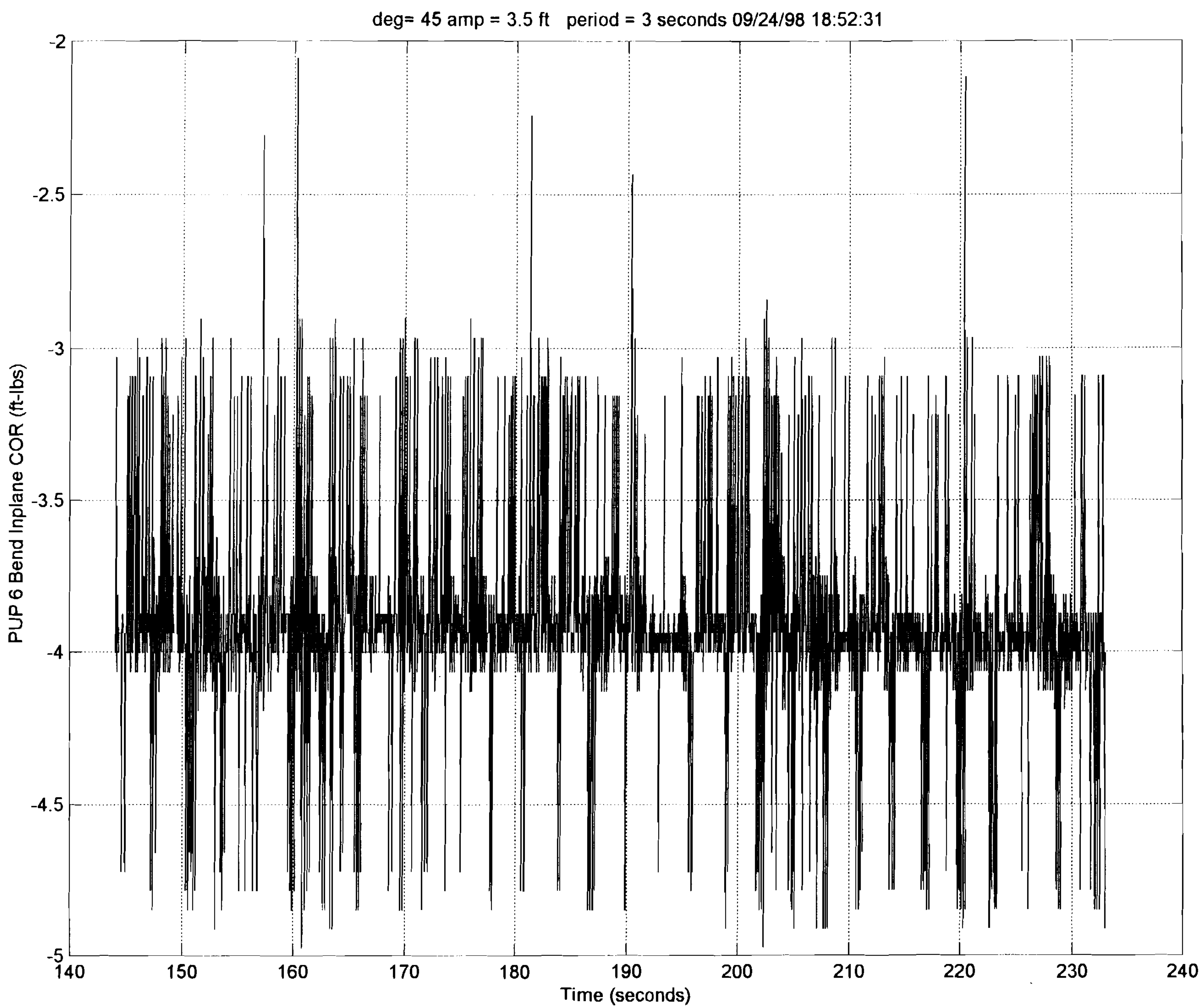


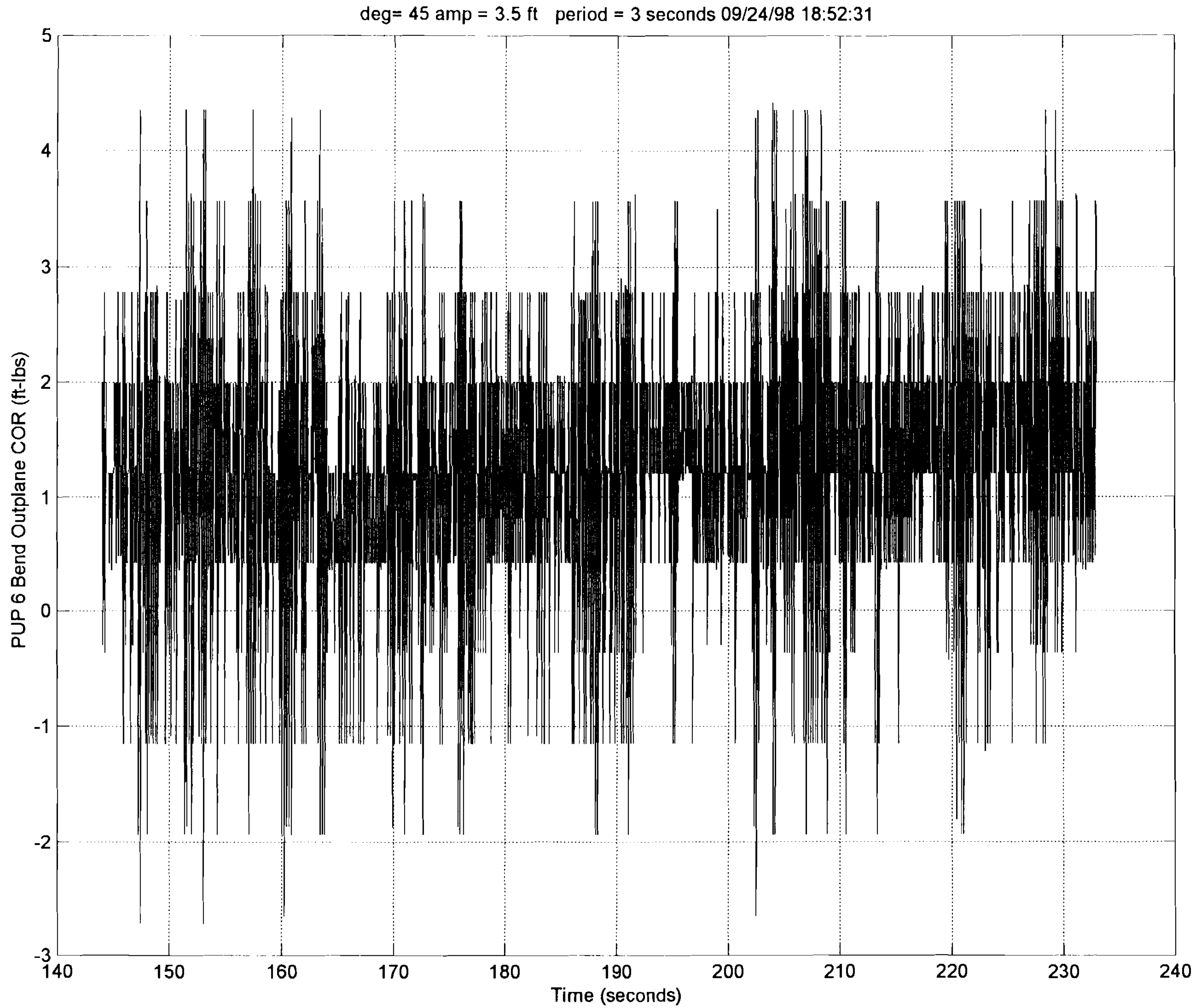
deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 5 Bend Inplane COR (ft-lbs)
0
-5
-10
-15
-20
-25
-30
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

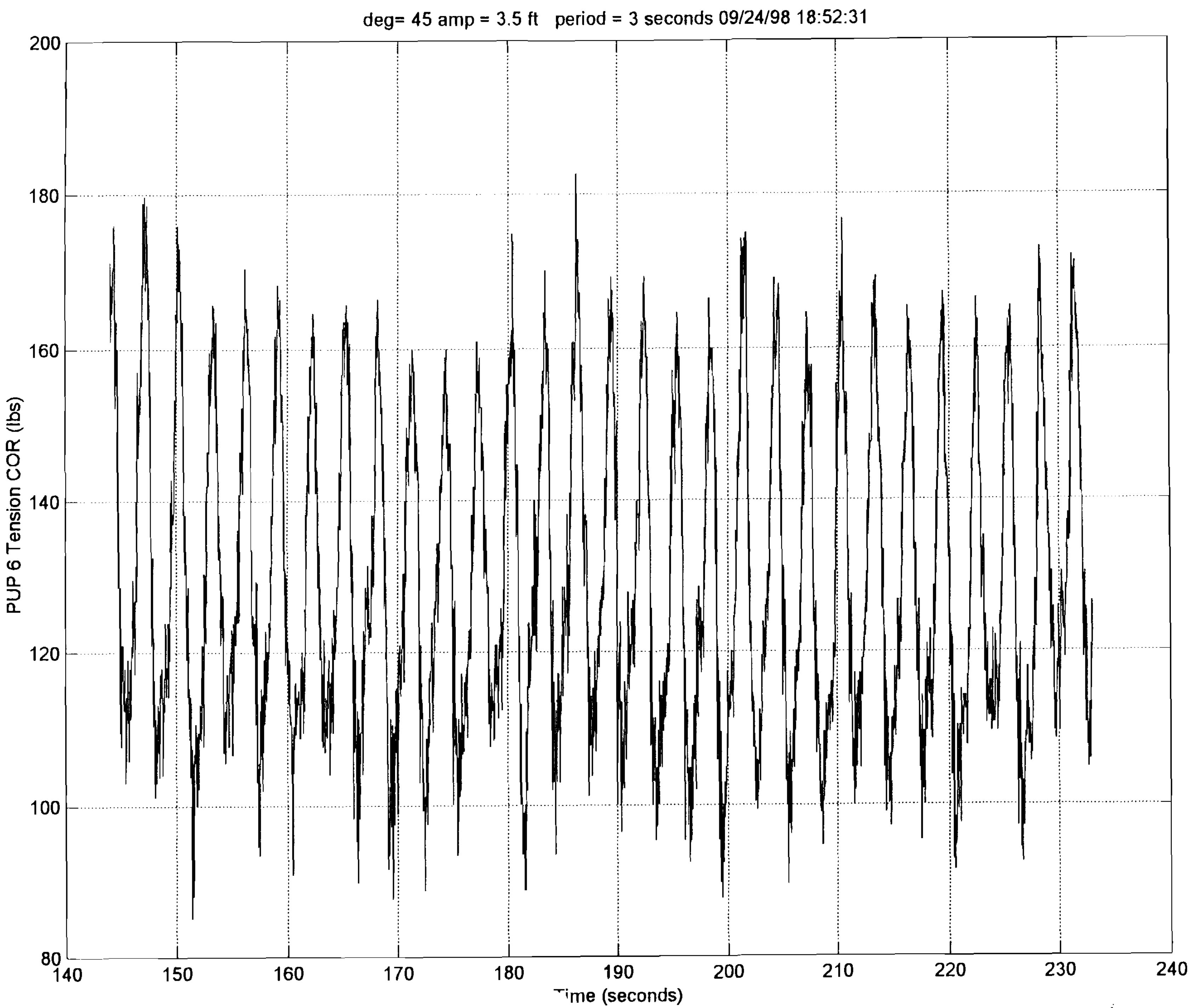

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 5 Bend Outplane COR (ft-lbs)
10
5
0
-5
-10
-15
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

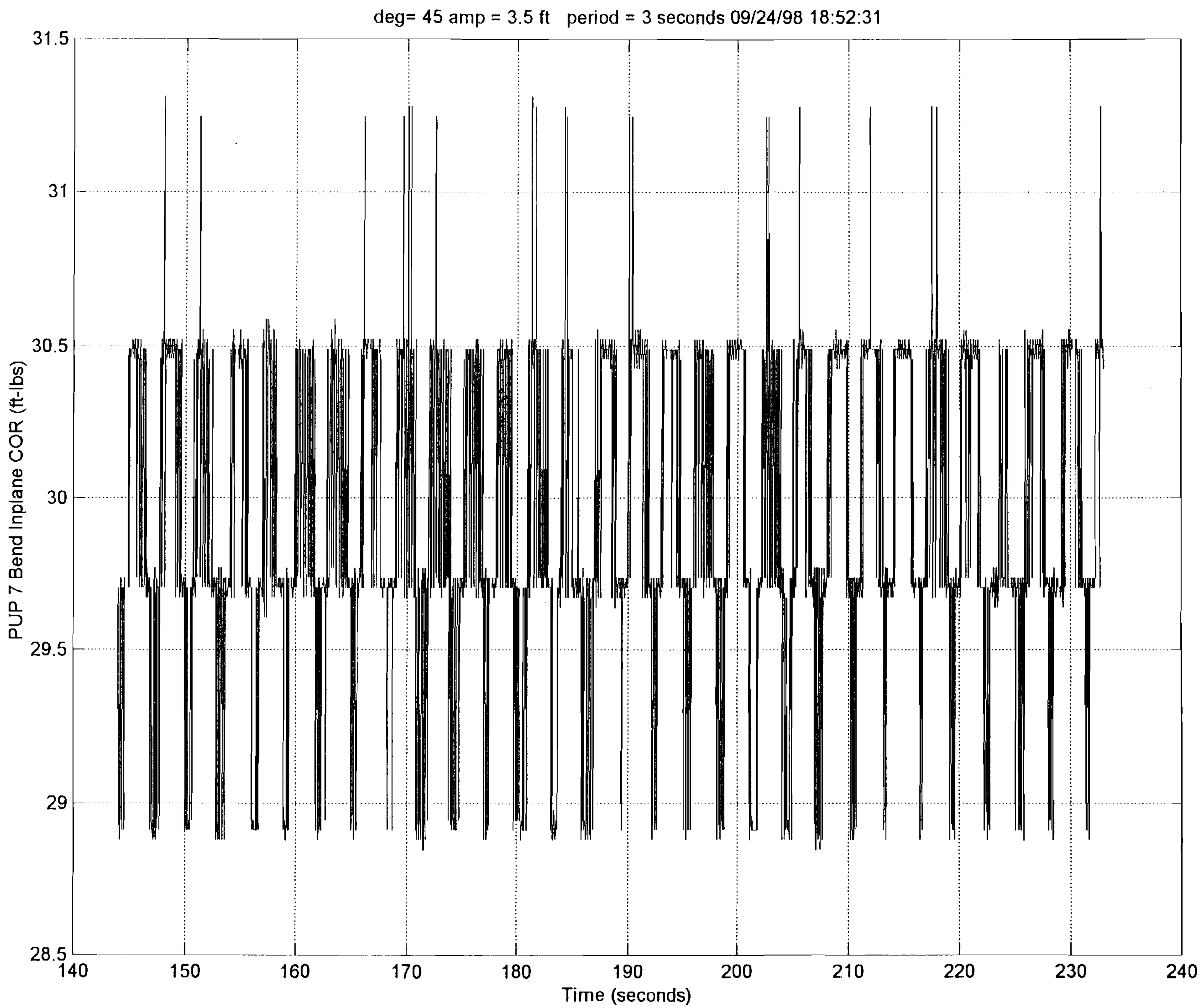
deg= 45 amp = 3.5 ft   period = 3 seconds 09/24/98 18:52:31

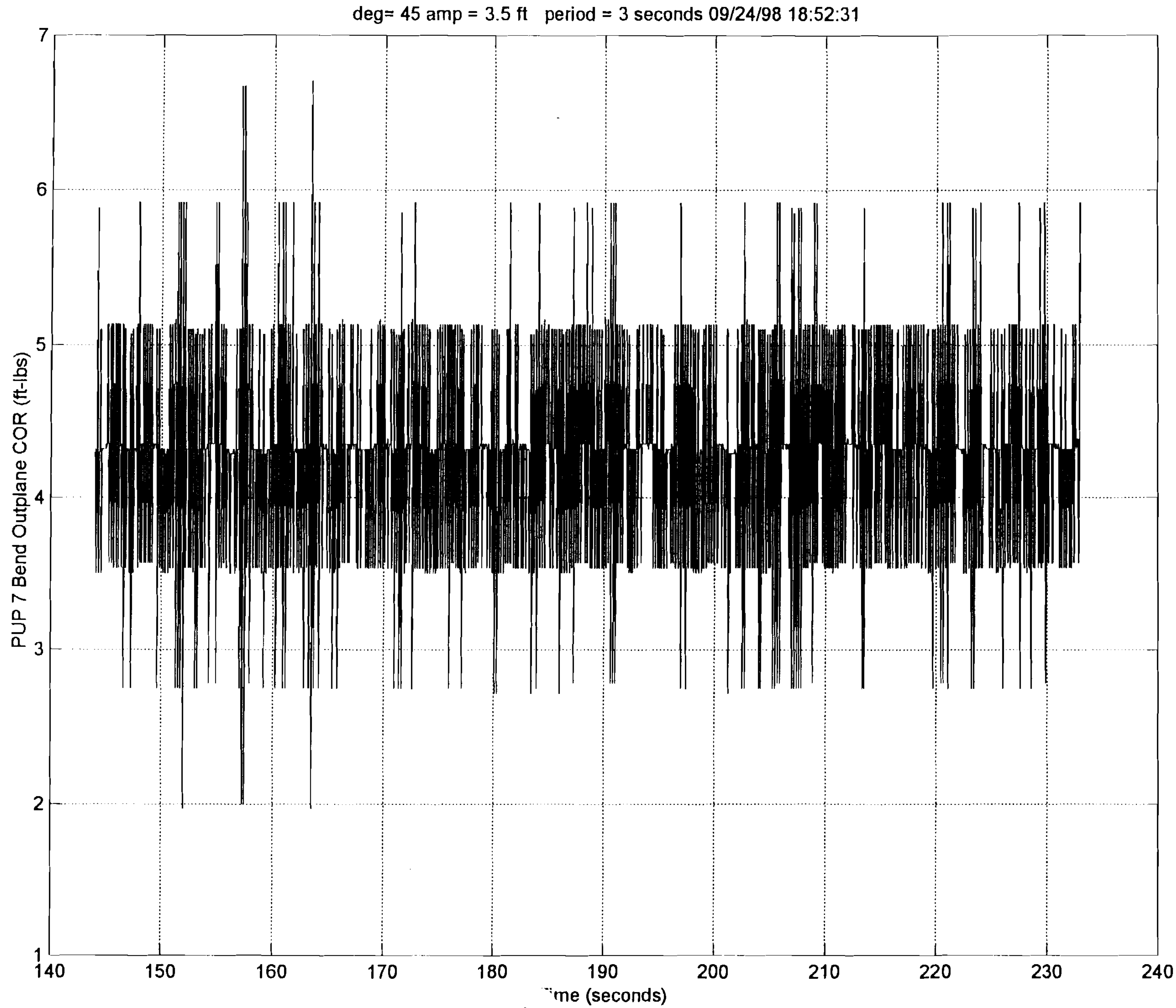


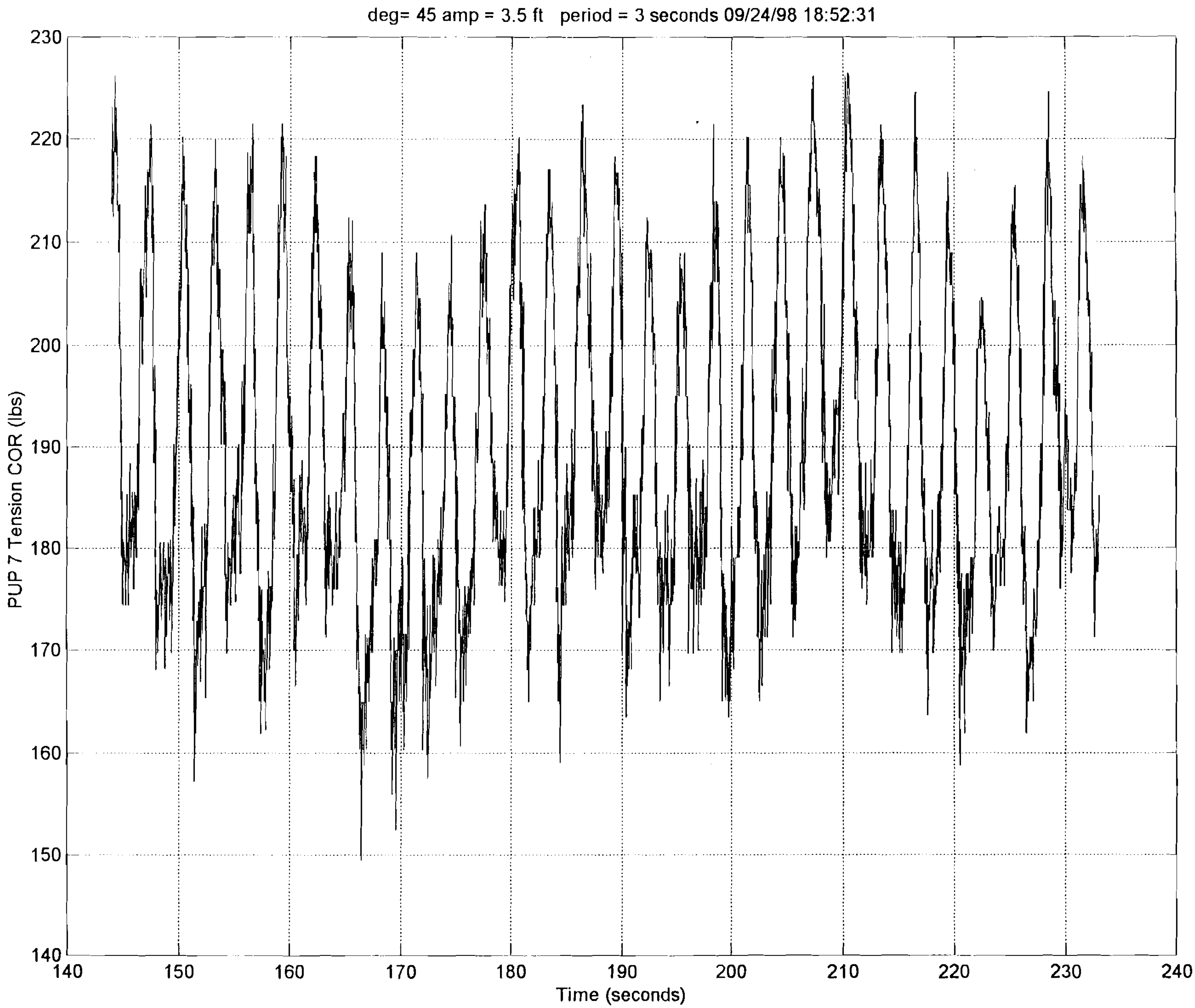

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 6 Bend Inplane COR (ft-lbs)
-2
-2.5
-3
-3.5
-4
-4.5
-5
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

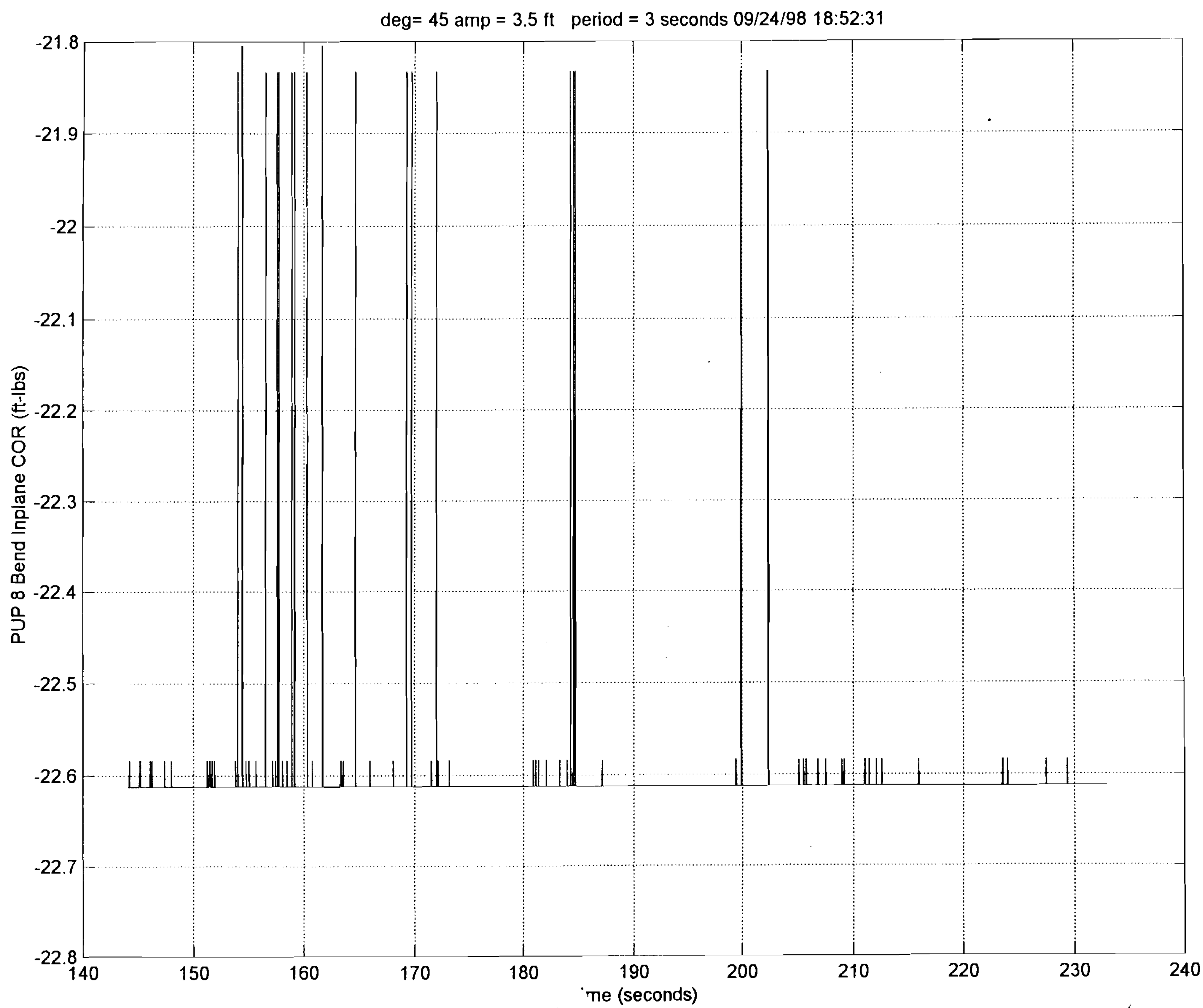

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 6 Bend Outplane COR (ft-lbs)
5
4
3
2
1
0
-1
-2
-3
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

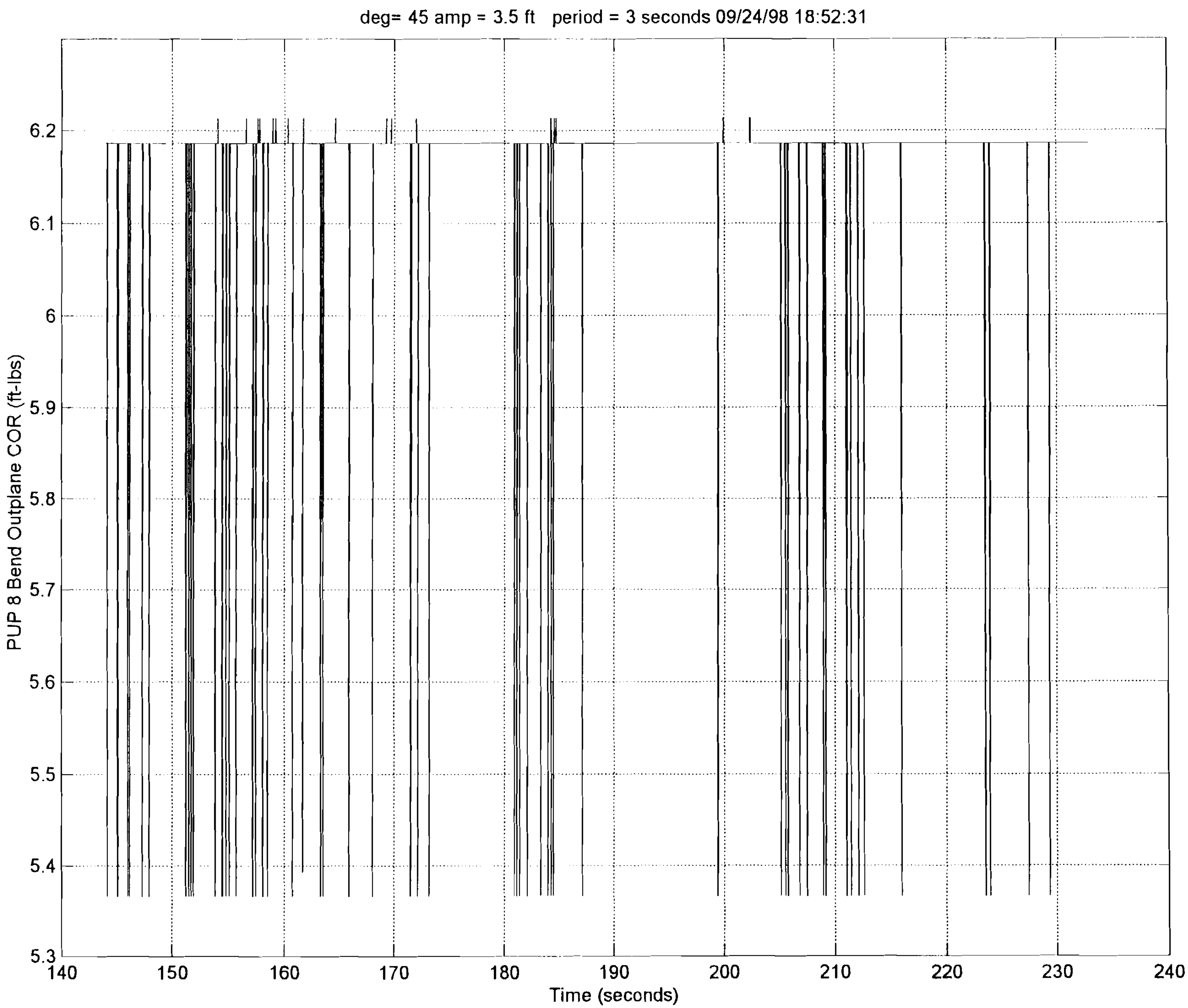

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 6 Tension COR (lbs)
200
180
160
140
120
100
80
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

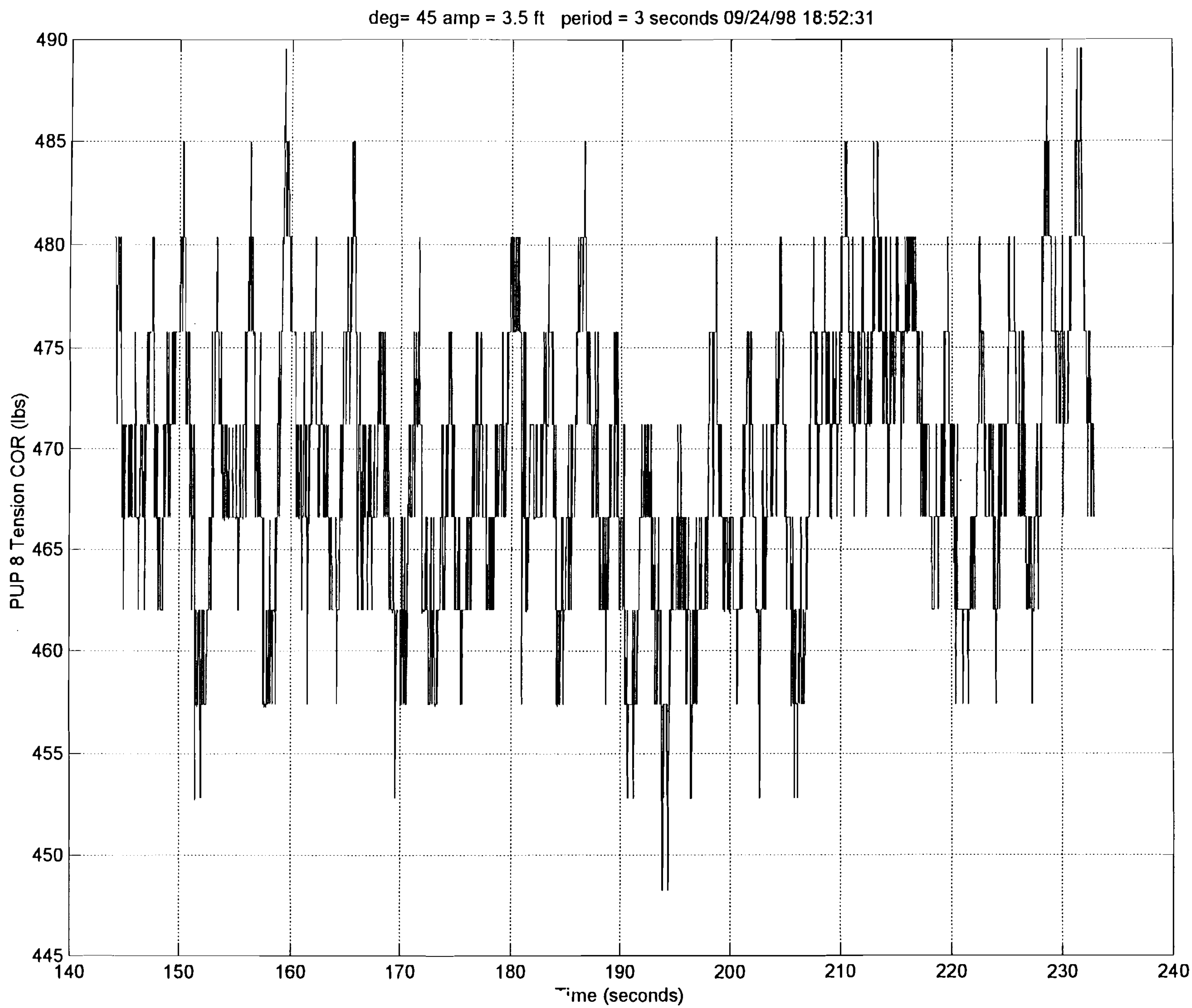

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 7 Bend Inplane COR (ft-lbs)
31.5
31
30.5
30
29.5
29
28.5
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

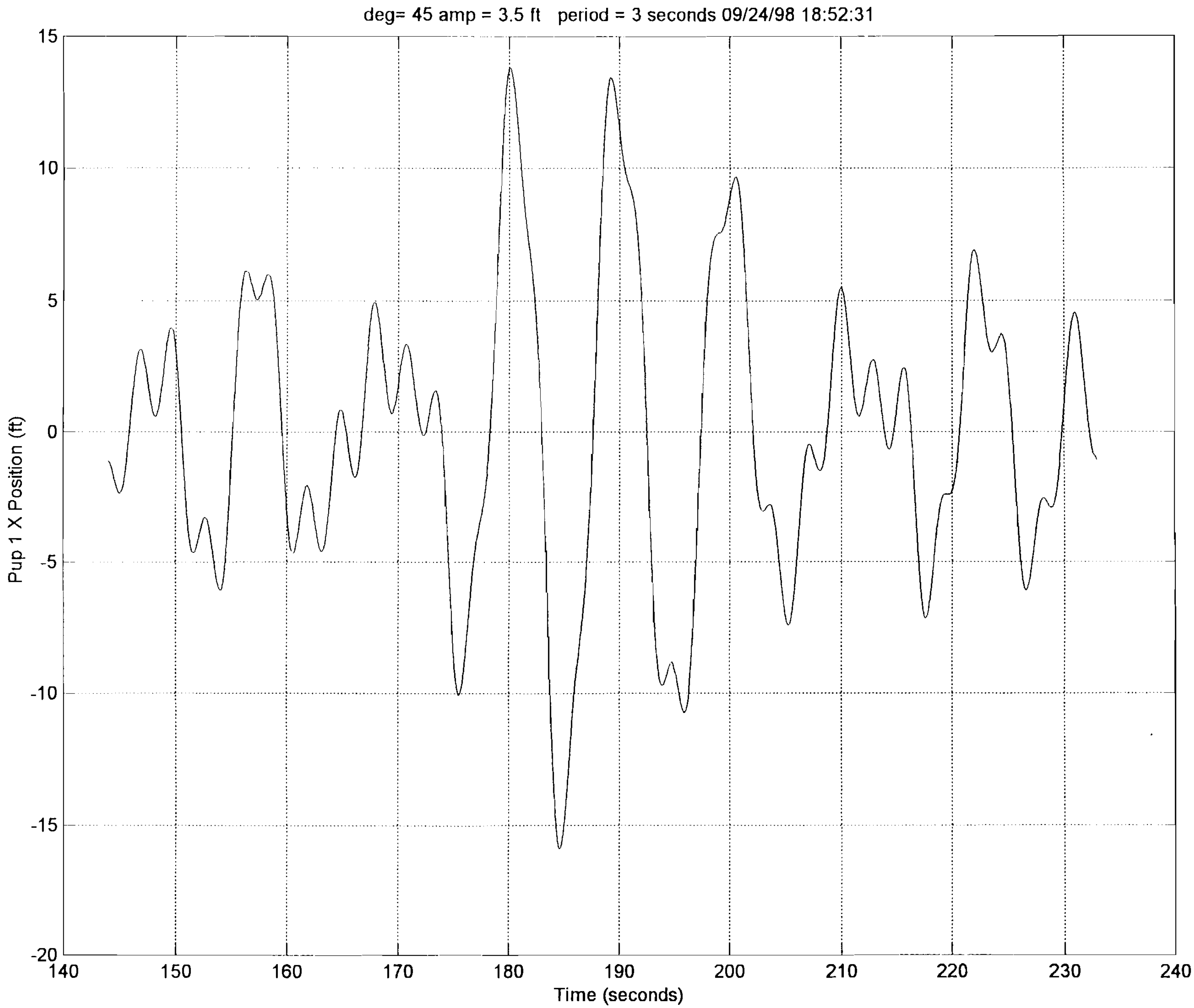

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 7 Bend Outplane COR (ft-lbs)
1
2
3
4
5
6
7
140
150
160
170
180
190
200
210
220
230
240
me (seconds)

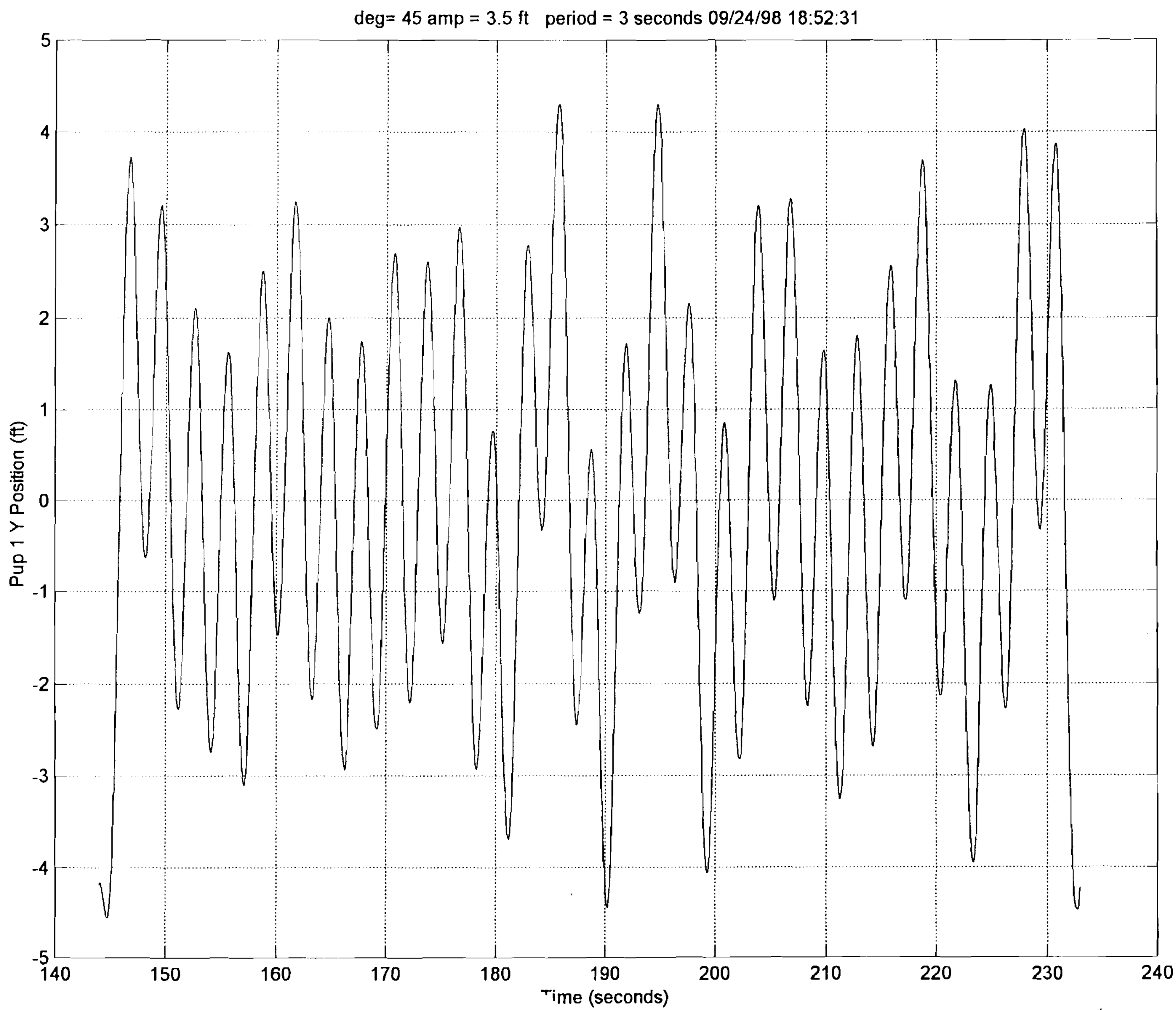

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
230
220
210
200
190
180
170
160
150
140
PUP 7 Tension COR (lbs)
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

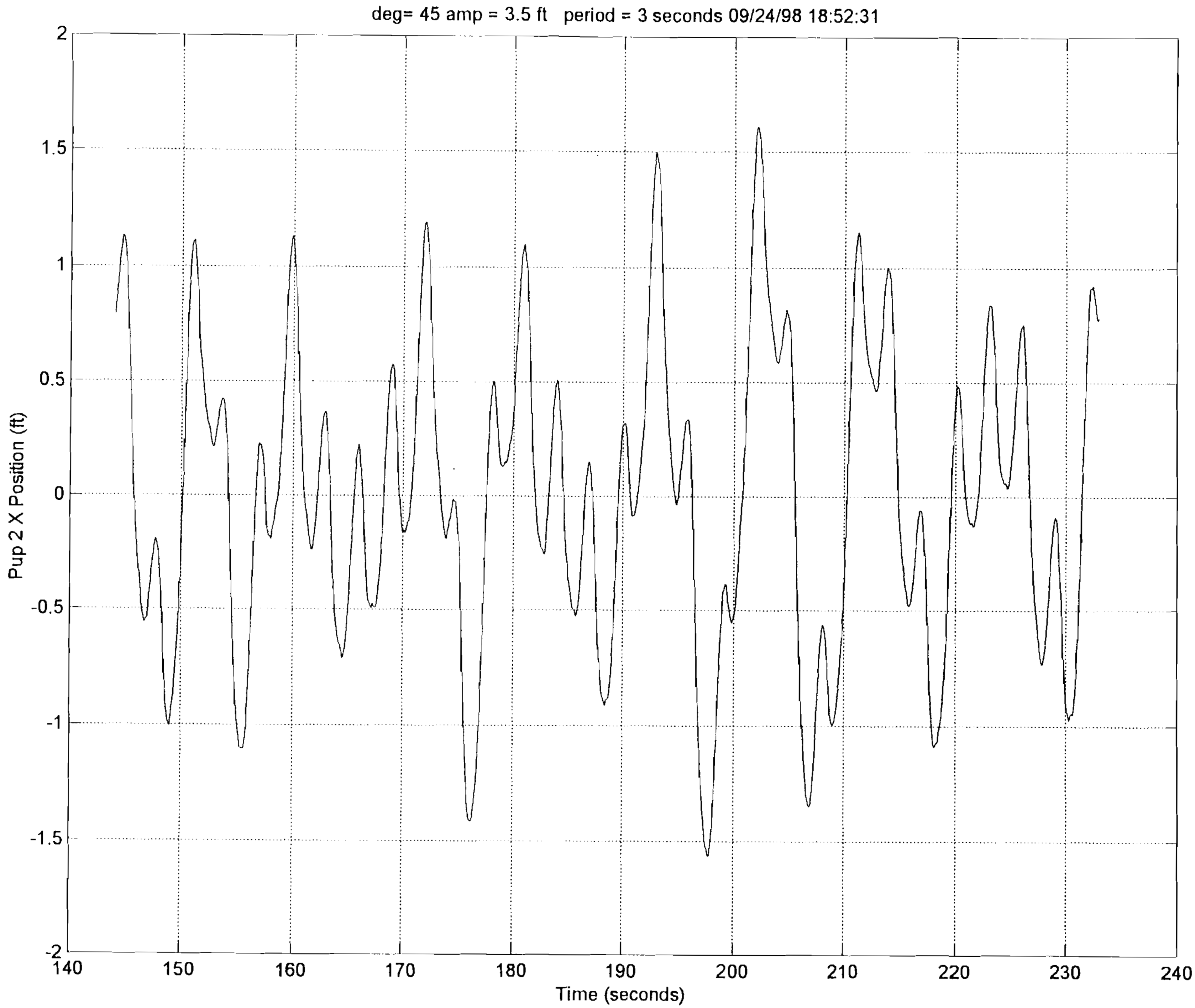

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 8 Bend Inplane COR (ft-lbs)
-21.8
-21.9
-22
-22.1
-22.2
-22.3
-22.4
-22.5
-22.6
-22.7
-22.8
140
150
160
170
180
190
200
210
220
230
240
me (seconds)


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 8 Bend Outplane COR (ft-lbs)
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

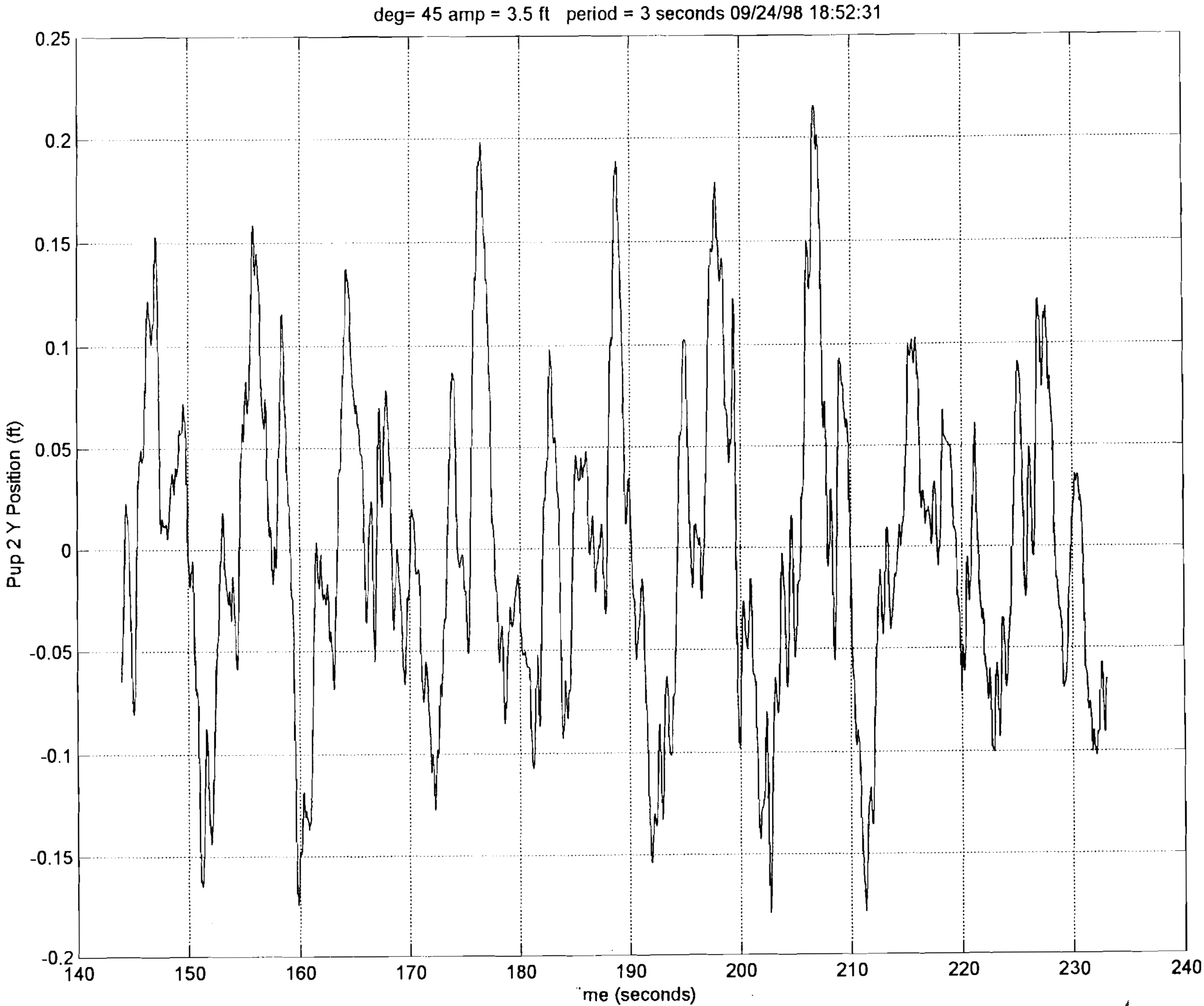

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
PUP 8 Tension COR (lbs)
490
485
480
475
470
465
460
455
450
445
140
150
160
170
180
190
200
210
220
230
240
ime (seconds)

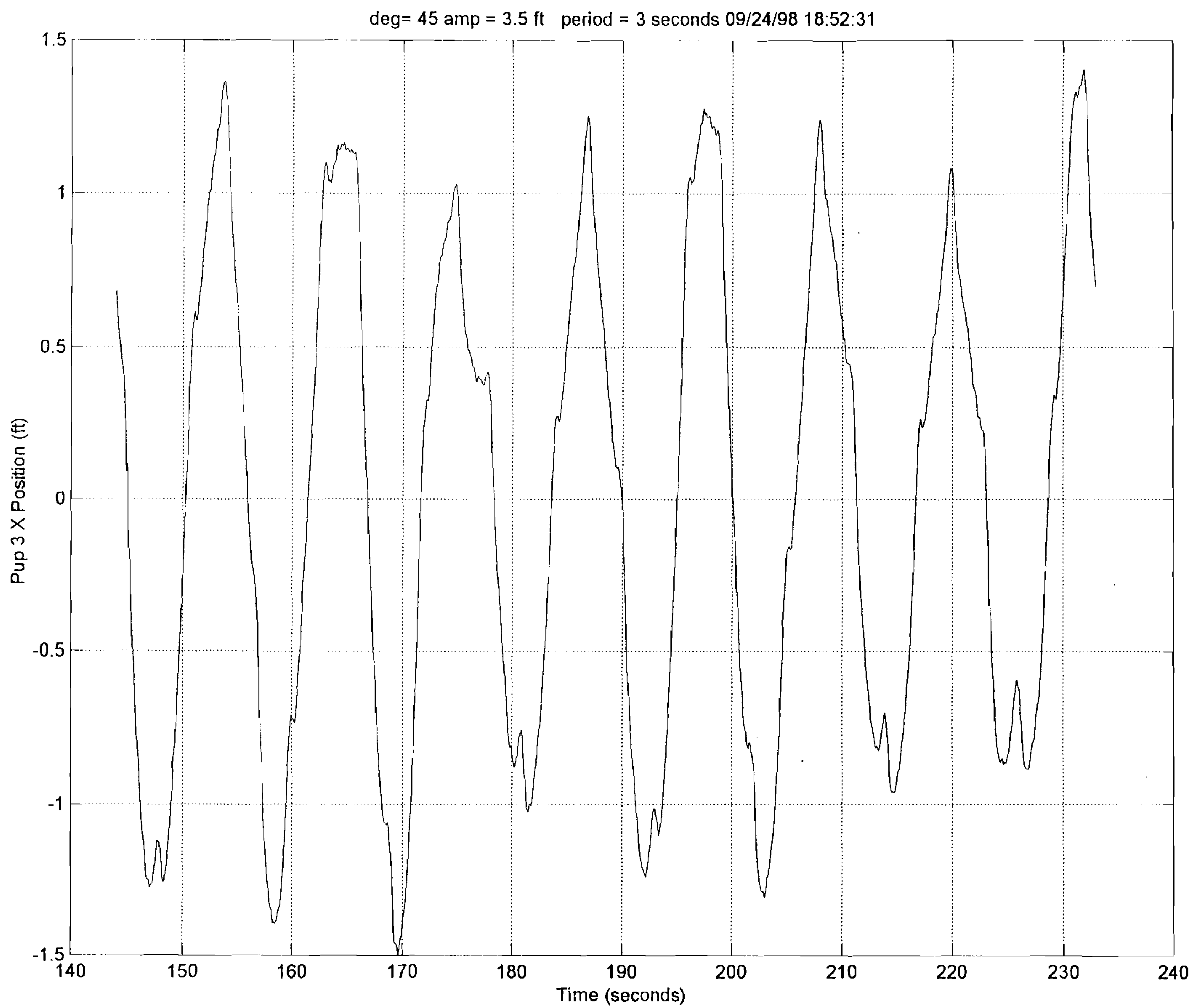

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 1 X Position (ft)
Time (seconds)
15
10
5
0
-5
-10
-15
-20
140
150
160
170
180
190
200
210
220
230
240


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 1 Y Position (ft)
Time (seconds)
5
4
3
2
1
0
-1
-2
-3
-4
-5
140
150
160
170
180
190
200
210
220
230
240

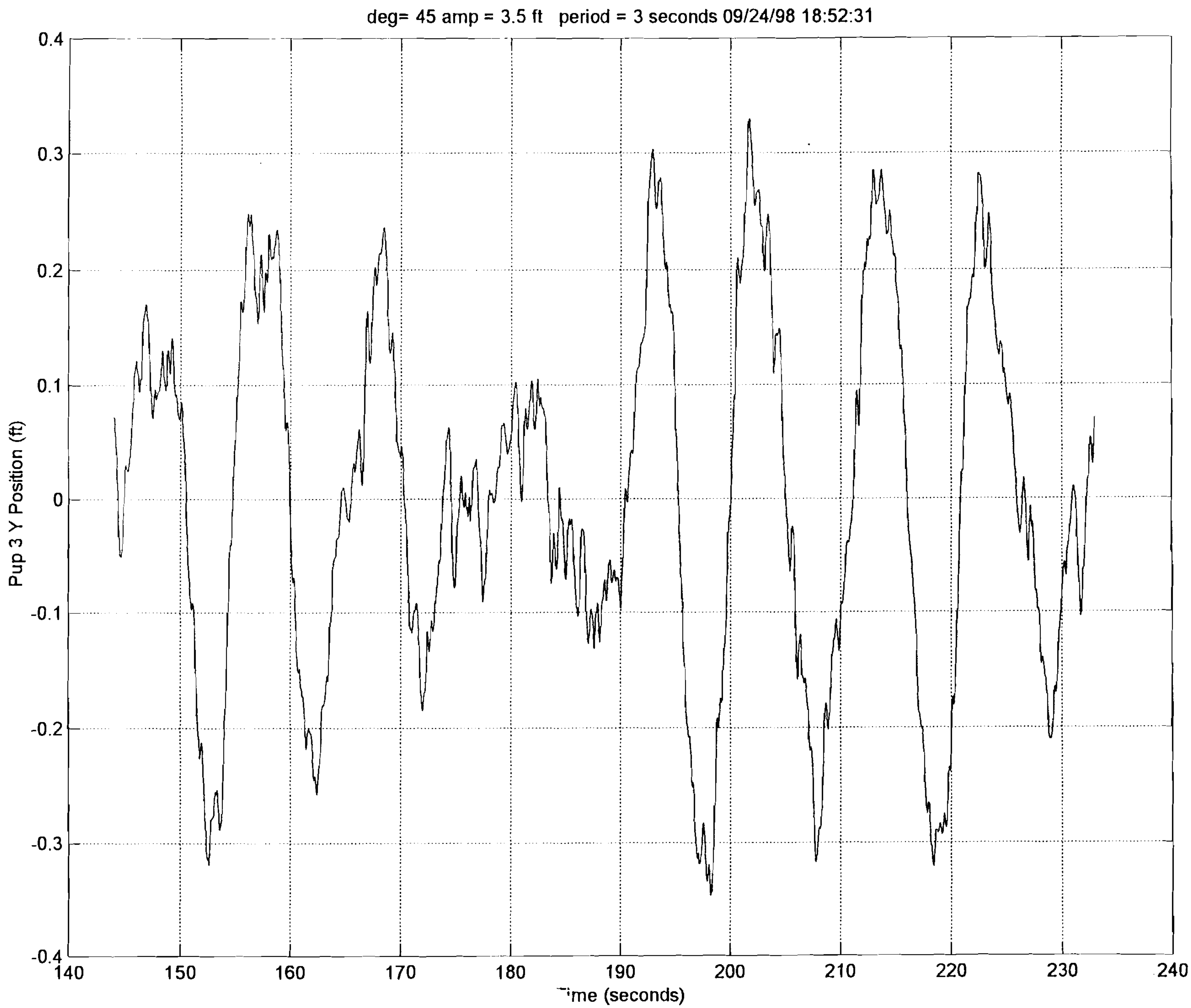


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 2 X Position (ft)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

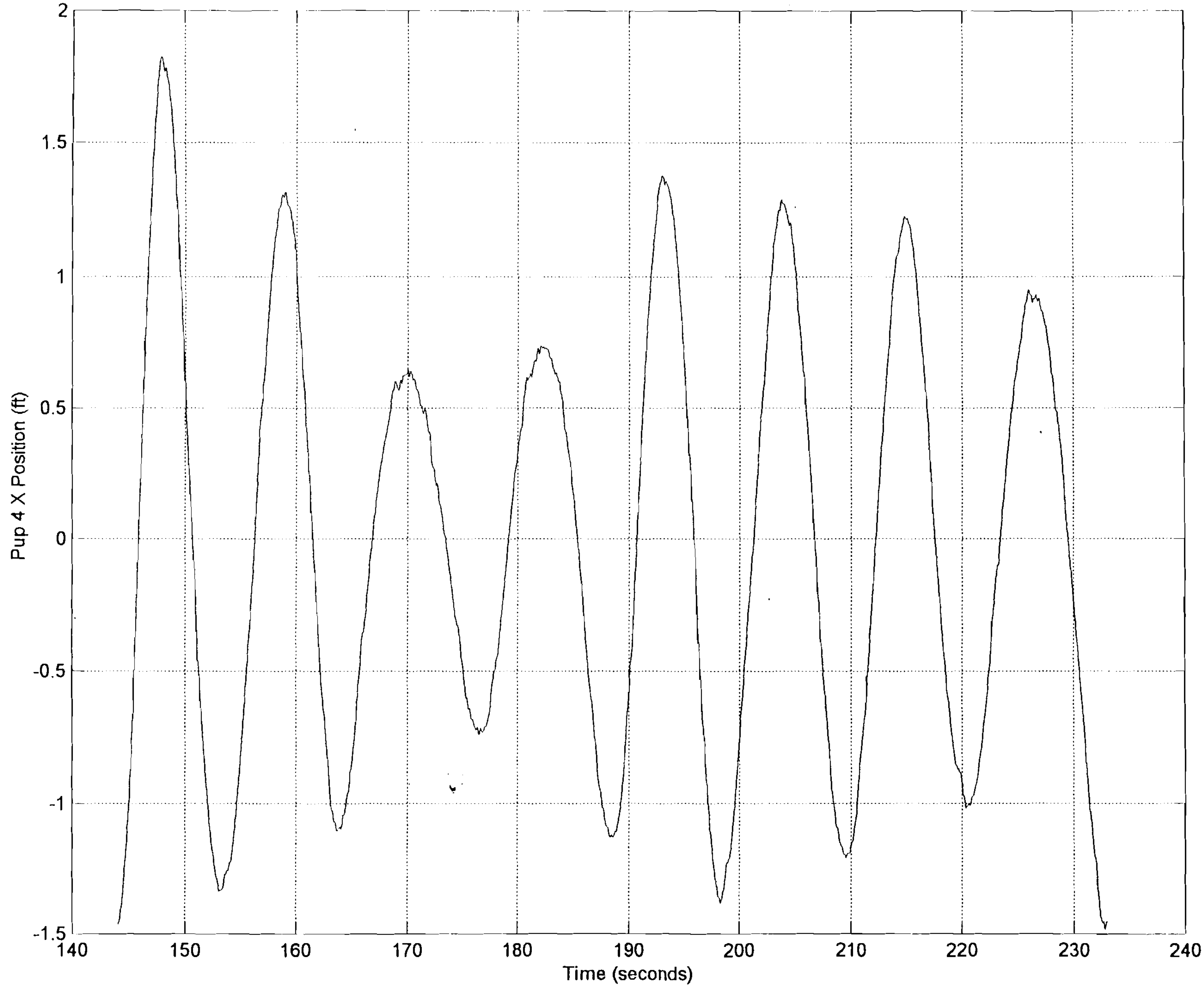

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 2 Y Position (ft)
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
140
150
160
170
180
190
200
210
220
230
240
me (seconds)

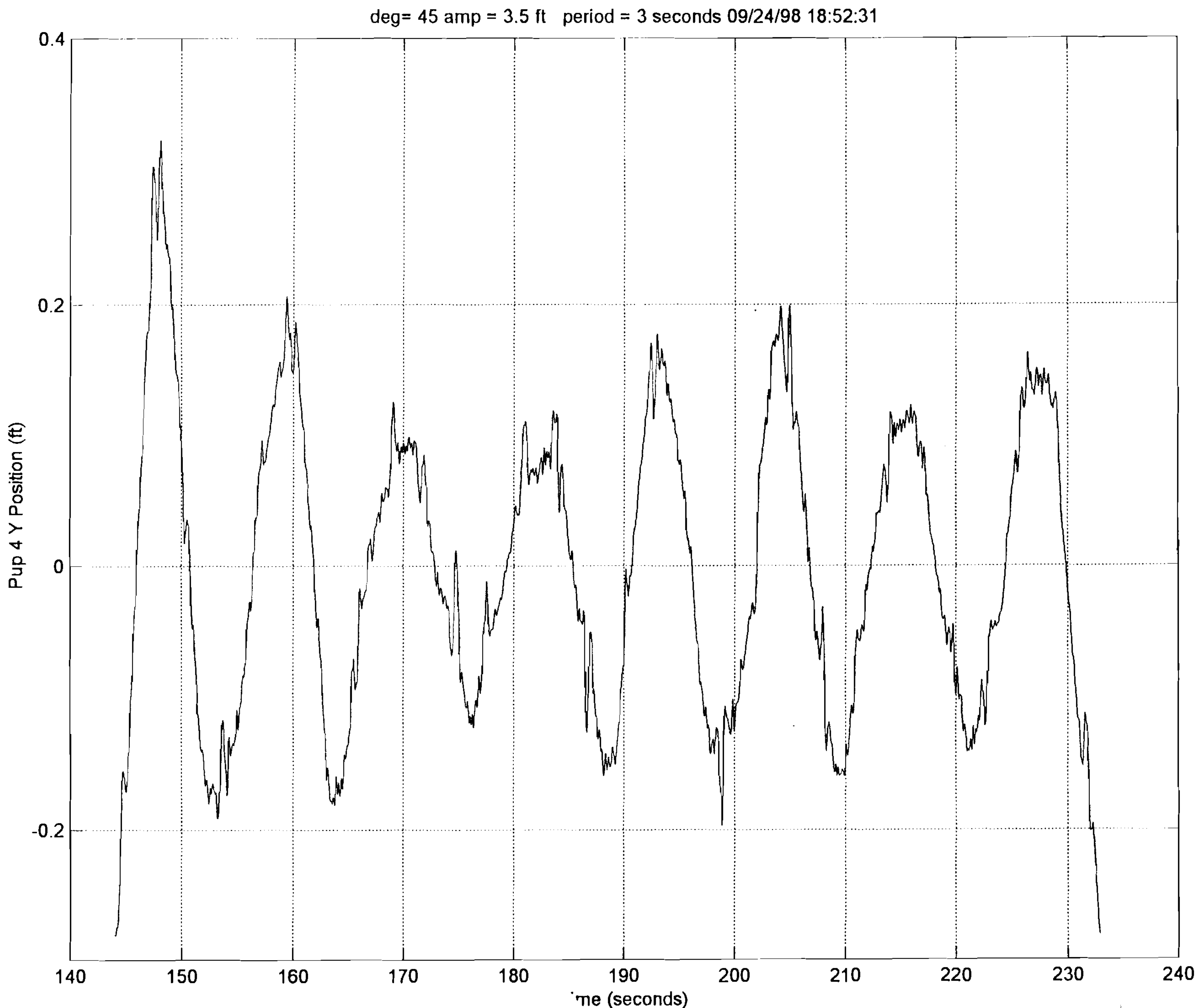


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 3 X Position (ft)
1.5
1
0.5
0
-0.5
-1
-1.5
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

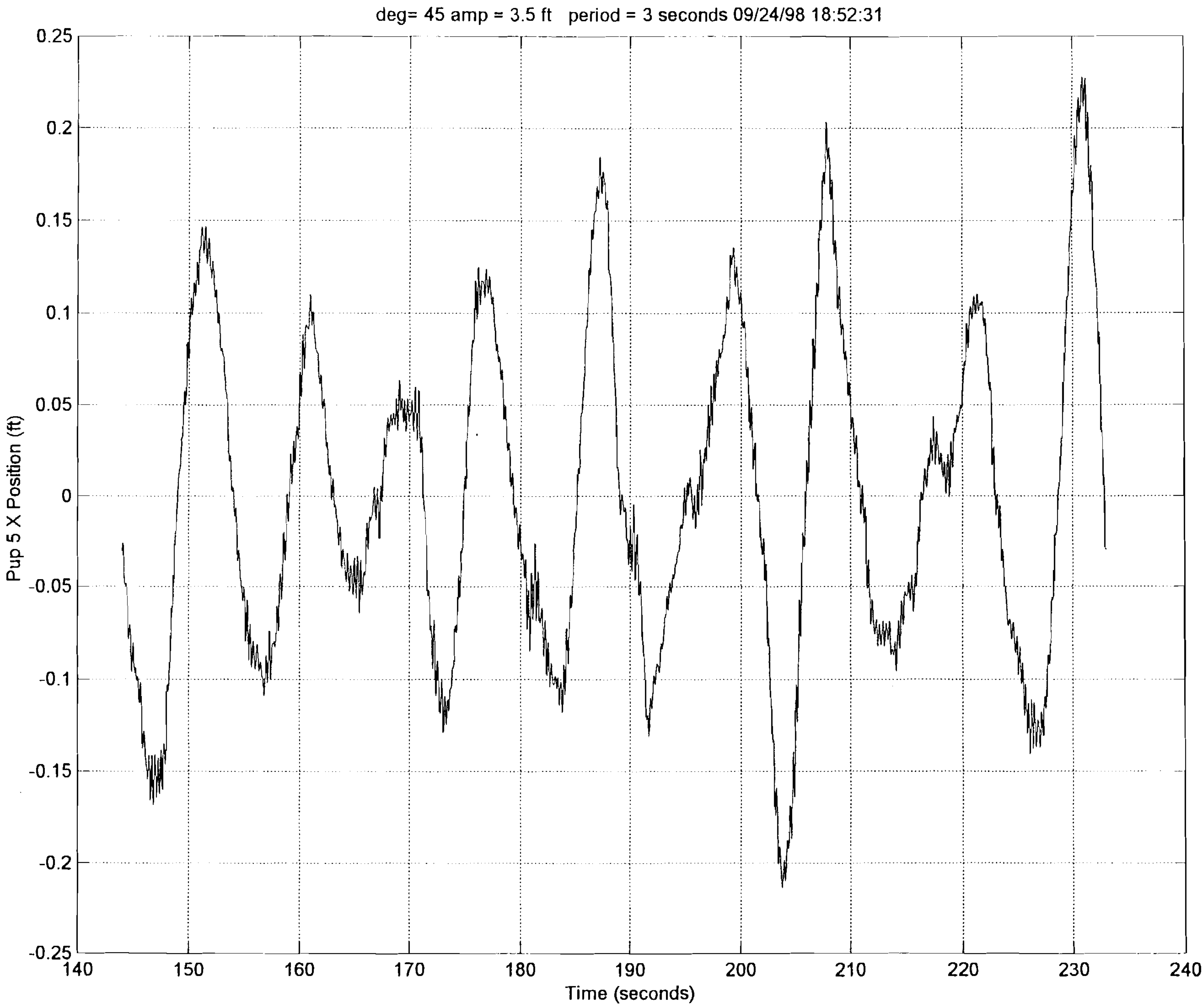

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 3 Y Position (ft)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
140
150
160
170
180
190
200
210
220
230
240
ime (seconds)

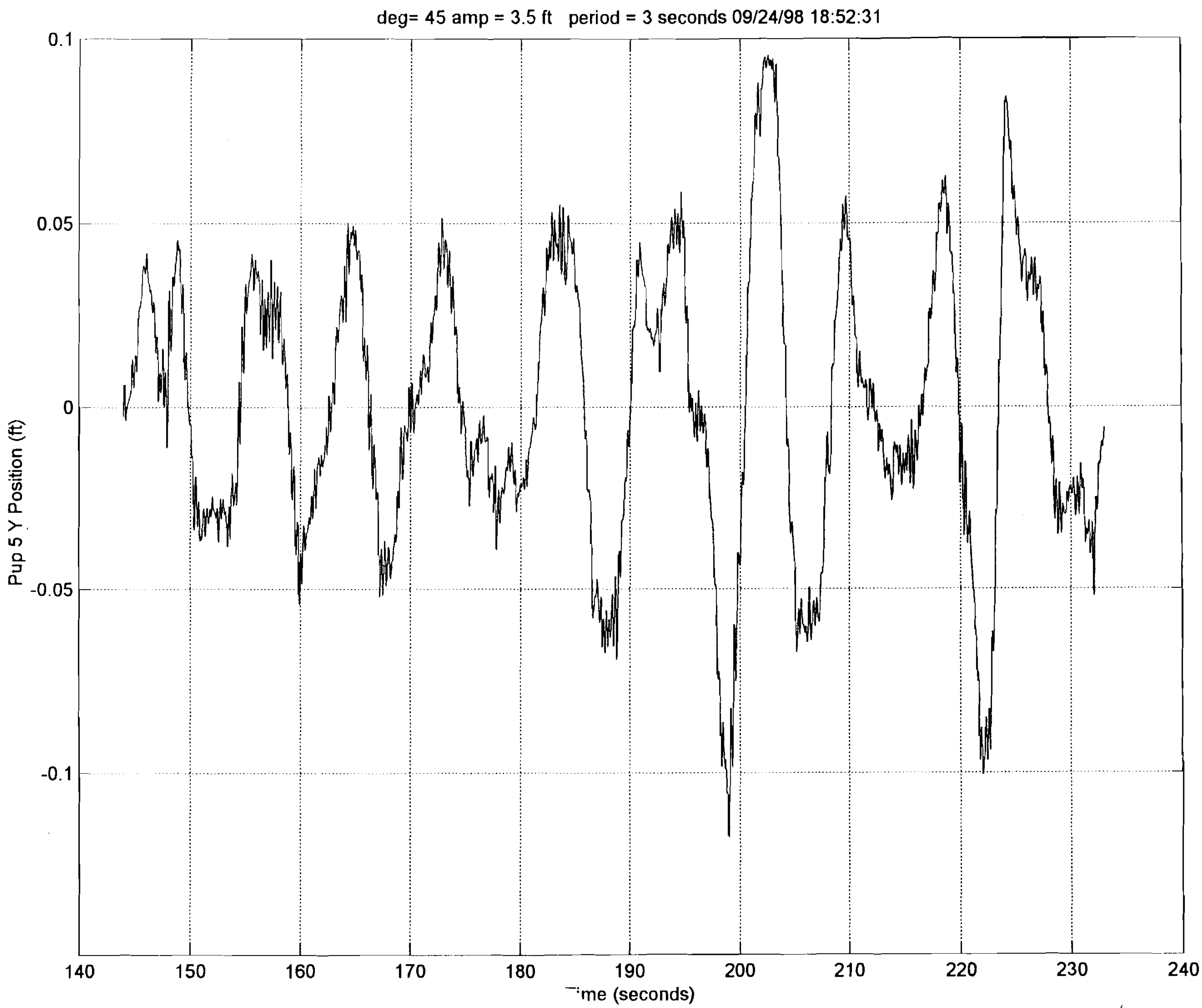
deg= 45 amp = 3.5 ft   period = 3 seconds 09/24/98 18:52:31



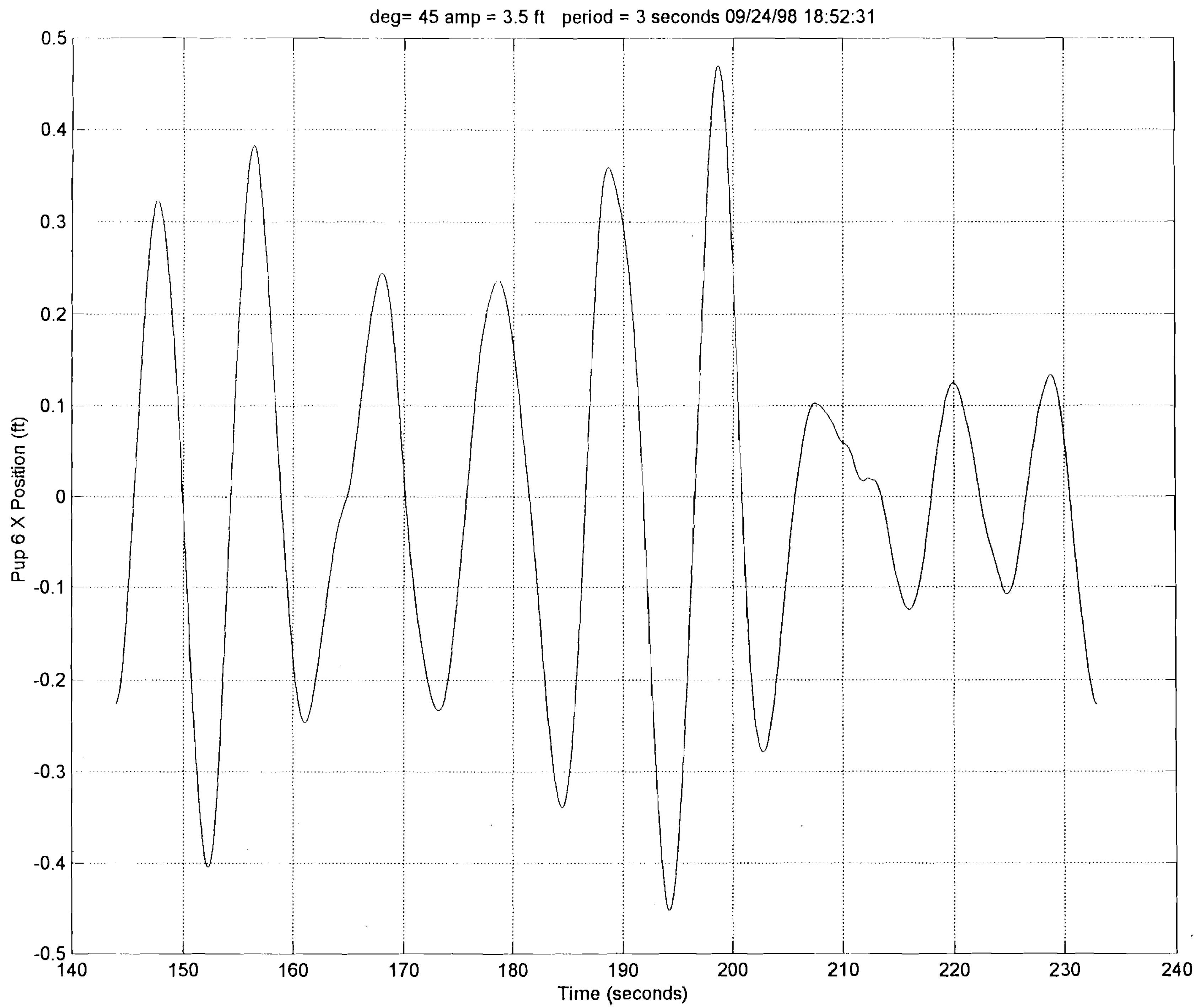


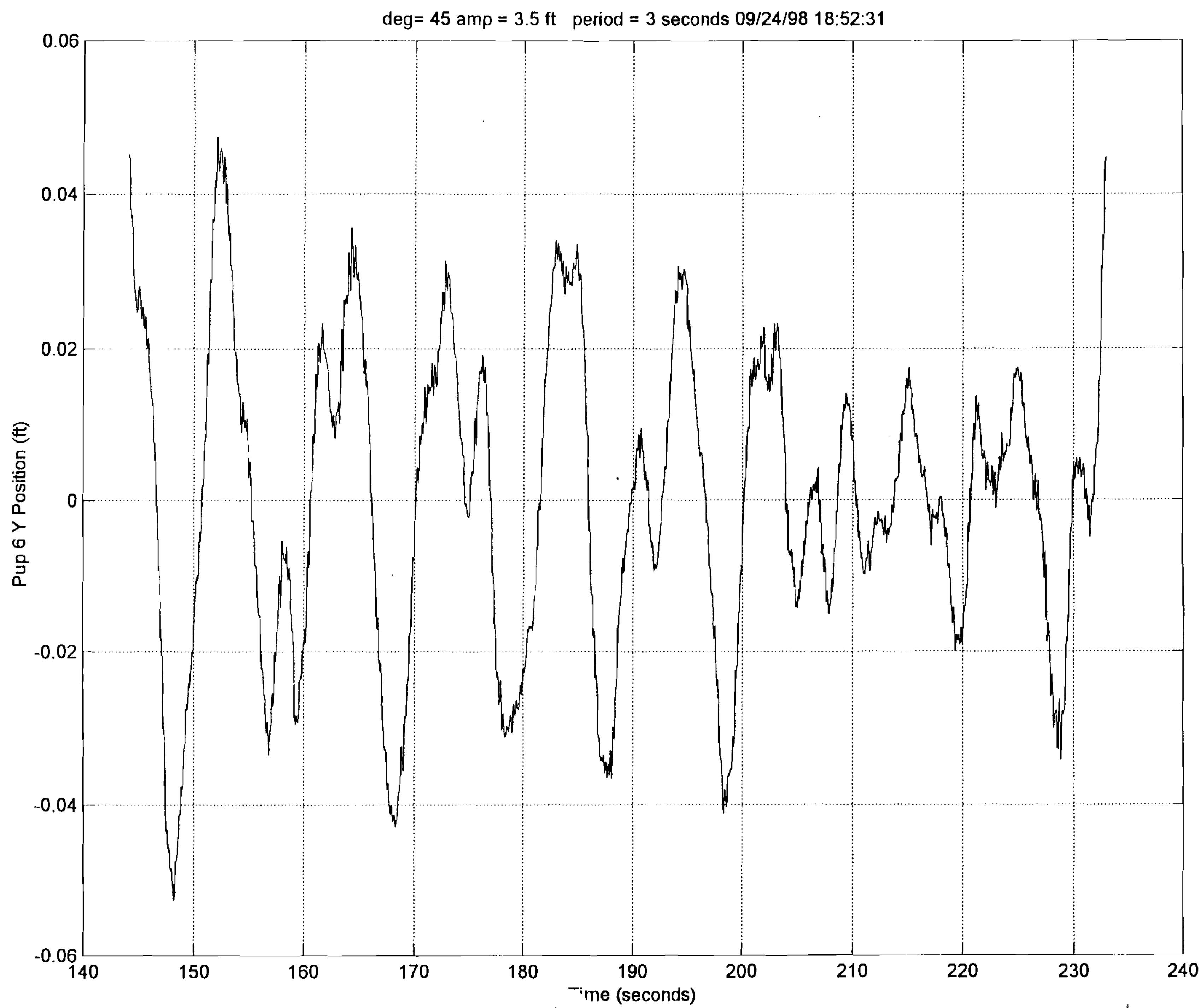
deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 4 Y Position (ft)
0.4
0.2
0
-0.2
140
150
160
170
180
190
200
210
220
230
240
'me (seconds)


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 5 X Position (ft)
Time (seconds)
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
140
150
160
170
180
190
200
210
220
230
240

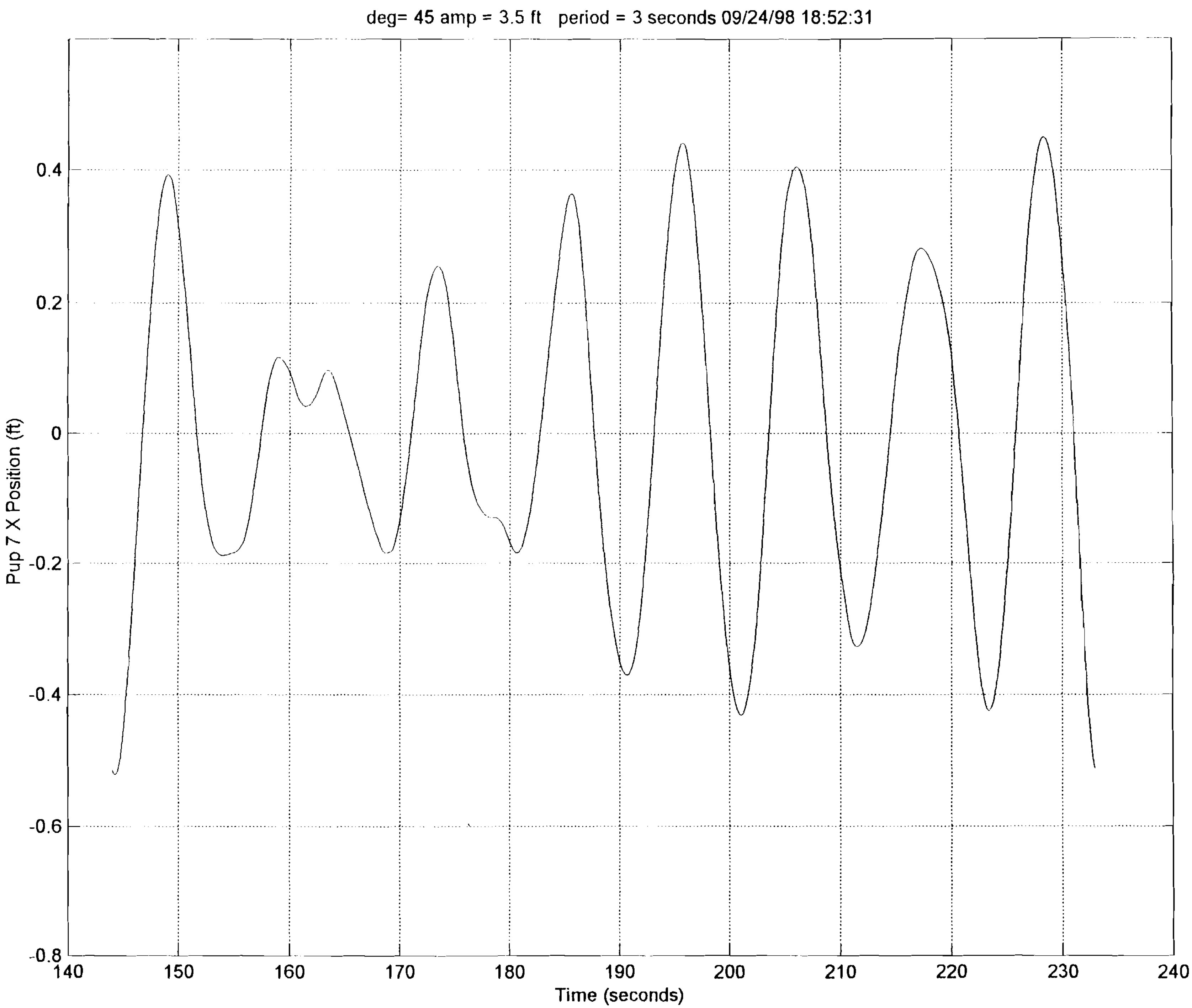


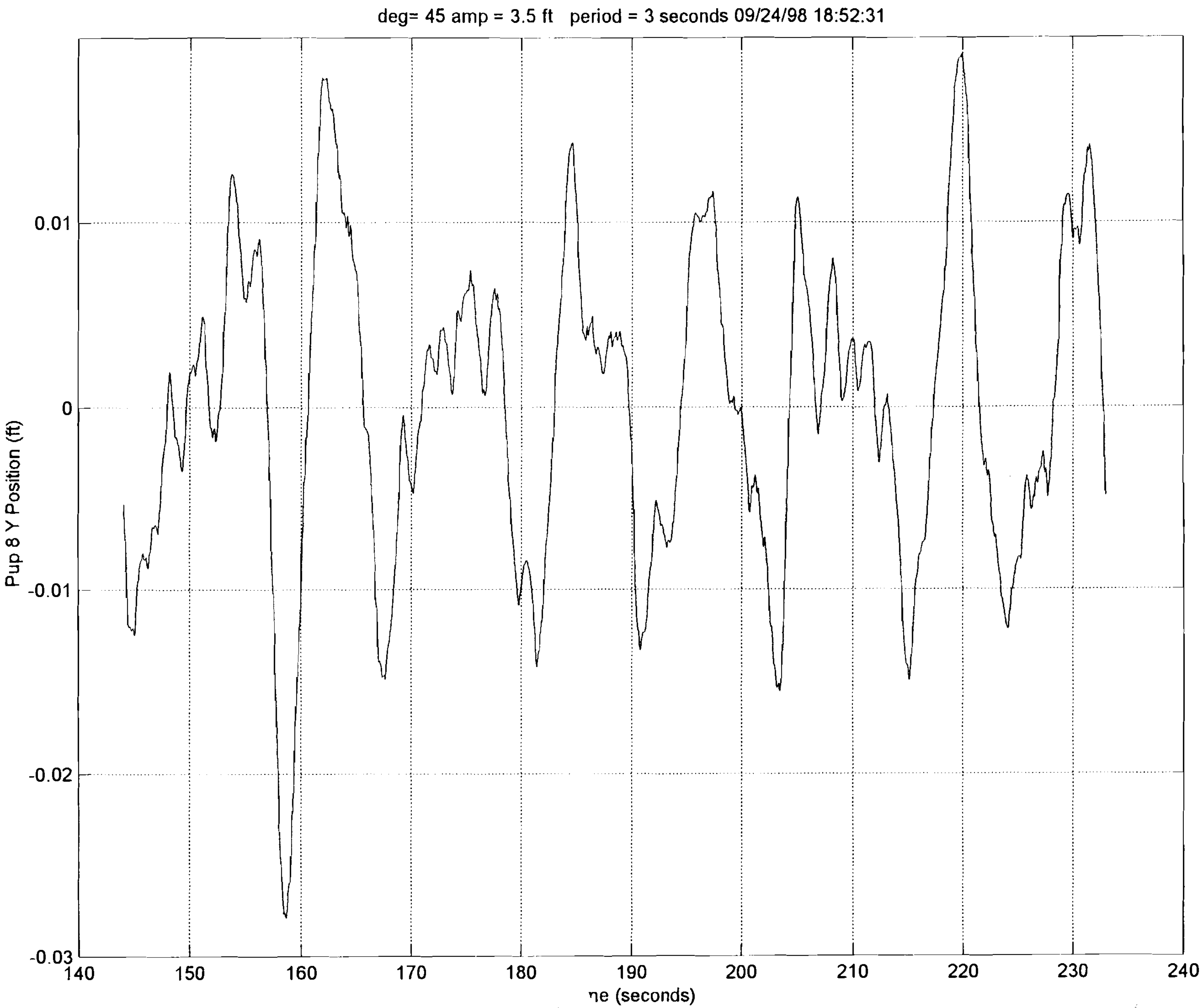
deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 5 Y Position (ft)
0.1
0.05
0
-0.05
-0.1
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 6 X Position (ft)
Time (seconds)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
140
150
160
170
180
190
200
210
220
230
240

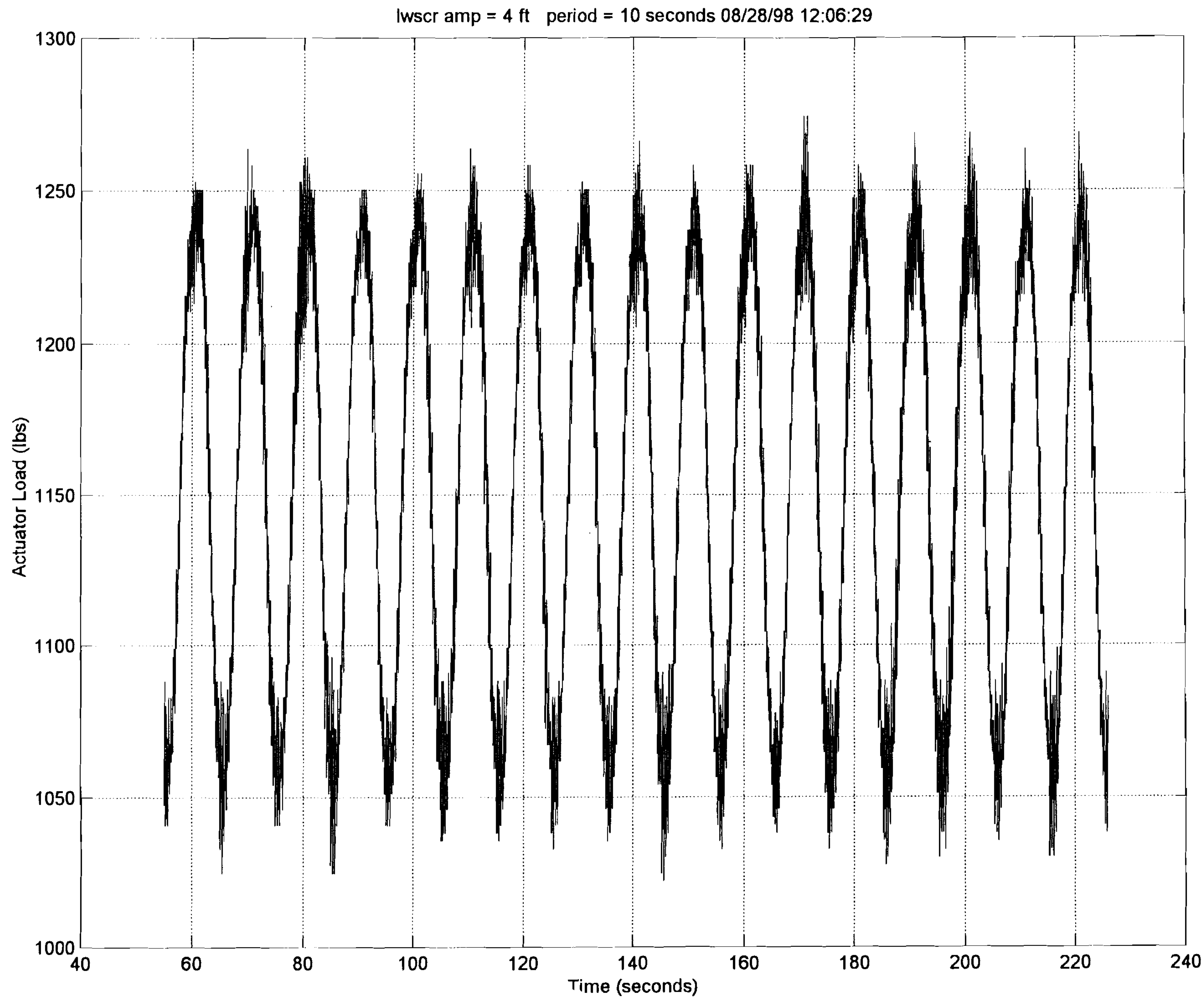


deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 6 Y Position (ft)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

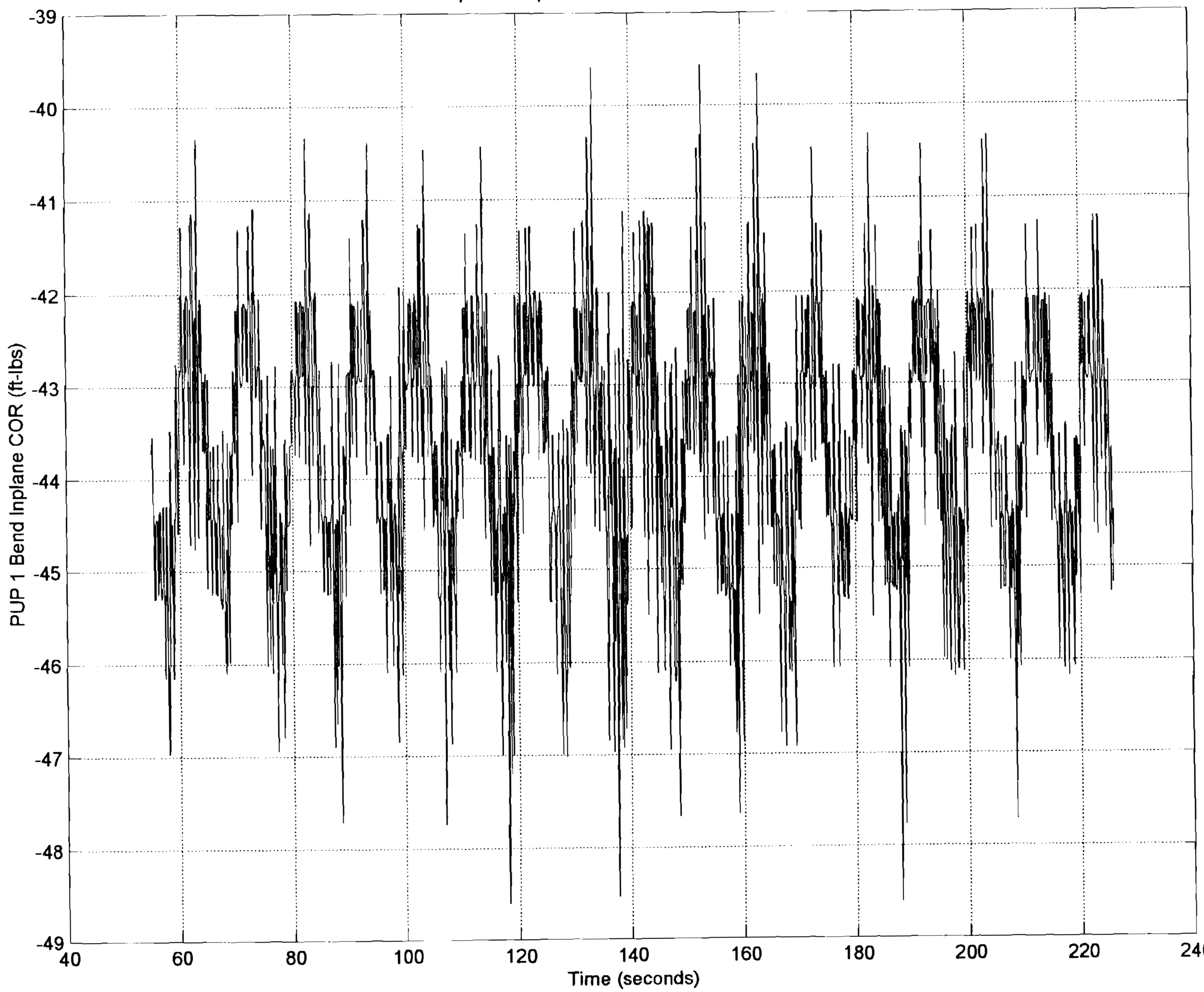

deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 7 X Position (ft)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
140
150
160
170
180
190
200
210
220
230
240
Time (seconds)

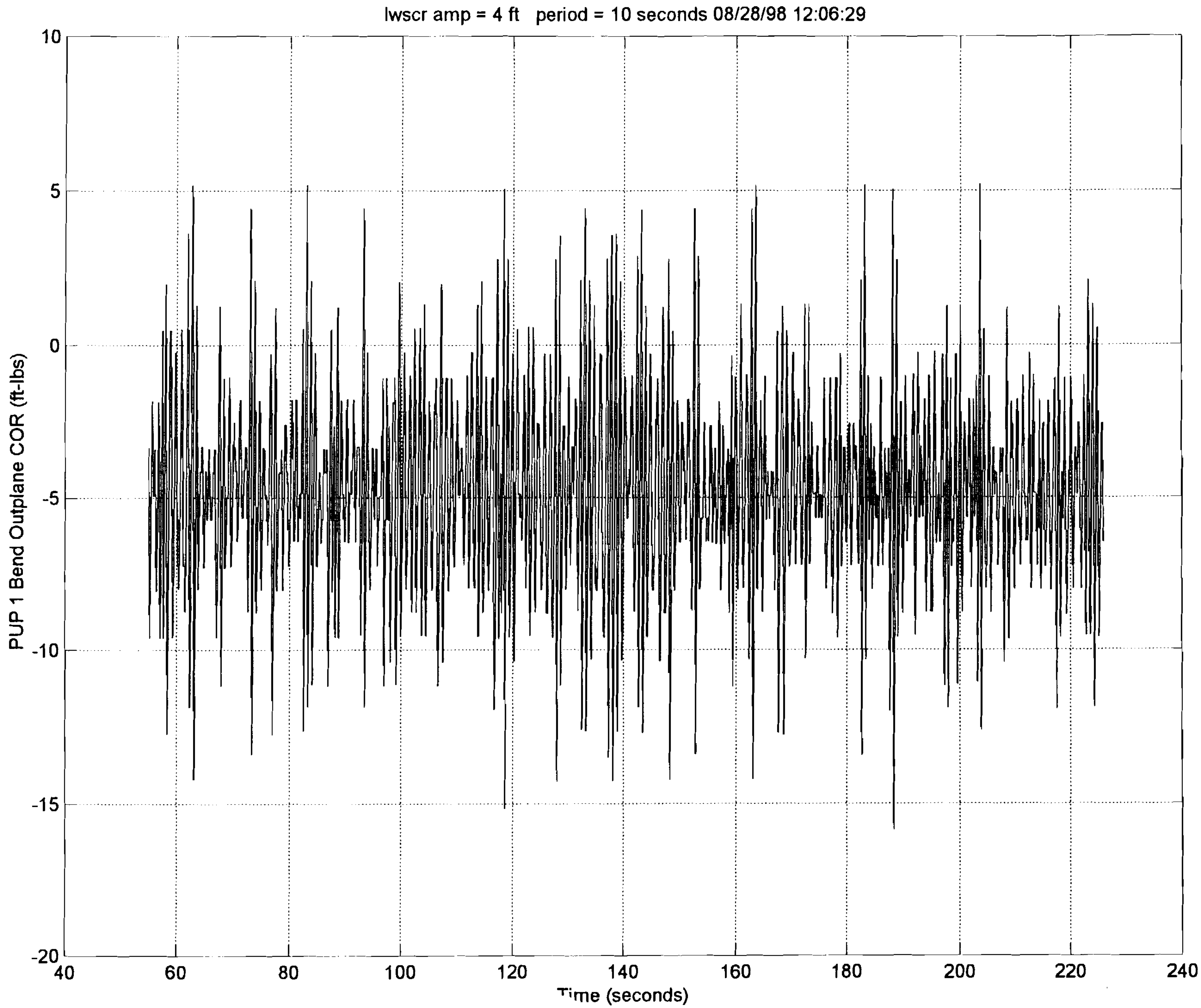


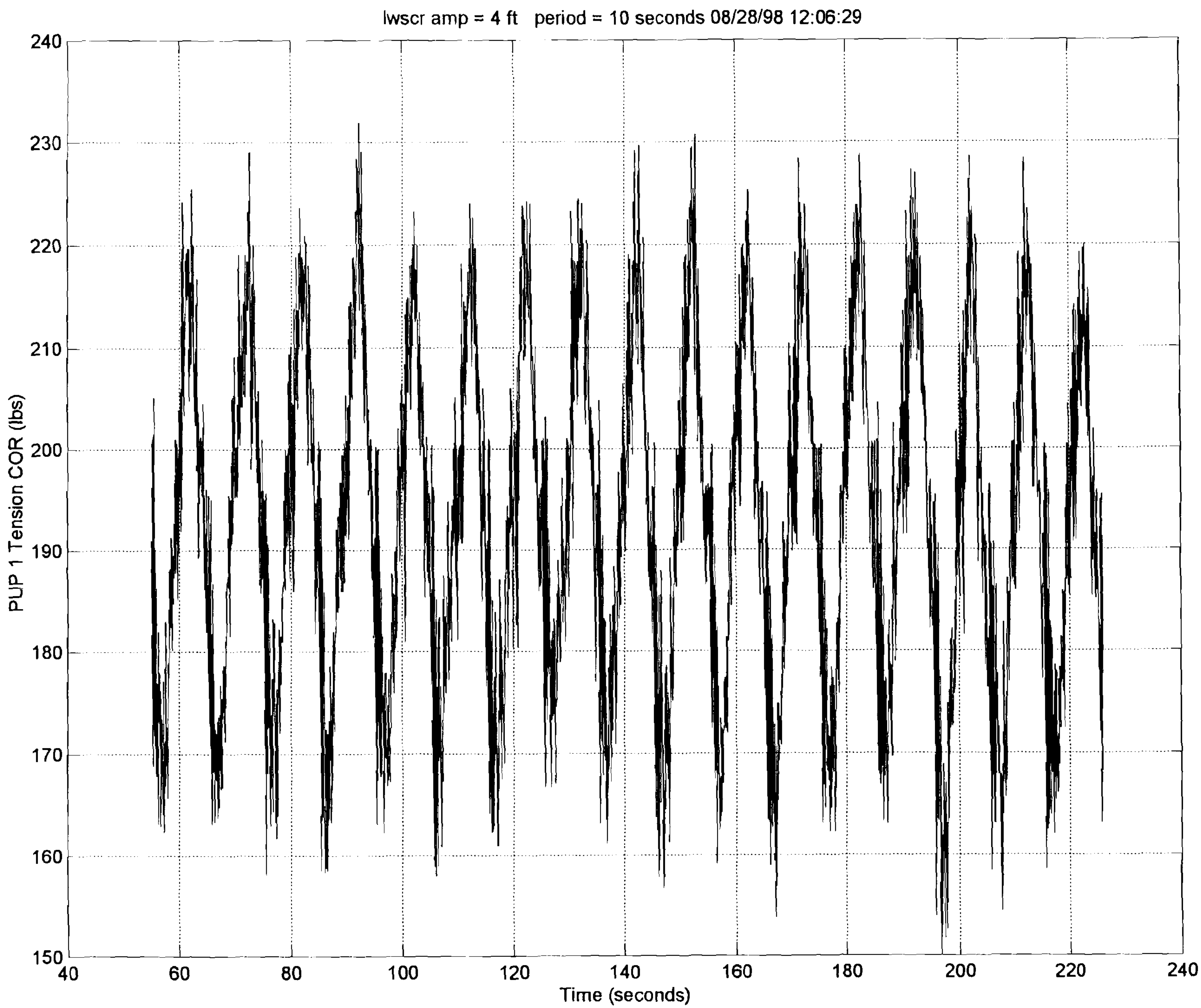
deg= 45 amp = 3.5 ft period = 3 seconds 09/24/98 18:52:31
Pup 8 Y Position (ft)
0.01
0
-0.01
-0.02
-0.03
140
150
160
170
180
190
200
210
220
230
240
ne (seconds)

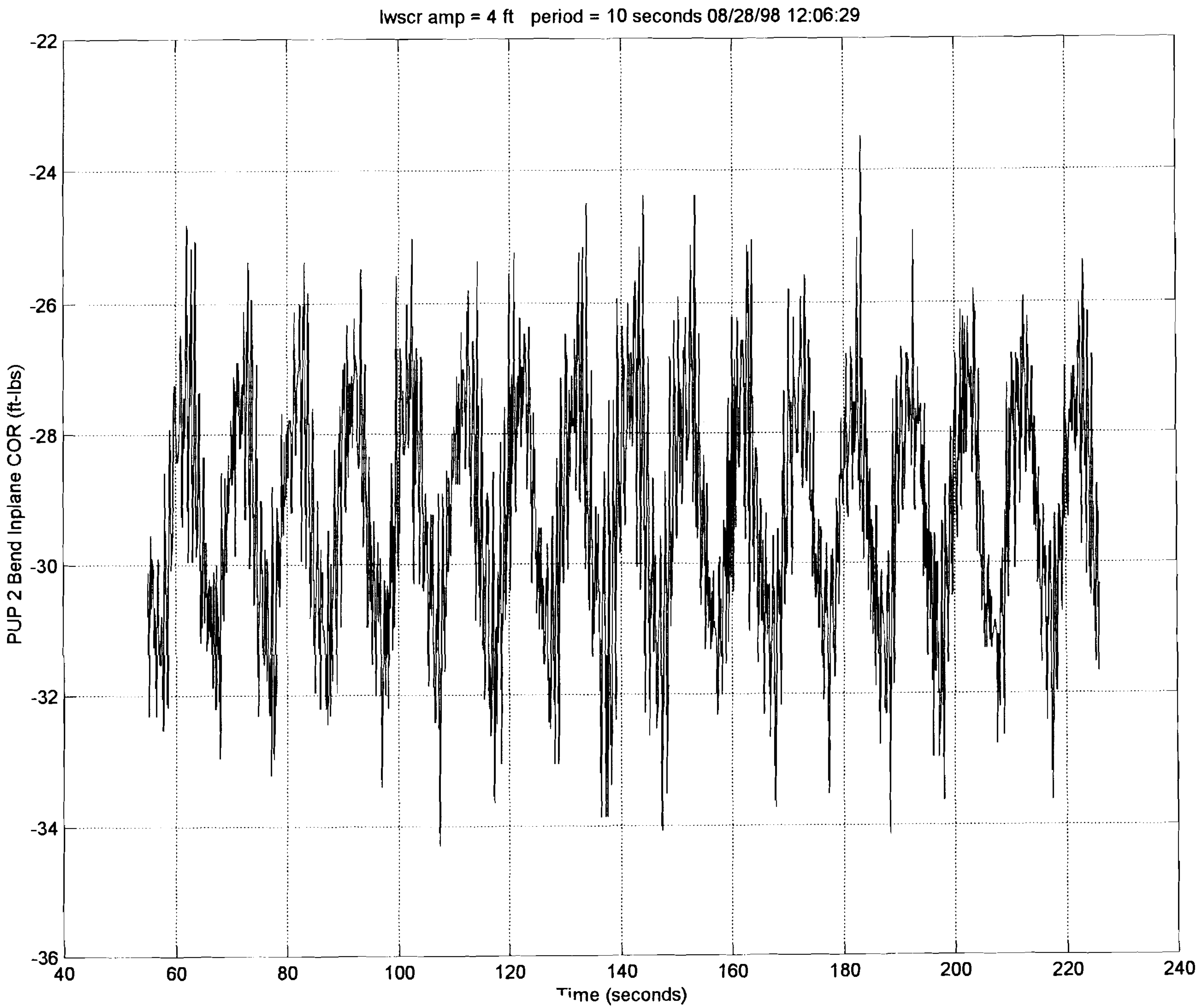

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Actuator Load (lbs)
1300
1250
1200
1150
1100
1050
1000
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

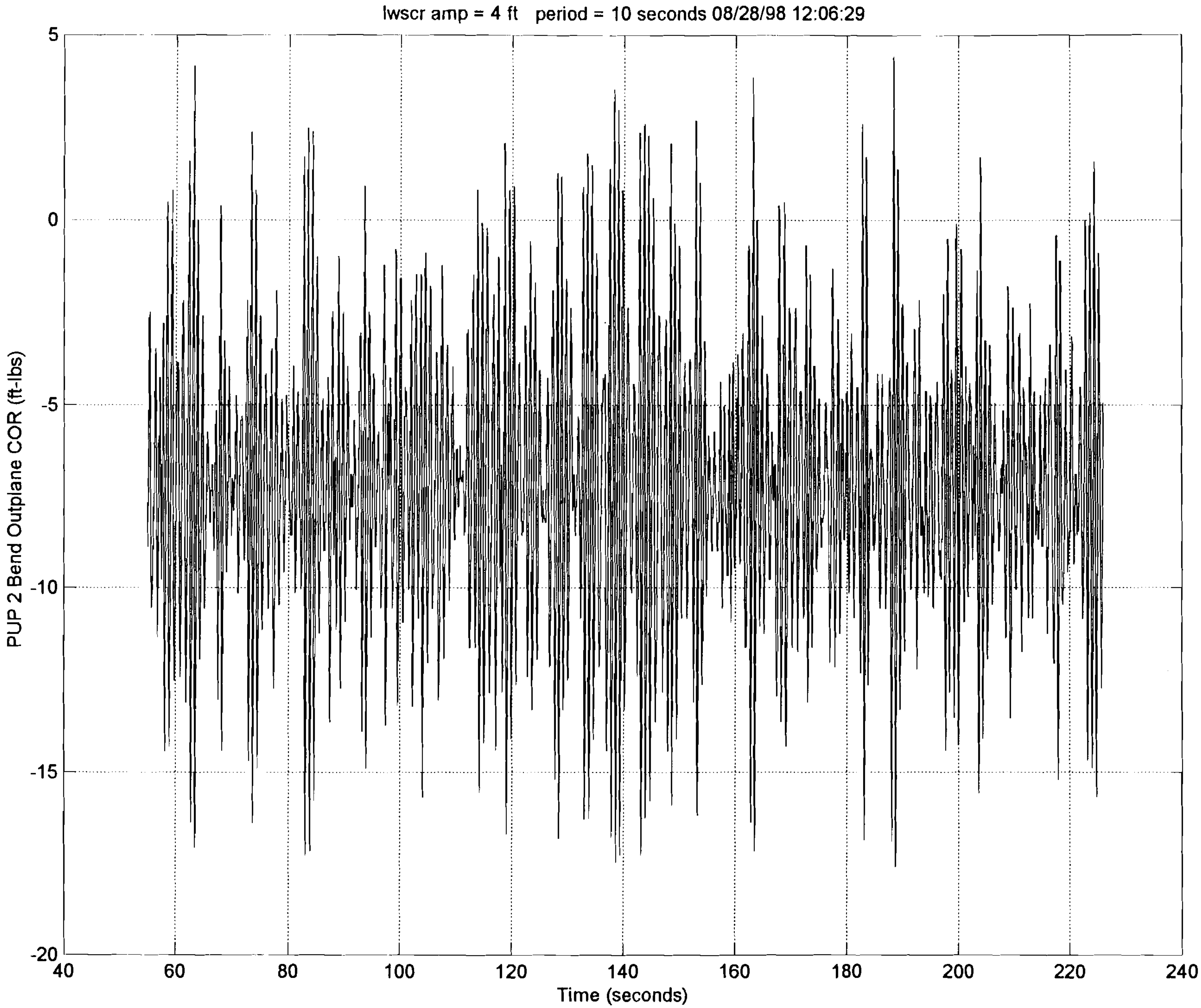
lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29

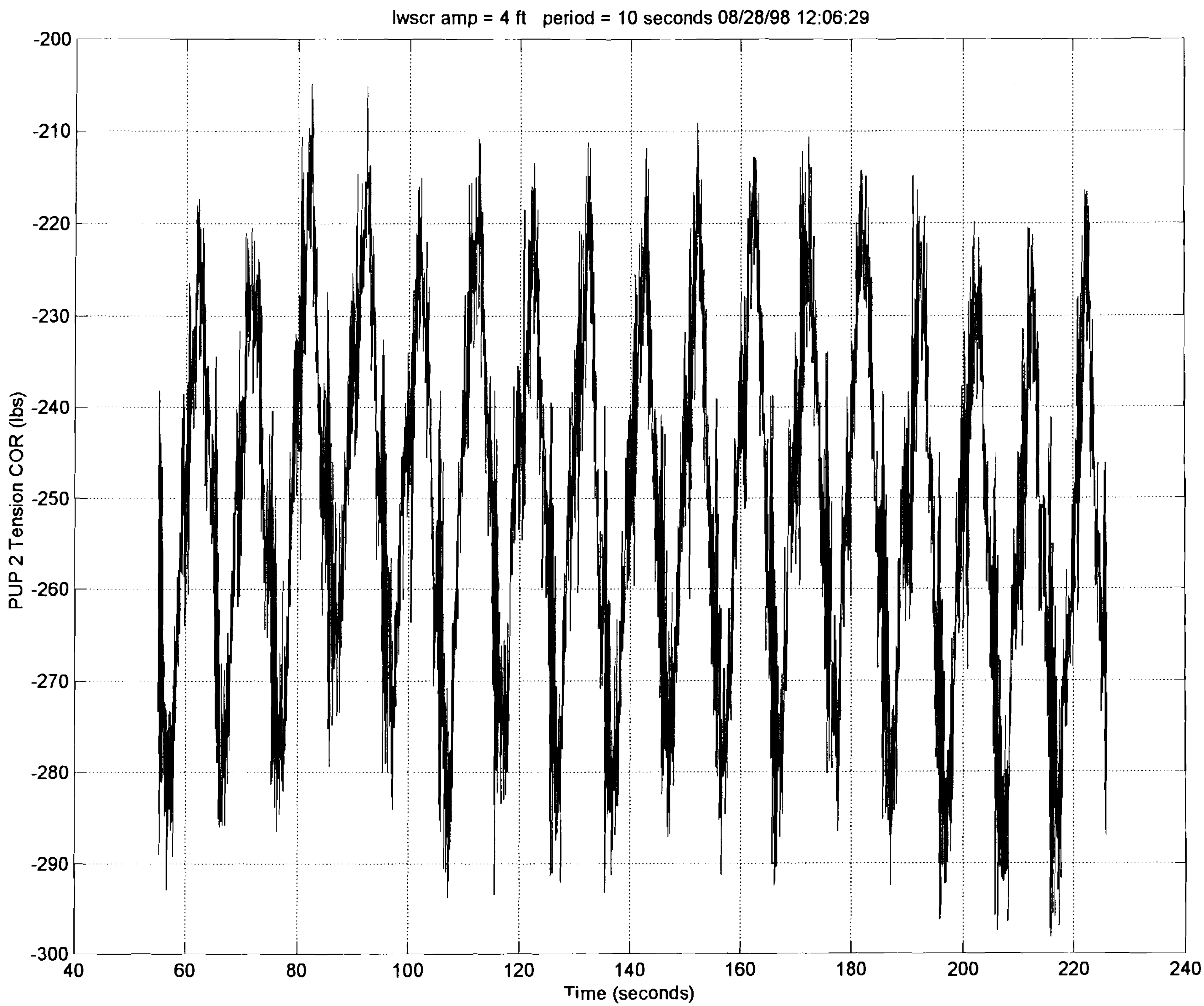


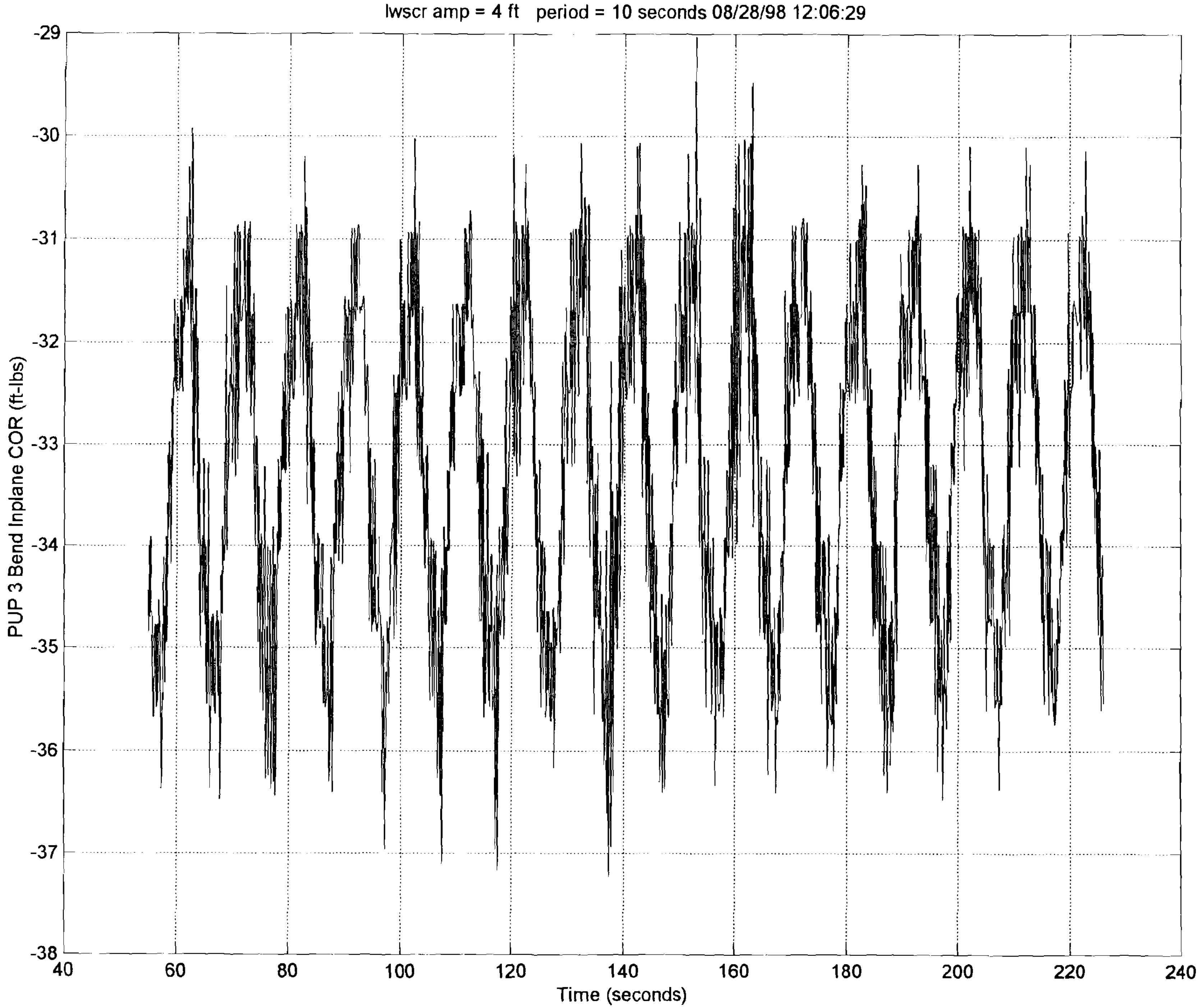

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
PUP 1 Bend Outplane COR (ft-lbs)
Time (seconds)
10
5
0
-5
-10
-15
-20
40
60
80
100
120
140
160
180
200
220
240

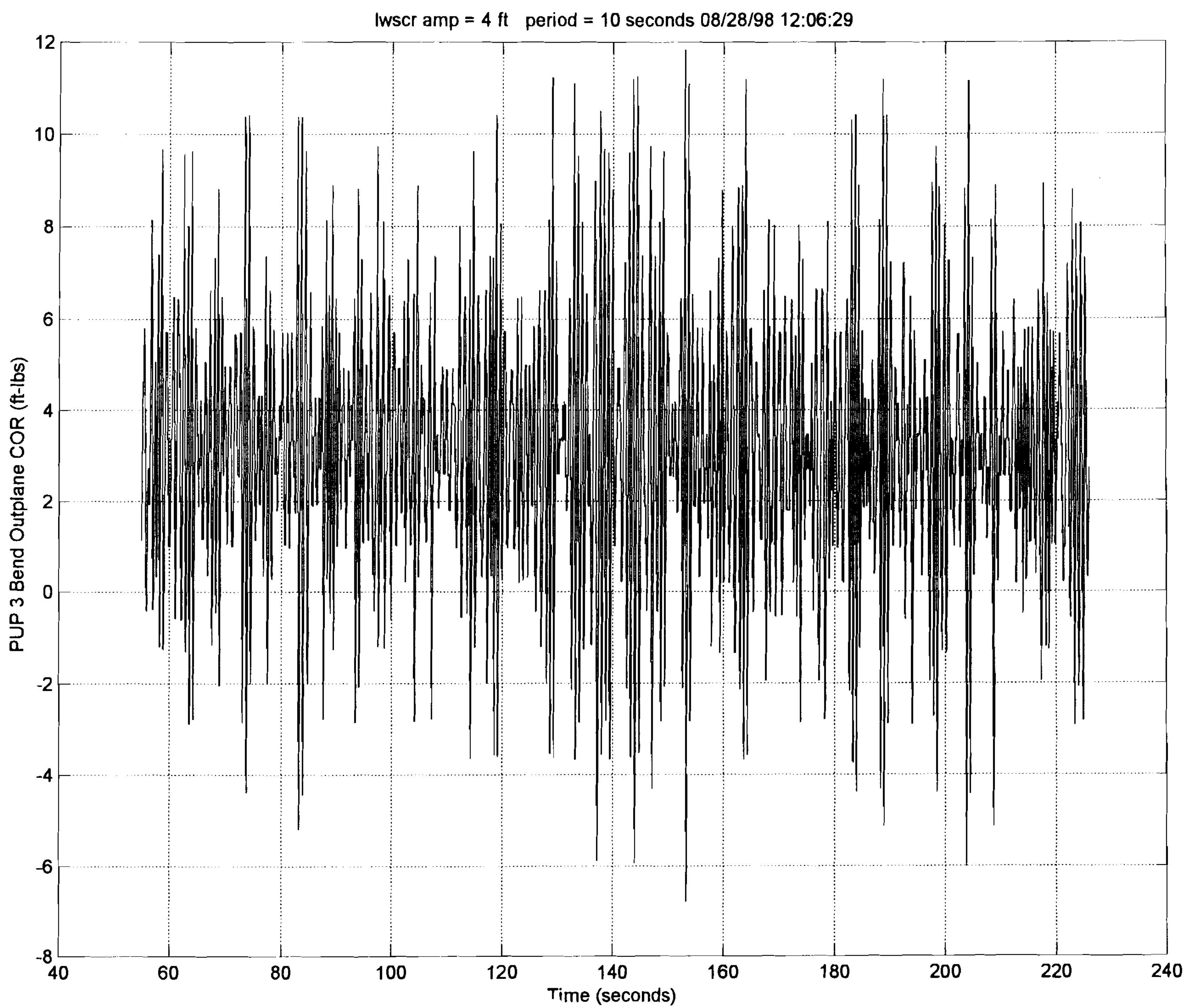

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 1 Tension COR (lbs)
Time (seconds)
240
230
220
210
200
190
180
170
160
150
40
60
80
100
120
140
160
180
200
220
240

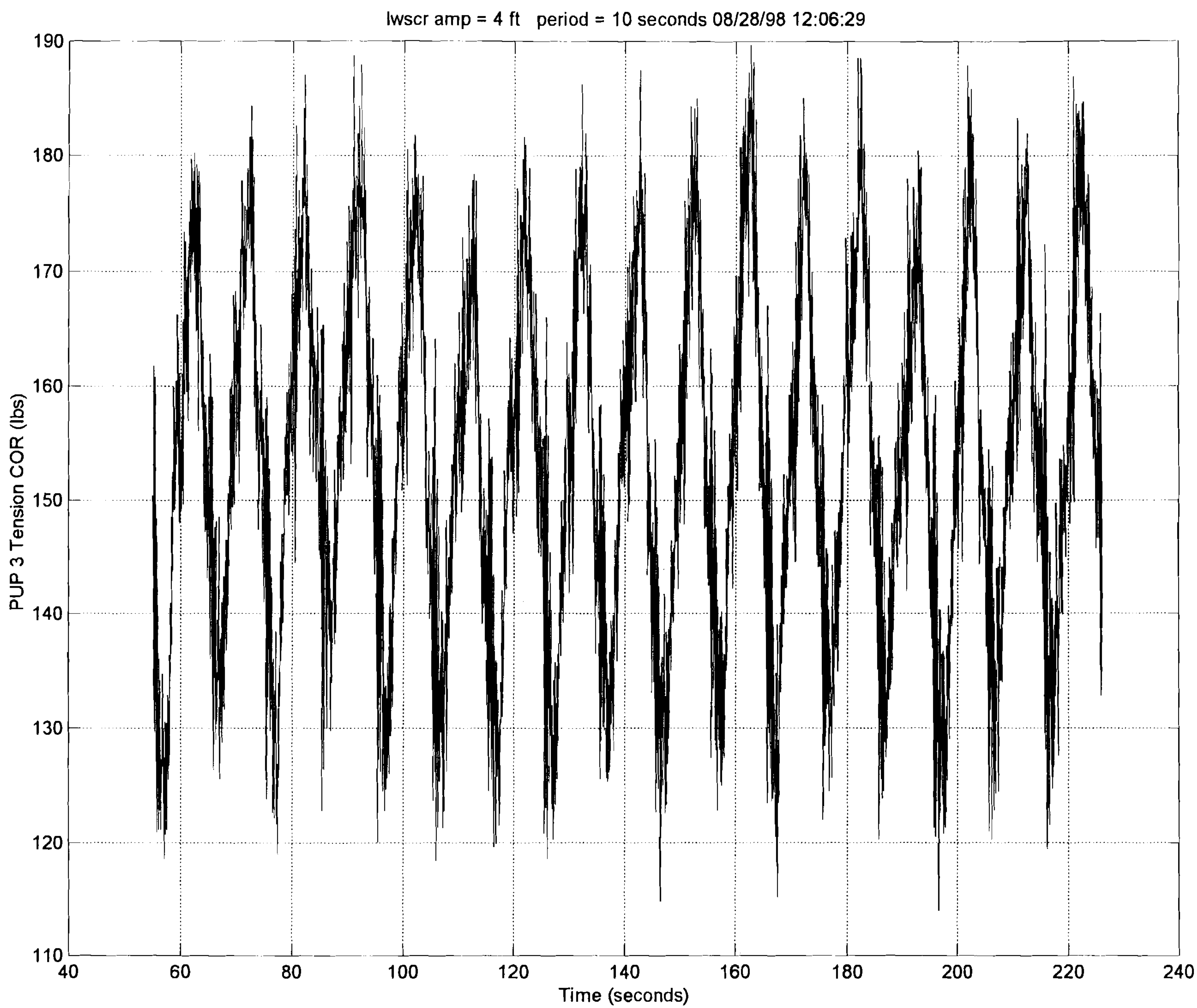

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
PUP 2 Bend Inplane COR (ft-lbs)
-22
-24
-26
-28
-30
-32
-34
-36
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

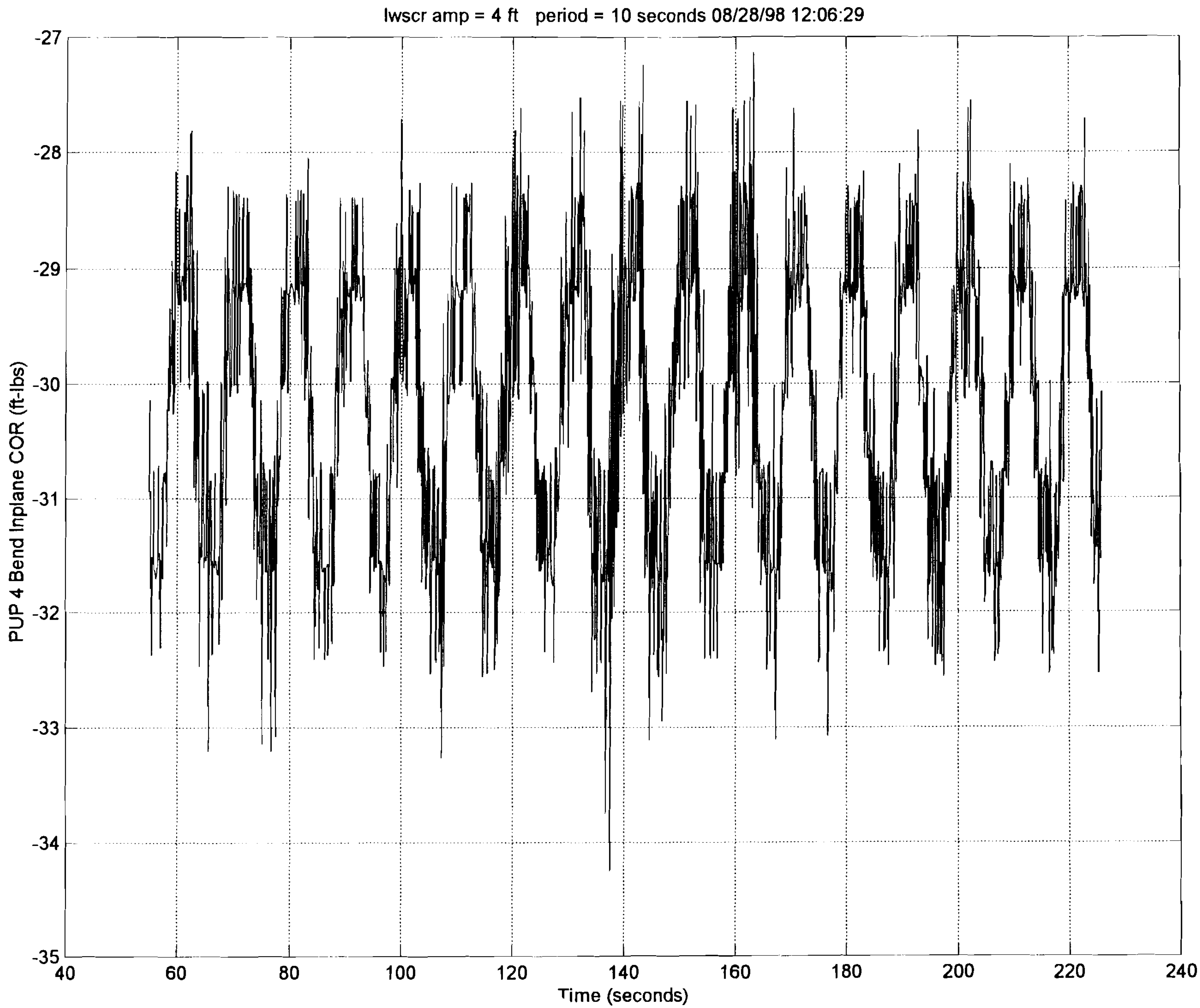

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 2 Bend Outplane COR (ft-lbs)
5
0
-5
-10
-15
-20
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

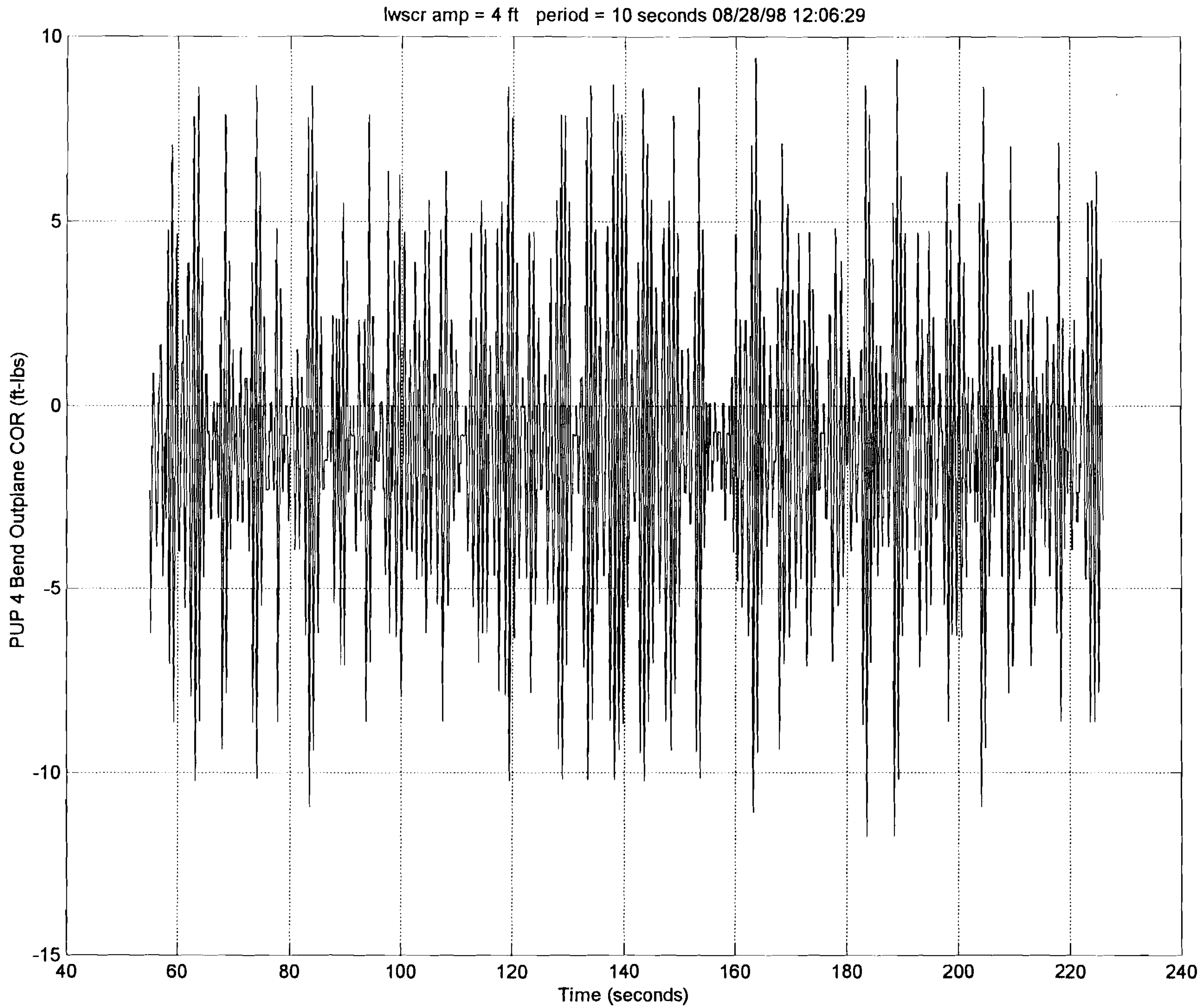

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 2 Tension COR (lbs)
-200
-210
-220
-230
-240
-250
-260
-270
-280
-290
-300
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)


lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 3 Bend Inplane COR (ft-lbs)
Time (seconds)
-29
-30
-31
-32
-33
-34
-35
-36
-37
-38
40
60
80
100
120
140
160
180
200
220
240

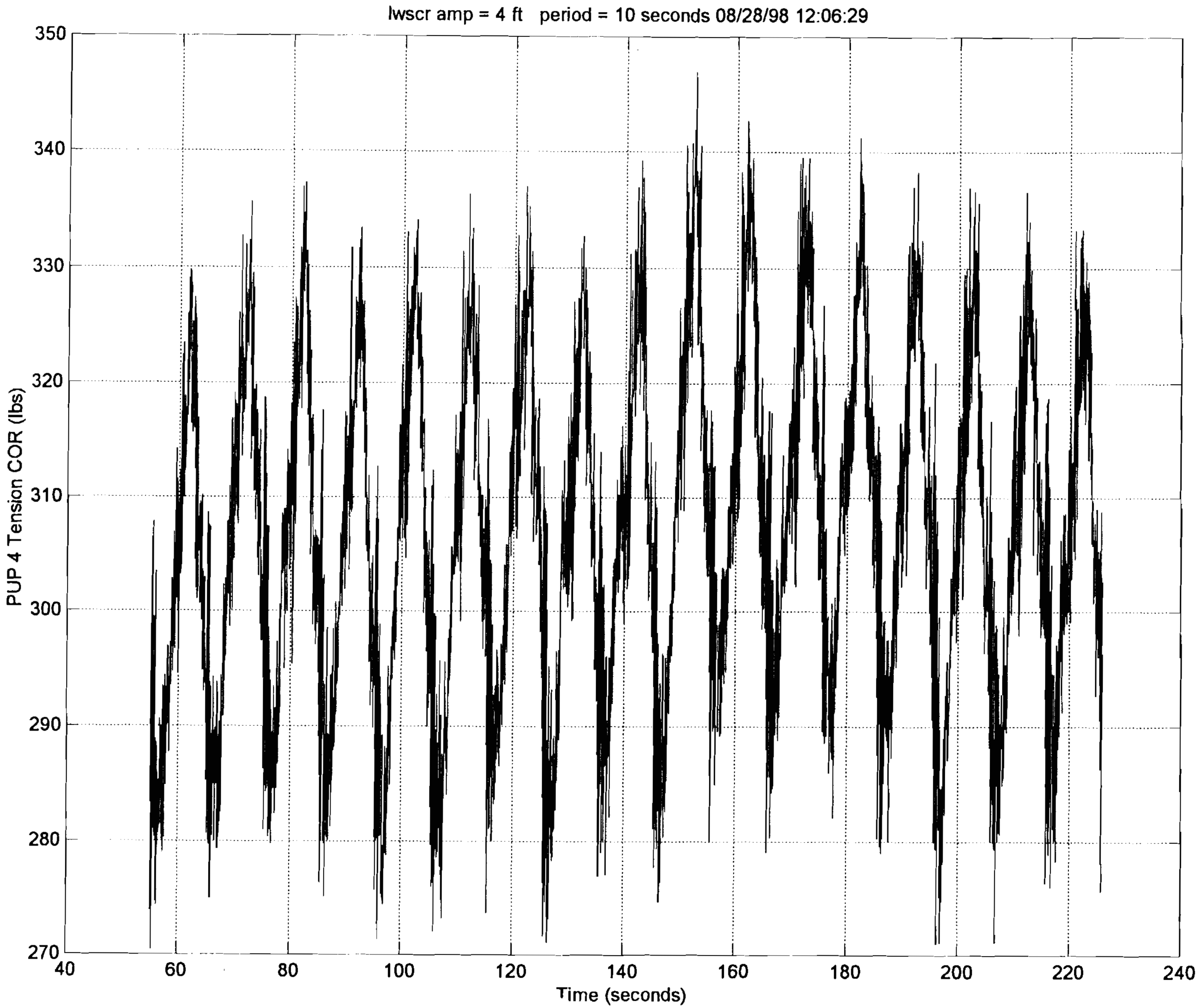

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
PUP 3 Bend Outplane COR (ft-lbs)
Time (seconds)
12
10
8
6
4
2
0
-2
-4
-6
-8
40
60
80
100
120
140
160
180
200
220
240

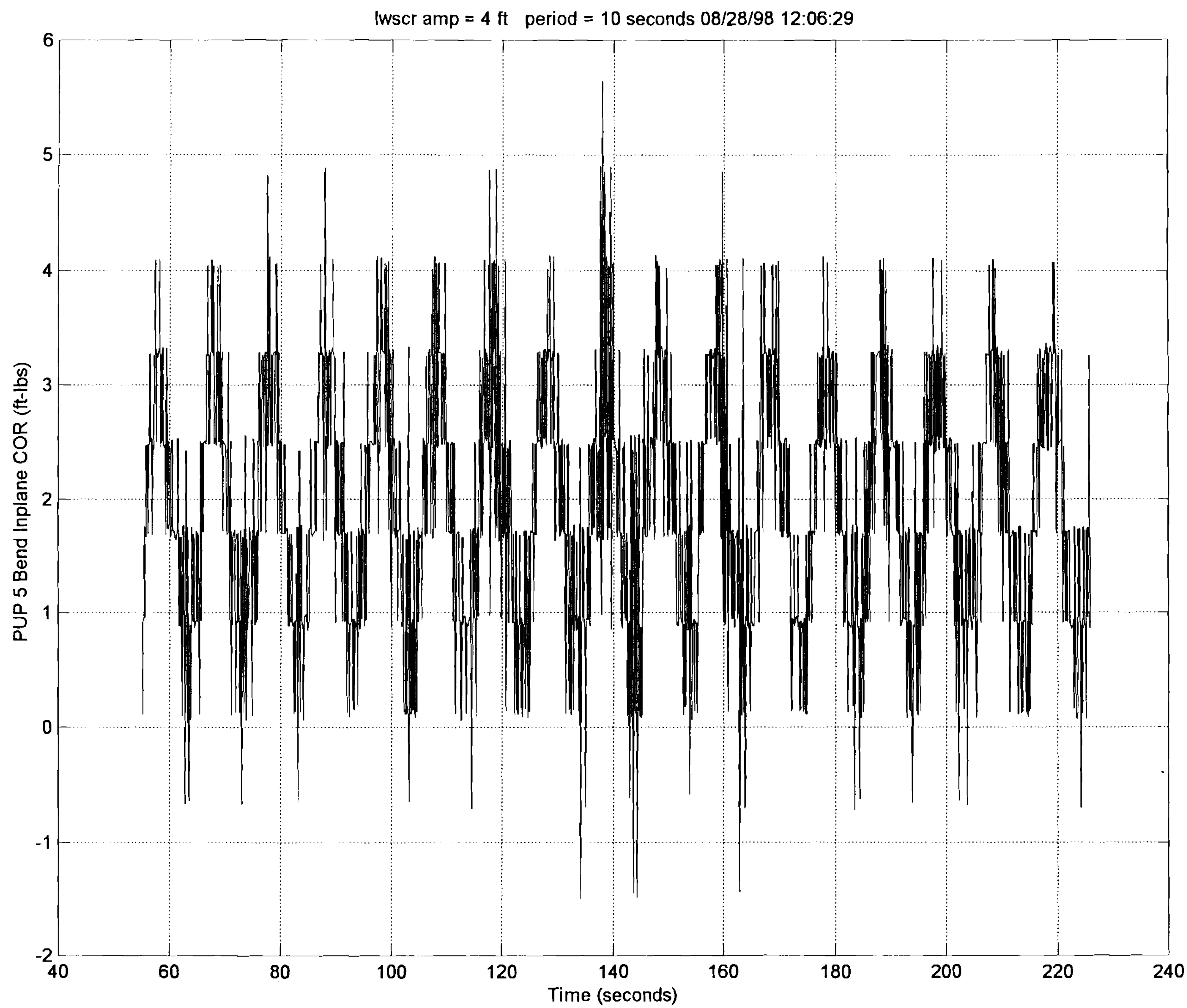

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 3 Tension COR (lbs)
Time (seconds)
190
180
170
160
150
140
130
120
110
40
60
80
100
120
140
160
180
200
220
240

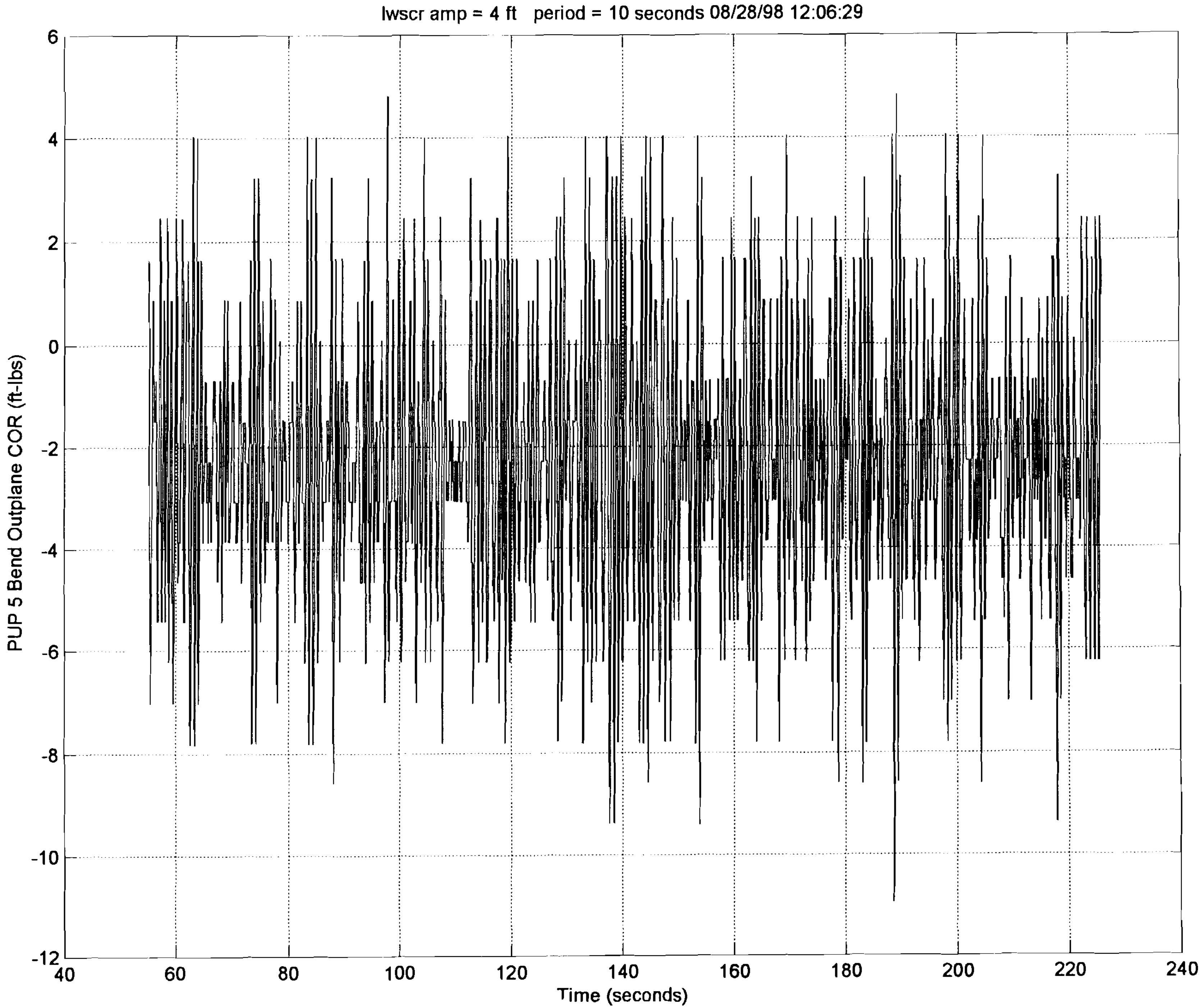

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 4 Bend Inplane COR (ft-lbs)
Time (seconds)
-27
-28
-29
-30
-31
-32
-33
-34
-35
40
60
80
100
120
140
160
180
200
220
240

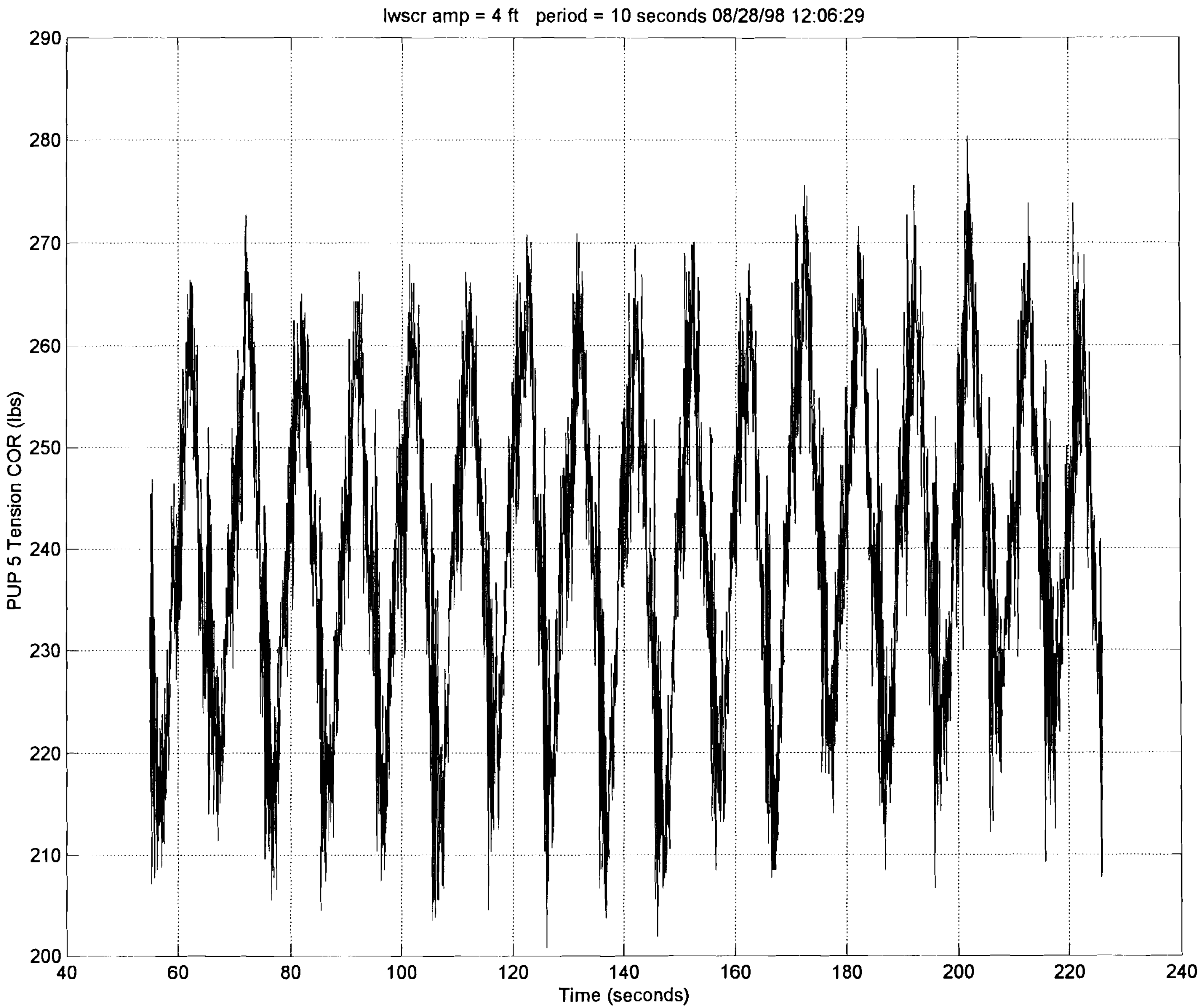


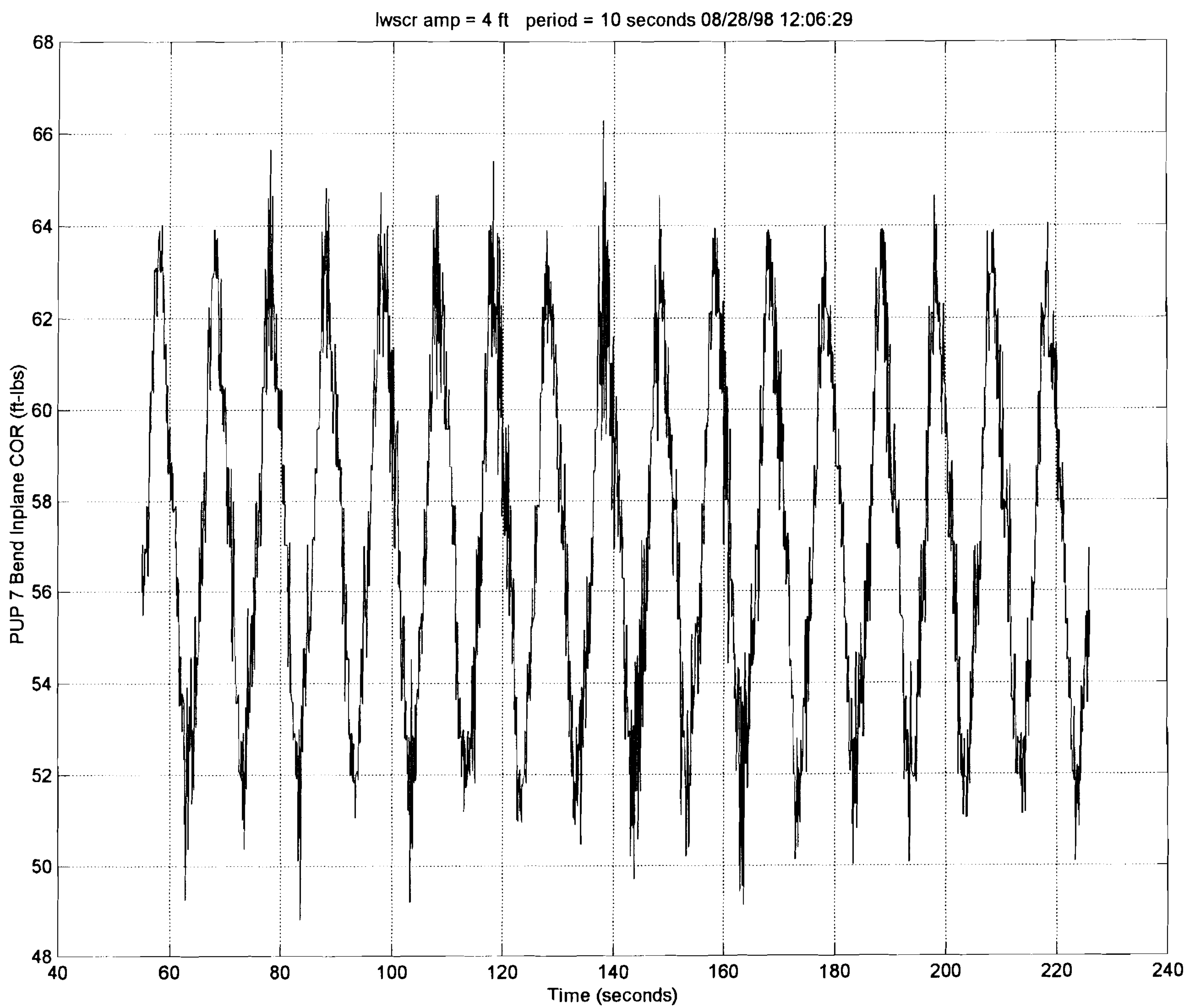
lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 4 Bend Outplane COR (ft-lbs)
10
5
0
-5
-10
-15
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

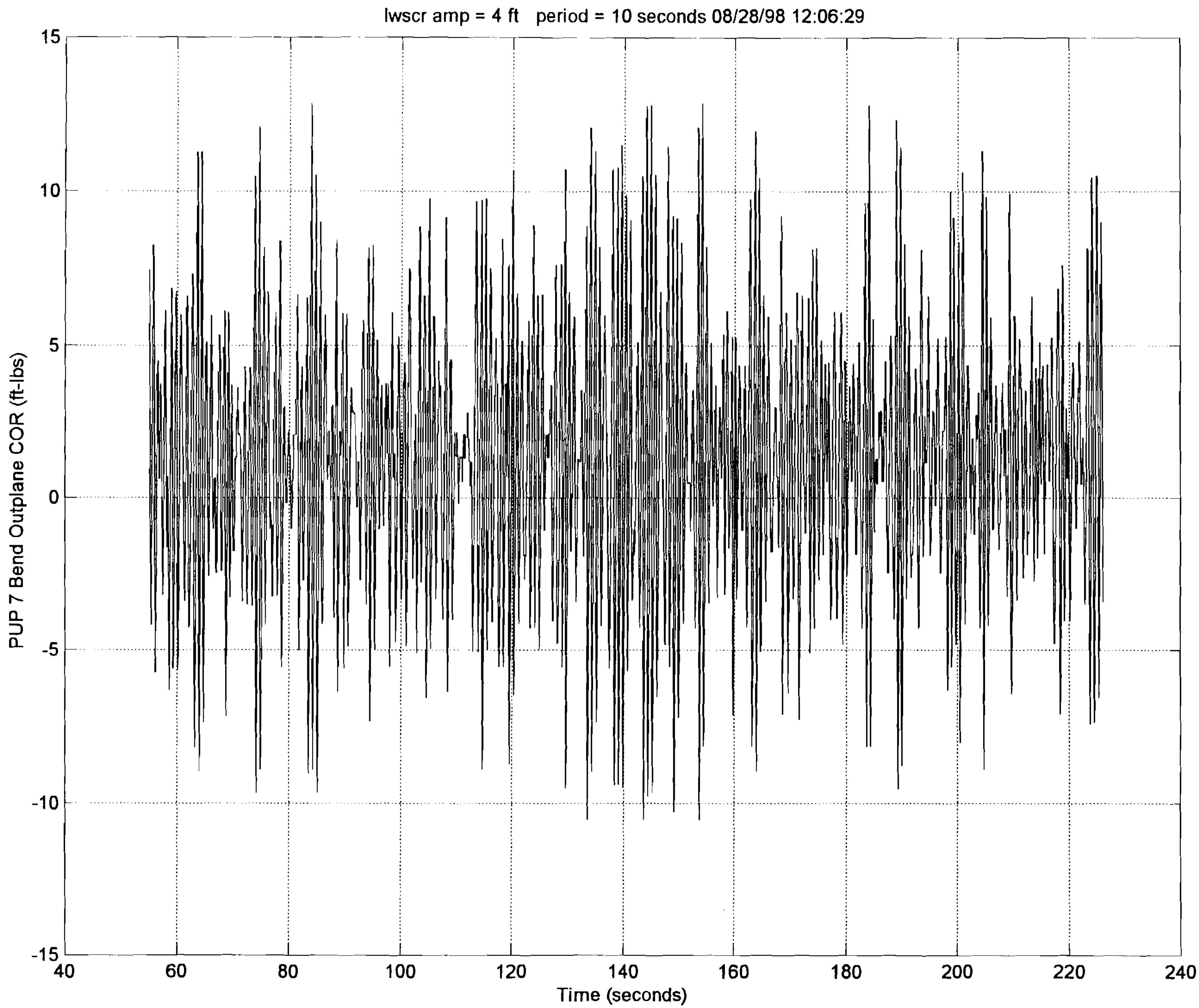

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 4 Tension COR (lbs)
Time (seconds)
350
340
330
320
310
300
290
280
270
40
60
80
100
120
140
160
180
200
220
240

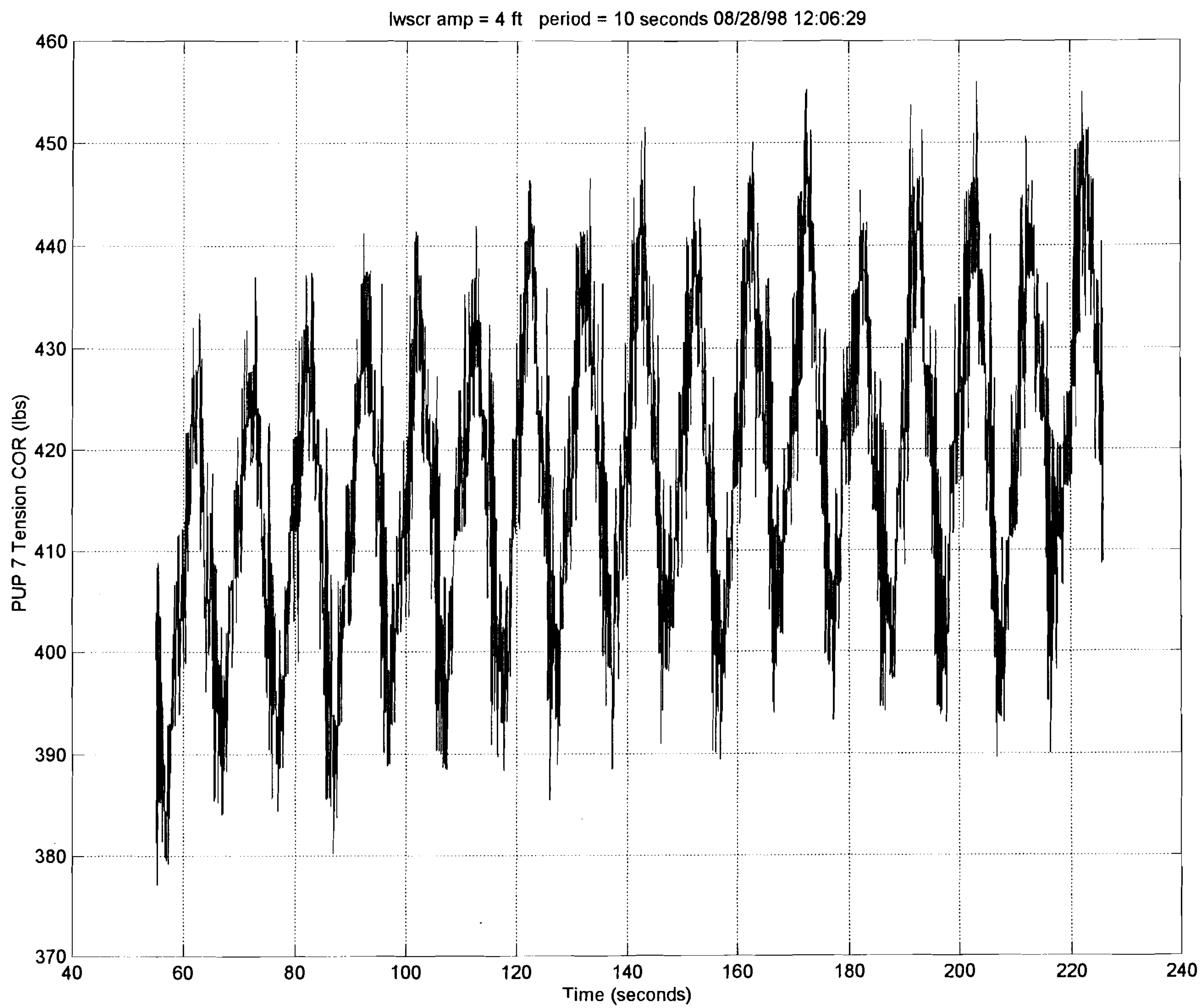

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 5 Bend Inplane COR (ft-lbs)
Time (seconds)
6
5
4
3
2
1
0
-1
-2
40
60
80
100
120
140
160
180
200
220
240

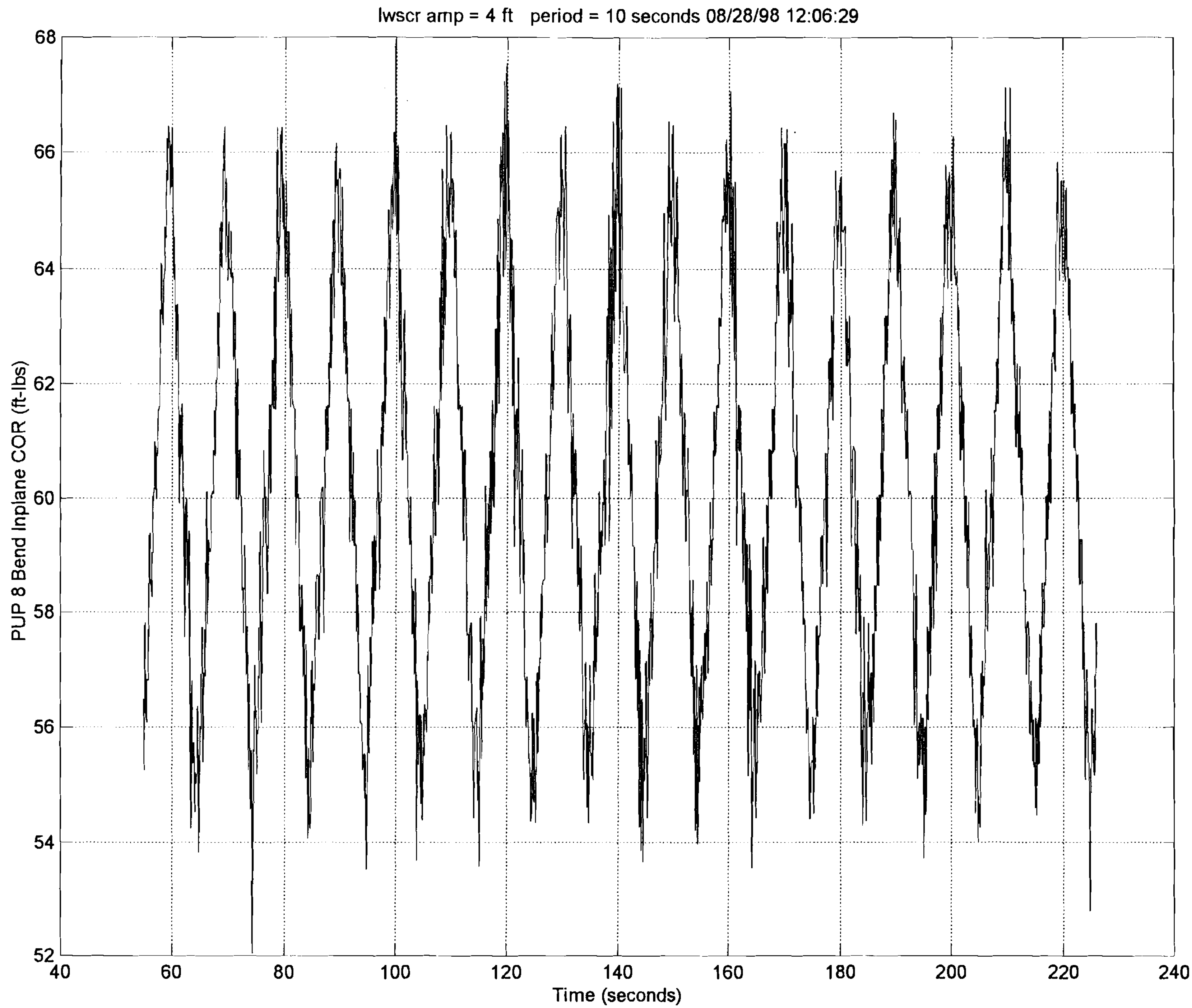

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 5 Bend Outplane COR (ft-lbs)
6
4
2
0
-2
-4
-6
-8
-10
-12
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

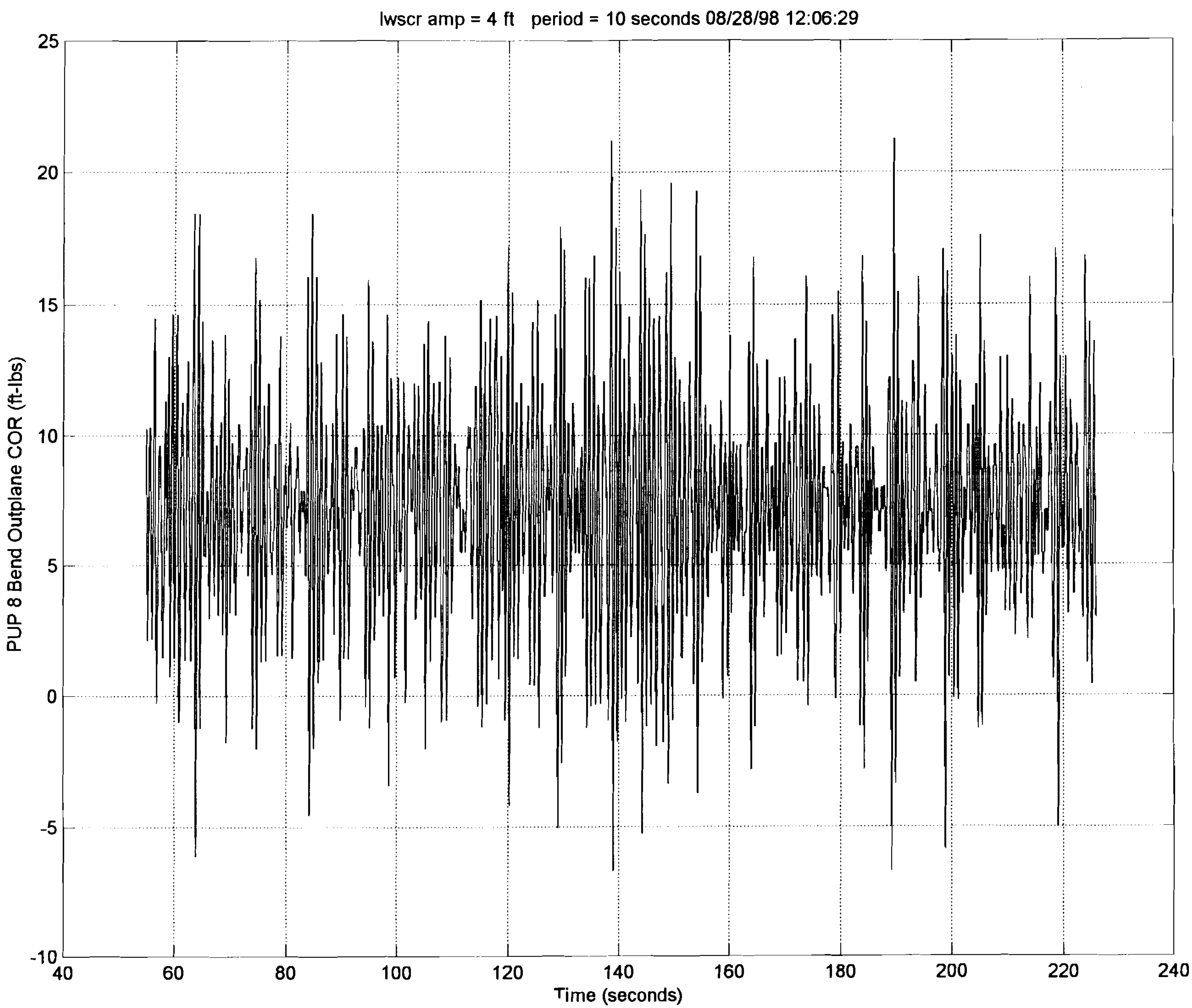

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
PUP 5 Tension COR (lbs)
Time (seconds)
290
280
270
260
250
240
230
220
210
200
40
60
80
100
120
140
160
180
200
220
240

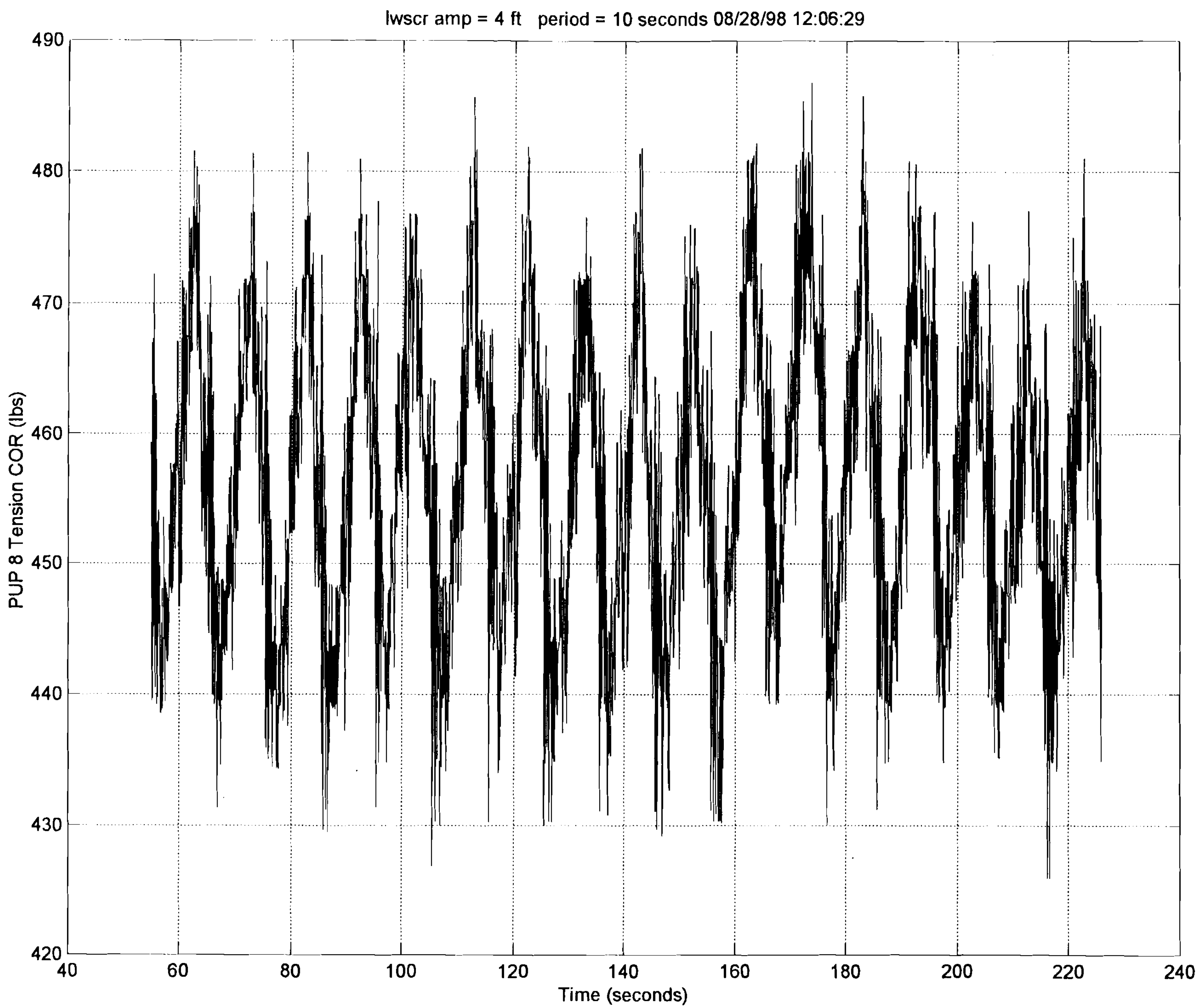

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 7 Bend Inplane COR (ft-lbs)
Time (seconds)
68
66
64
62
60
58
56
54
52
50
48
40
60
80
100
120
140
160
180
200
220
240

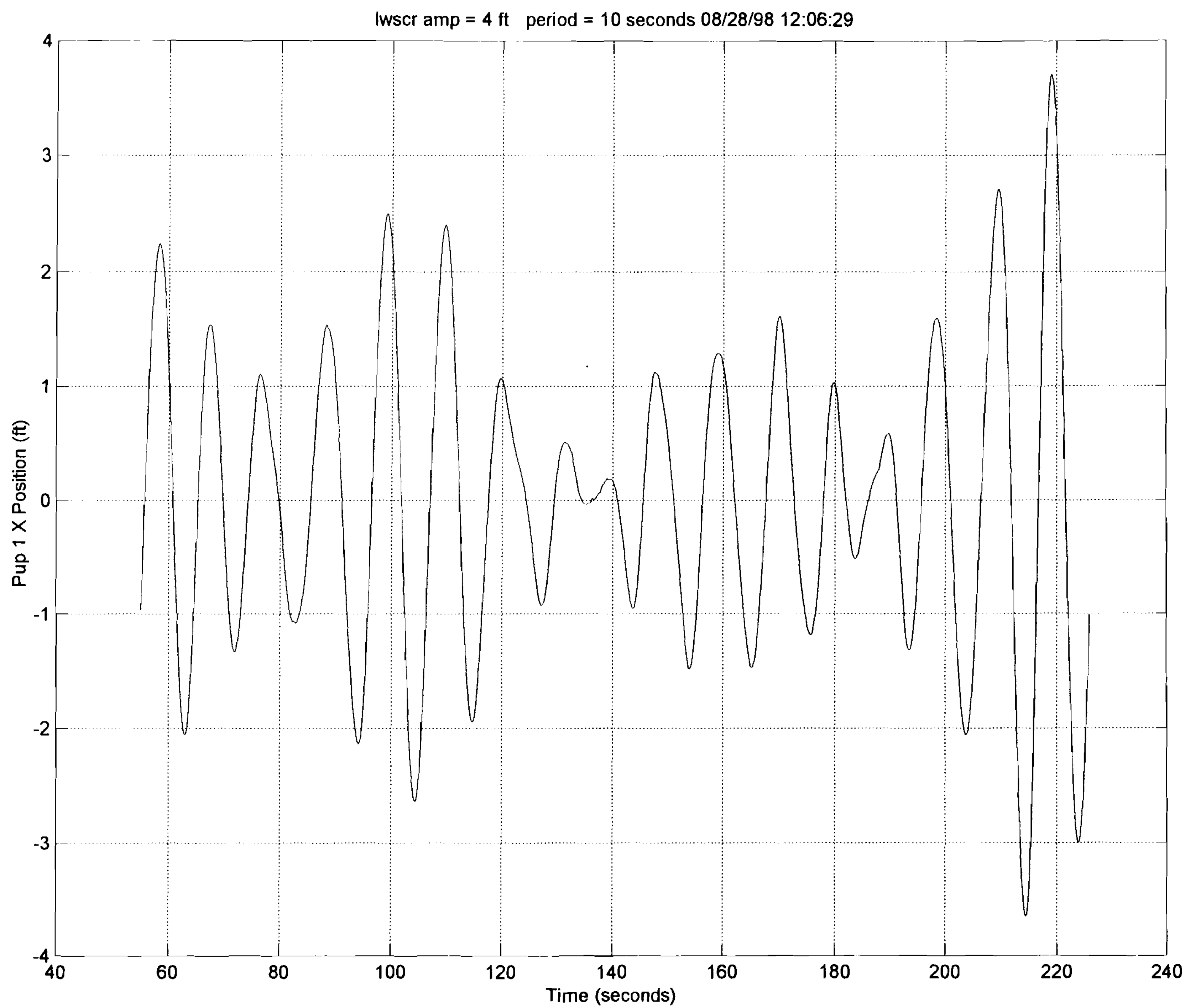

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 7 Bend Outplane COR (ft-lbs)
Time (seconds)
15
10
5
0
-5
-10
-15
40
60
80
100
120
140
160
180
200
220
240

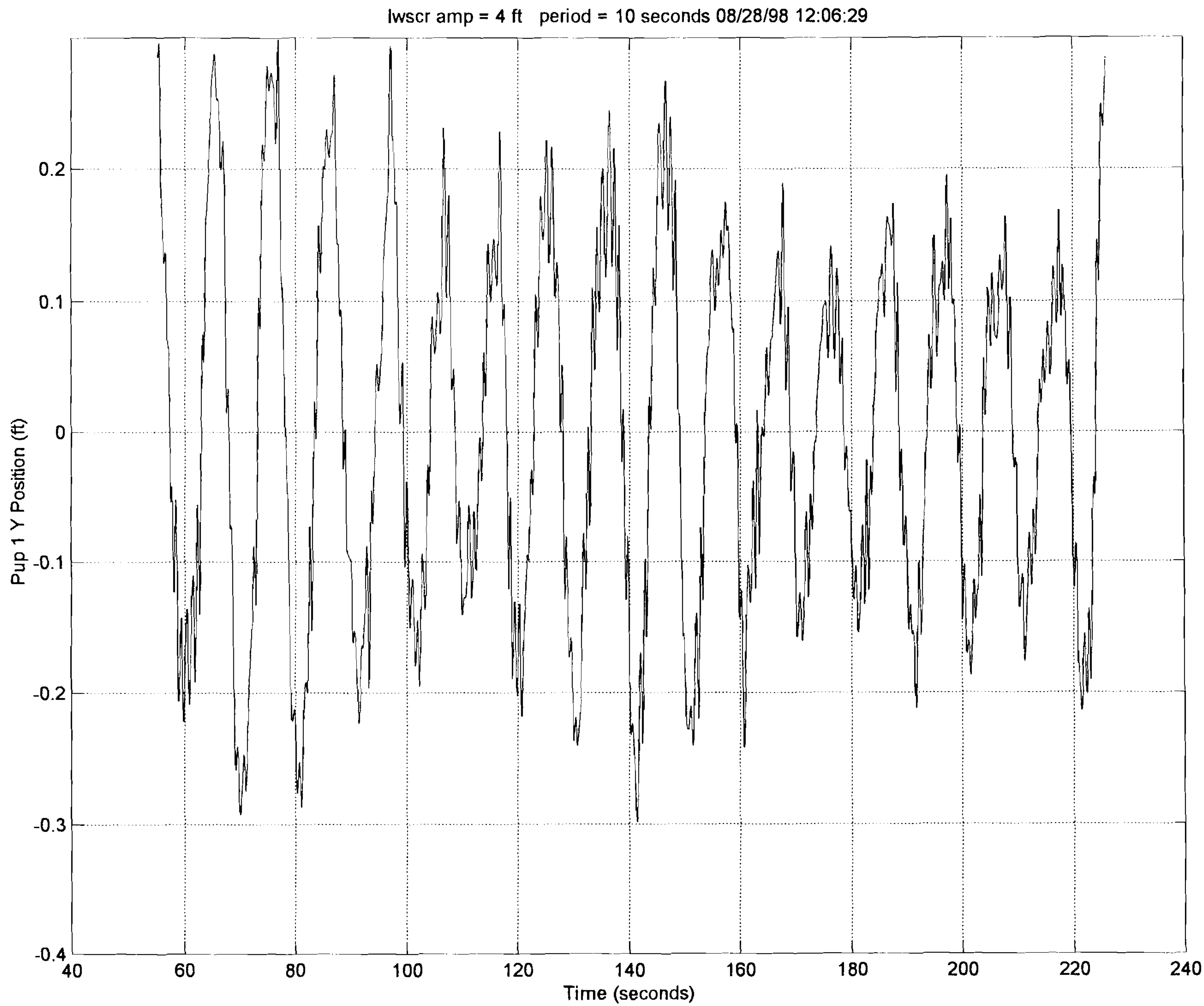

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 7 Tension COR (lbs)
Time (seconds)
460
450
440
430
420
410
400
390
380
370
40
60
80
100
120
140
160
180
200
220
240

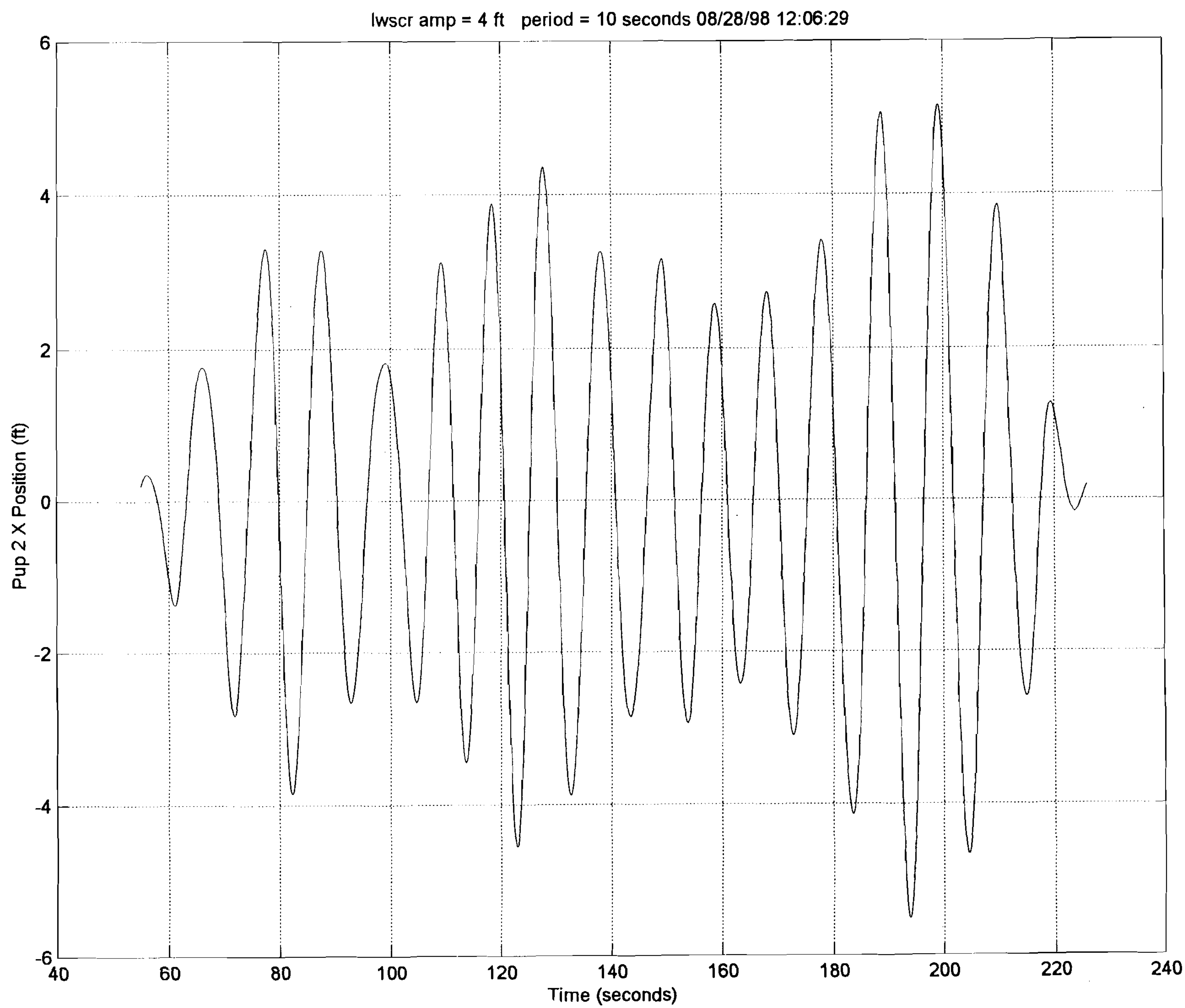

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
PUP 8 Bend Inplane COR (ft-lbs)
Time (seconds)
68
66
64
62
60
58
56
54
52
40
60
80
100
120
140
160
180
200
220
240

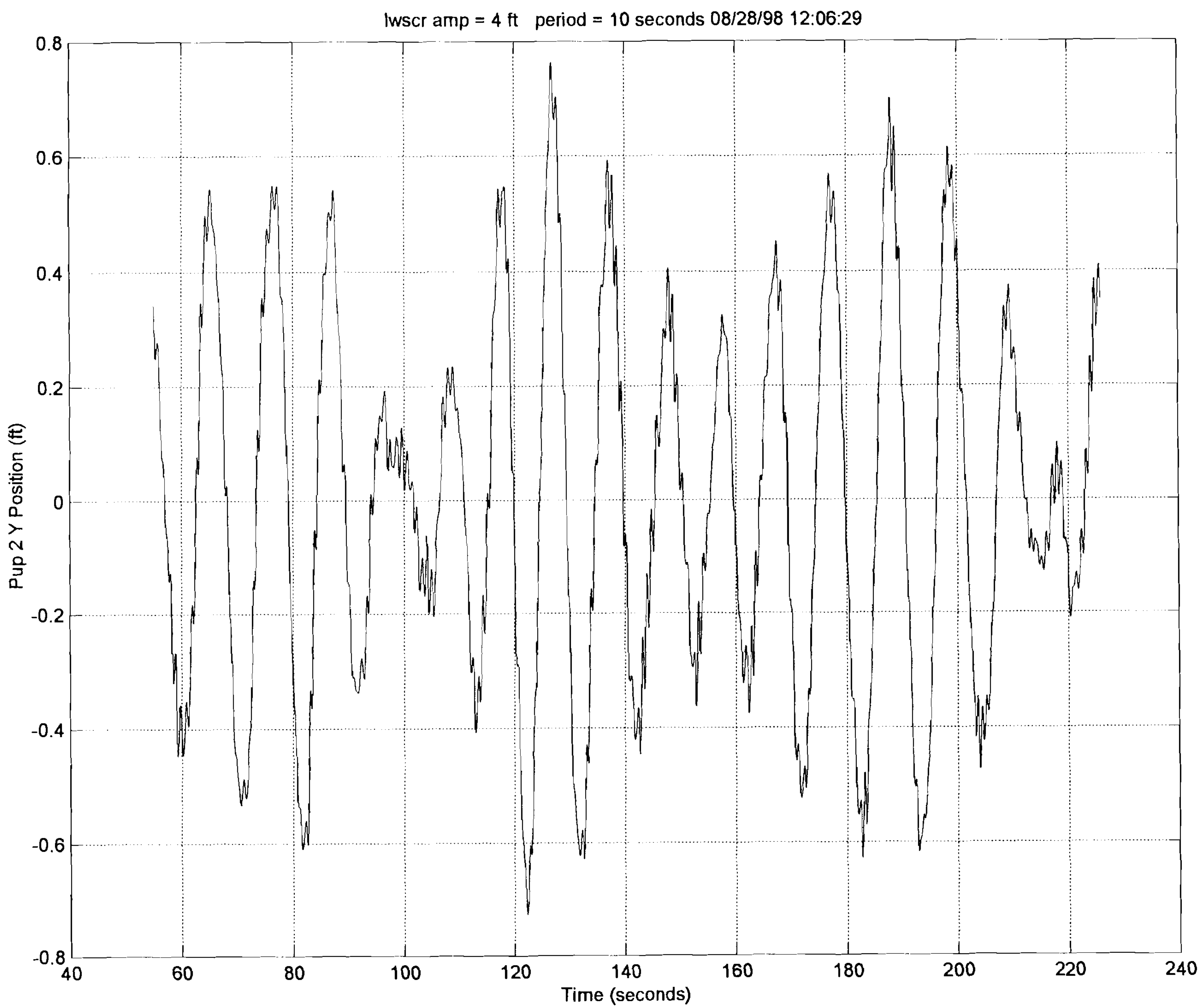

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
PUP 8 Bend Outplane COR (ft-lbs)
Time (seconds)
25
20
15
10
5
0
-5
-10
40
60
80
100
120
140
160
180
200
220
240


lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
PUP 8 Tension COR (lbs)
Time (seconds)
490
480
470
460
450
440
430
420
40
60
80
100
120
140
160
180
200
220
240

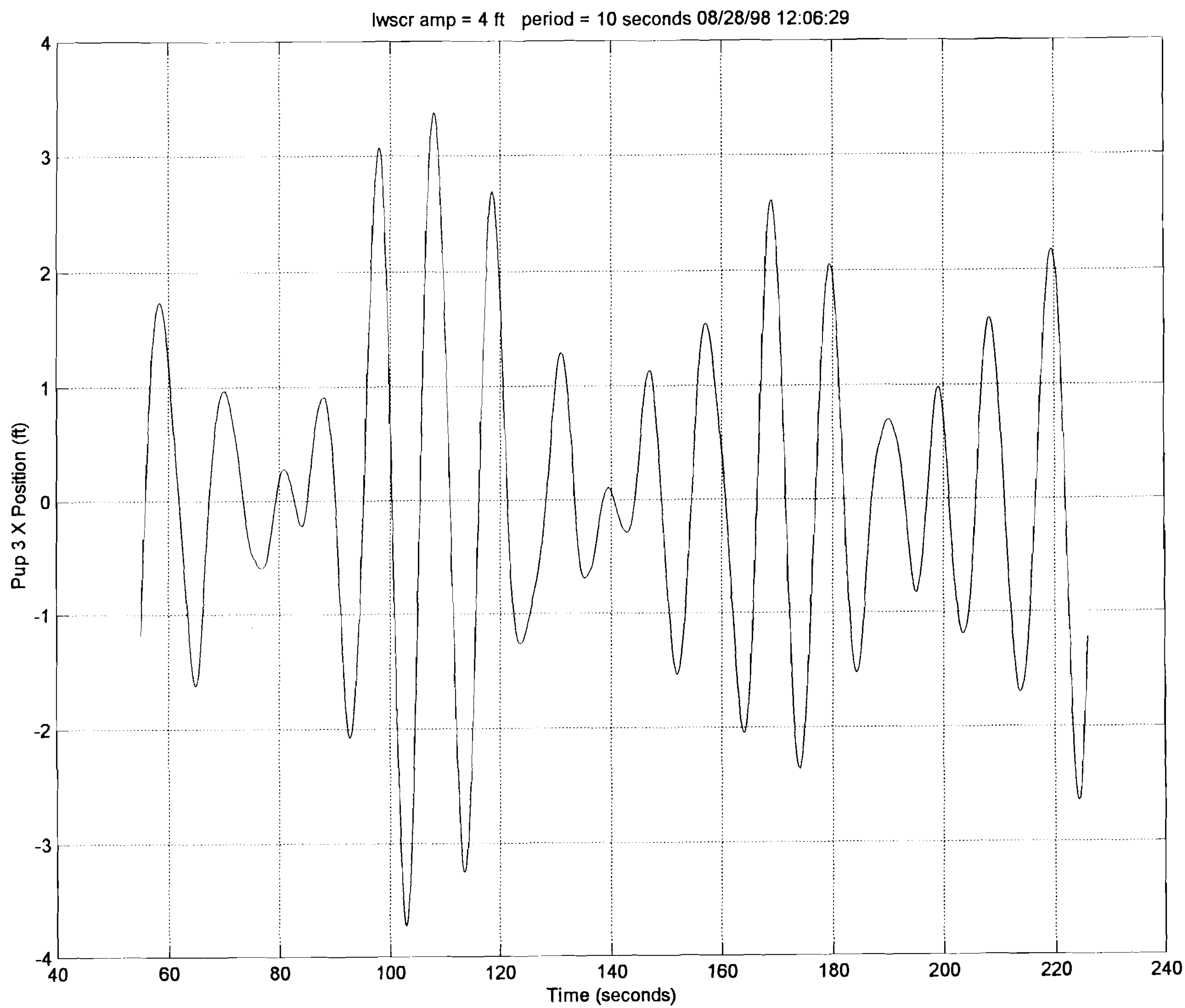

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
Pup 1 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
40
60
80
100
120
140
160
180
200
220
240


lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 1 Y Position (ft)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

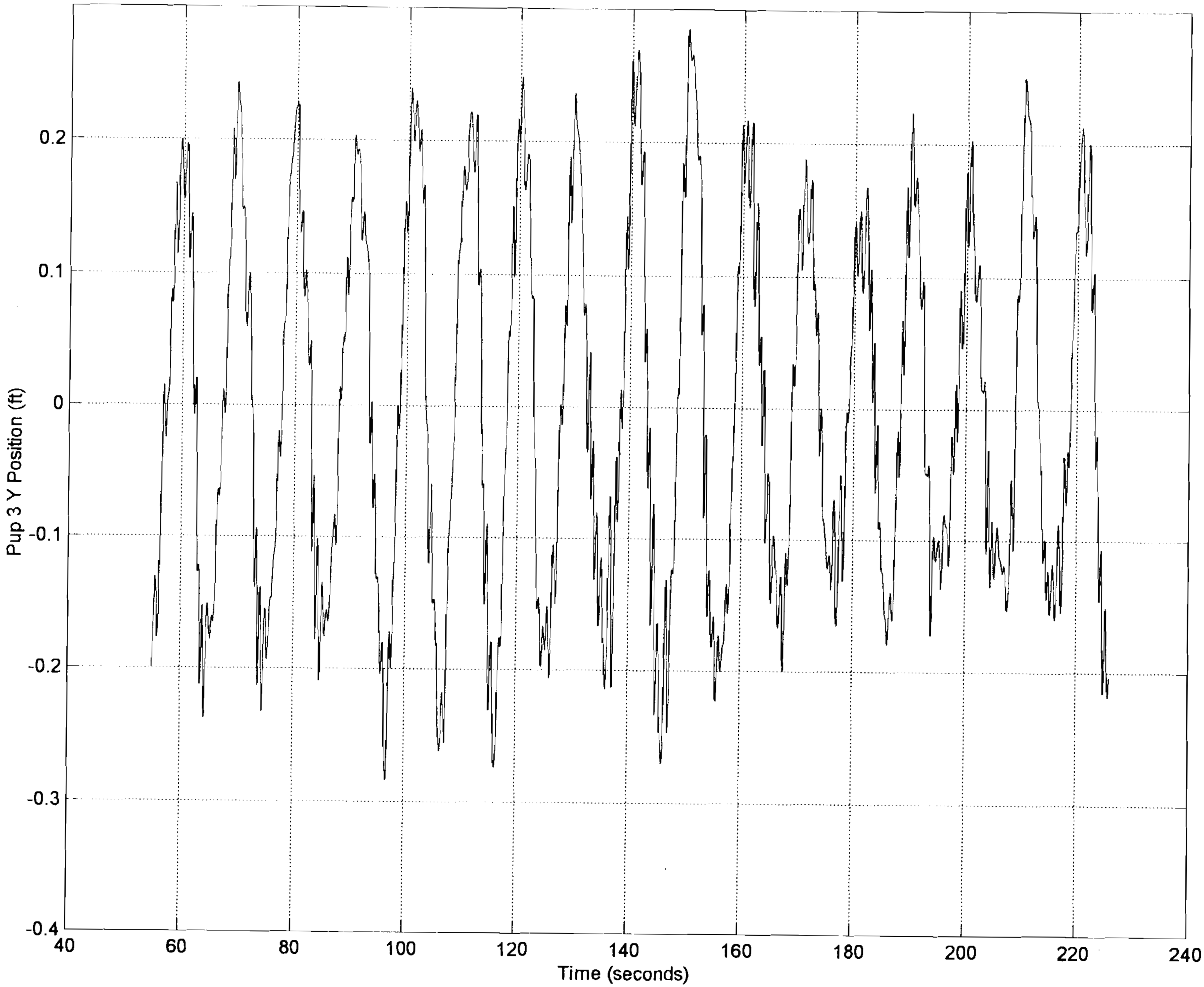

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 2 X Position (ft)
6
4
2
0
-2
-4
-6
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

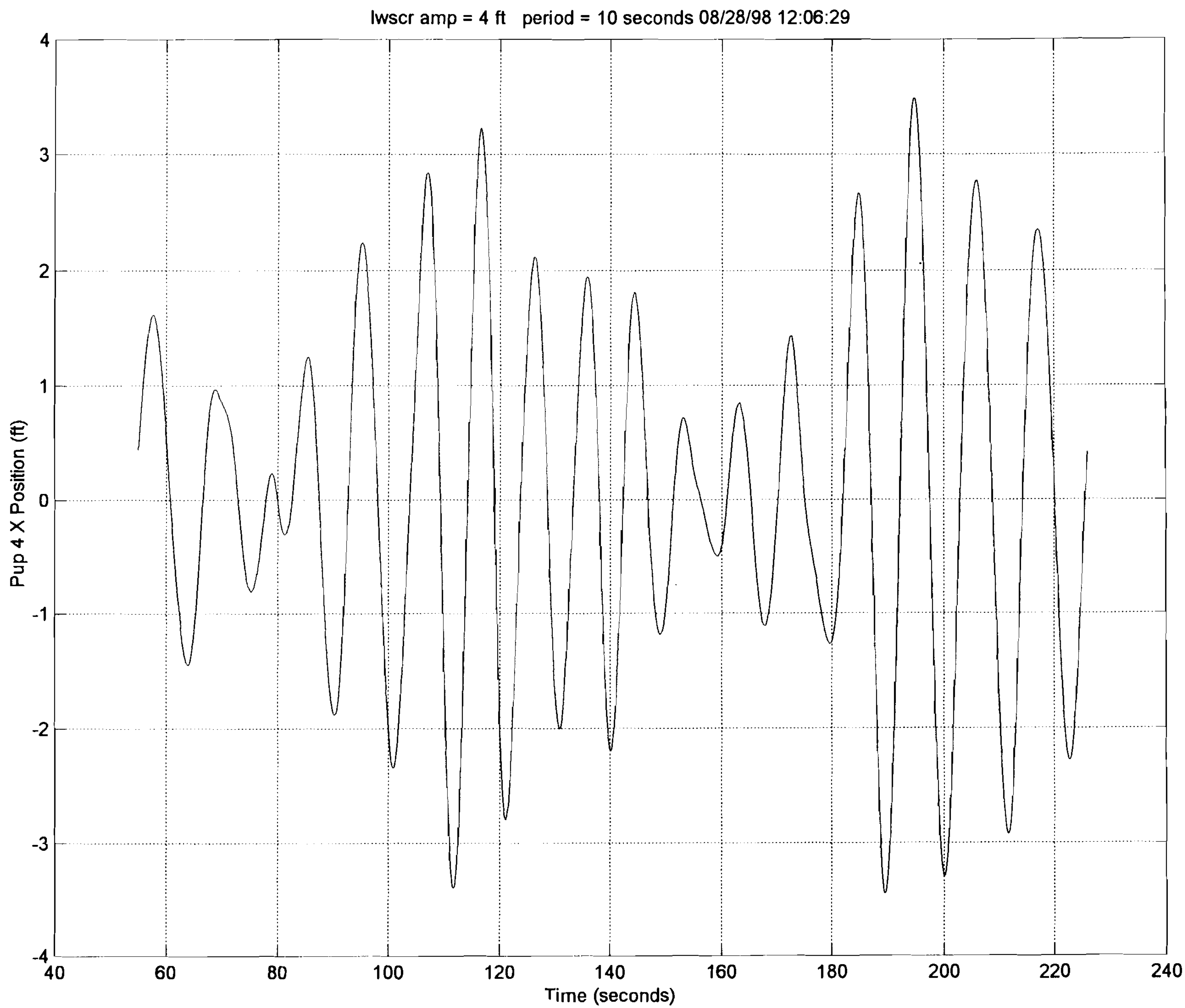


lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 2 Y Position (ft)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

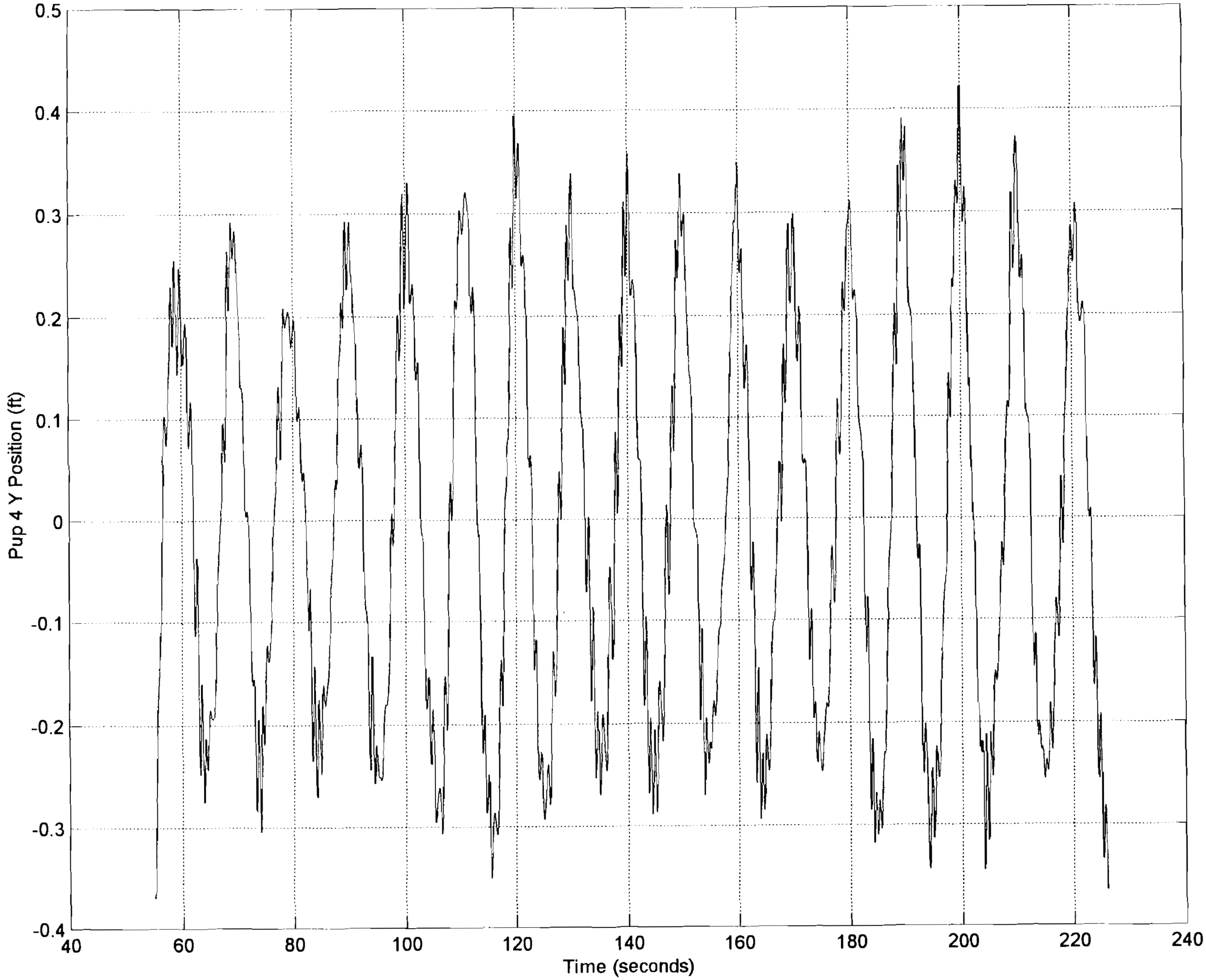

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 3 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
40
60
80
100
120
140
160
180
200
220
240

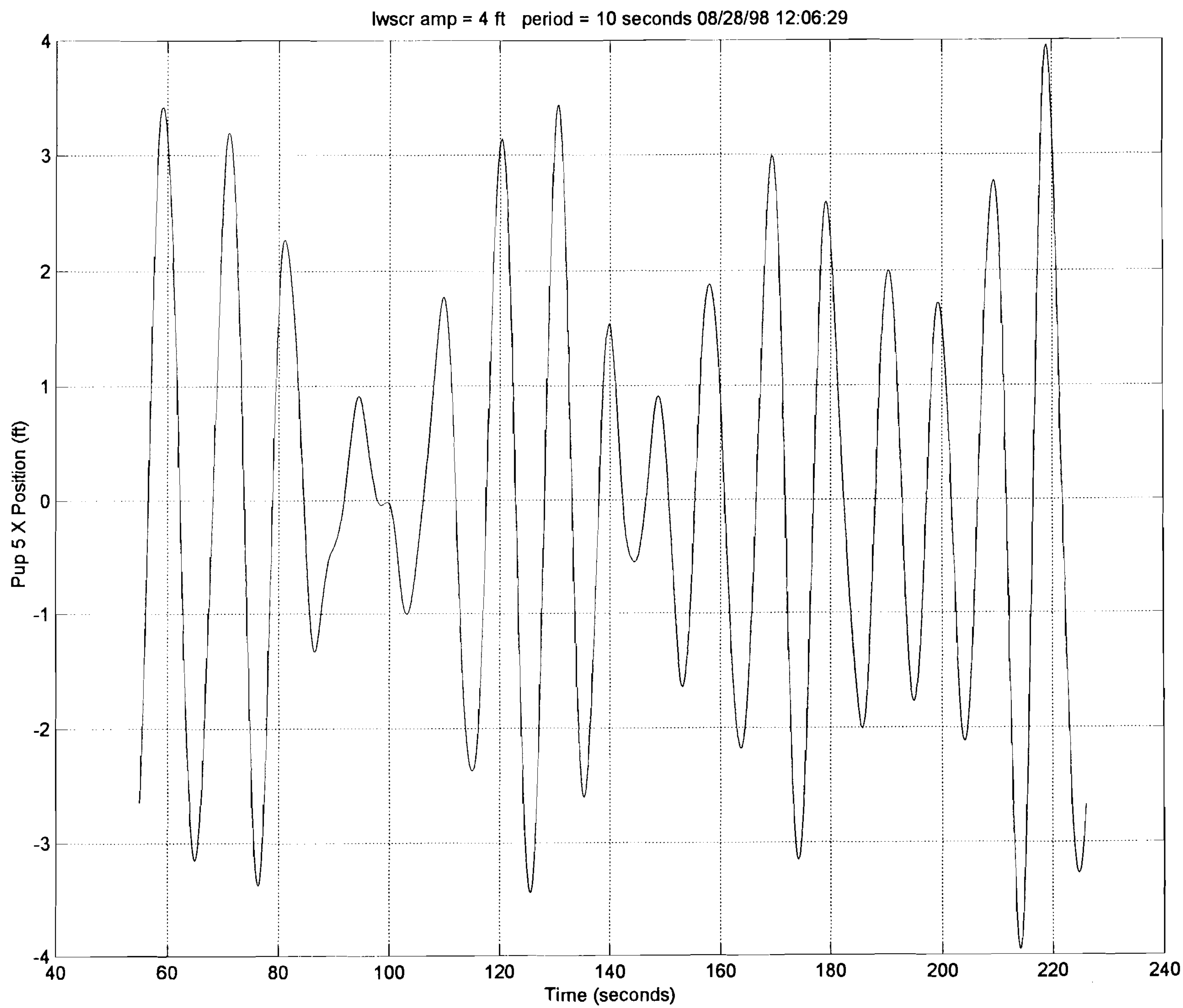
lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29

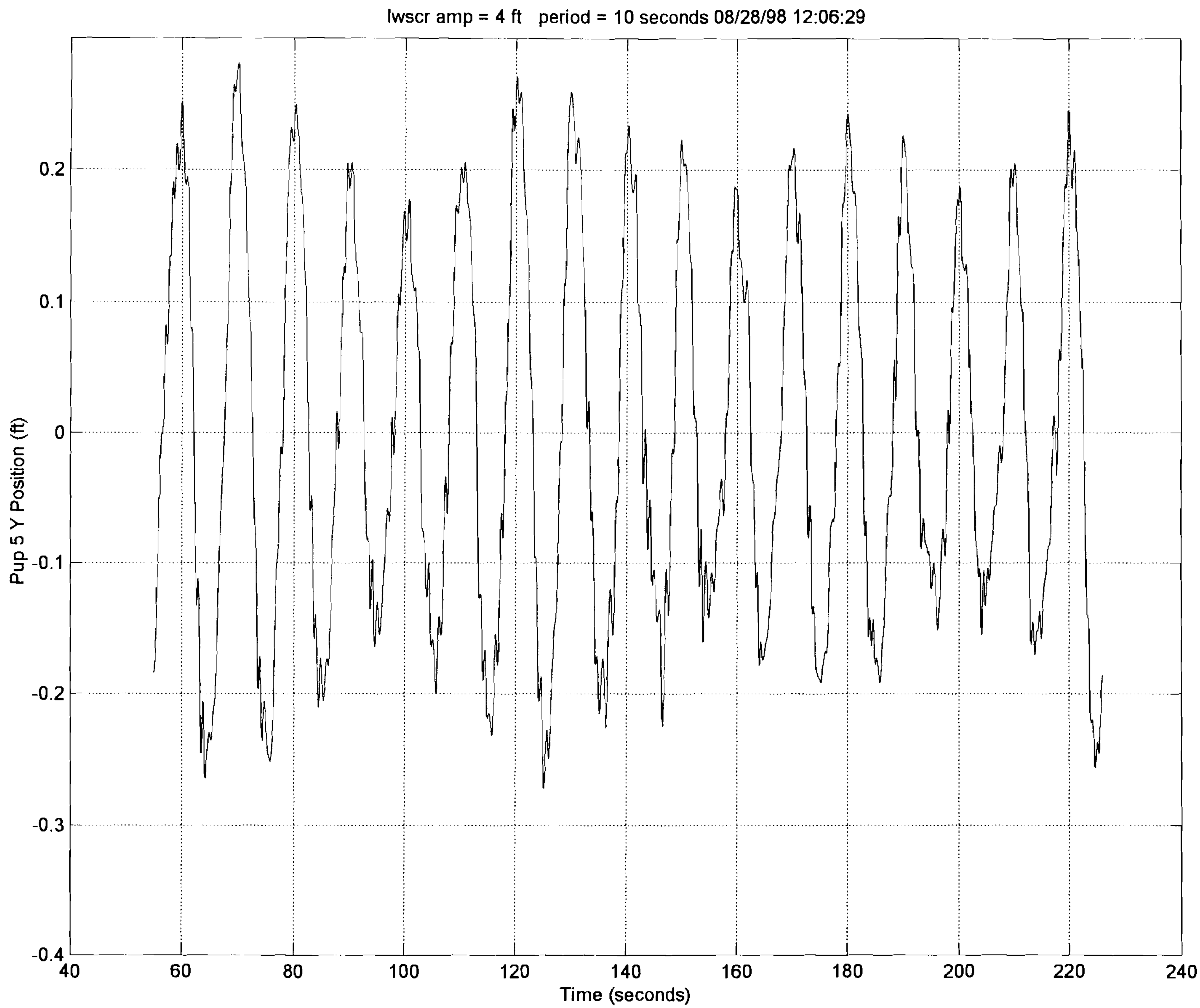


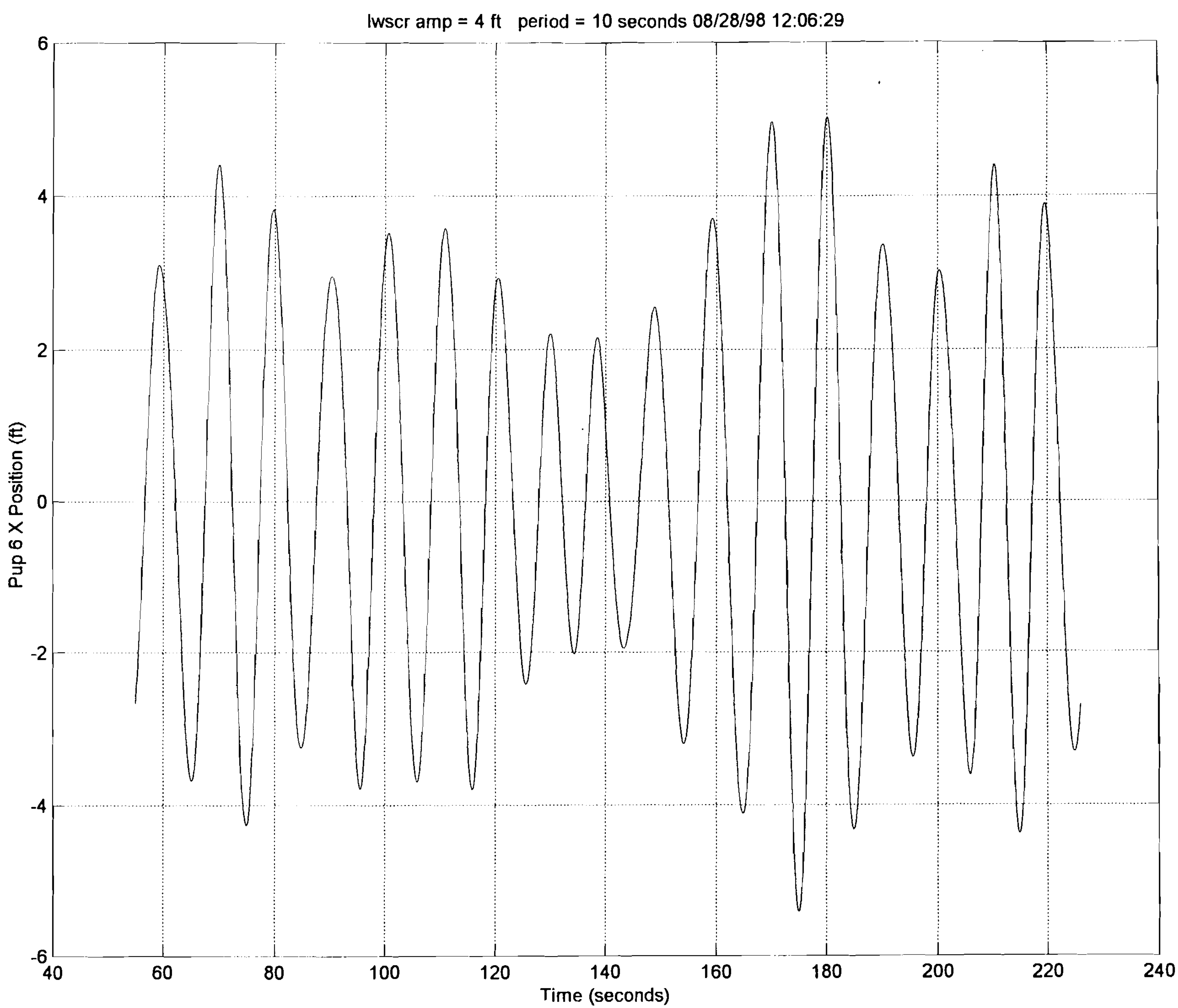

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
Pup 4 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
40
60
80
100
120
140
160
180
200
220
240

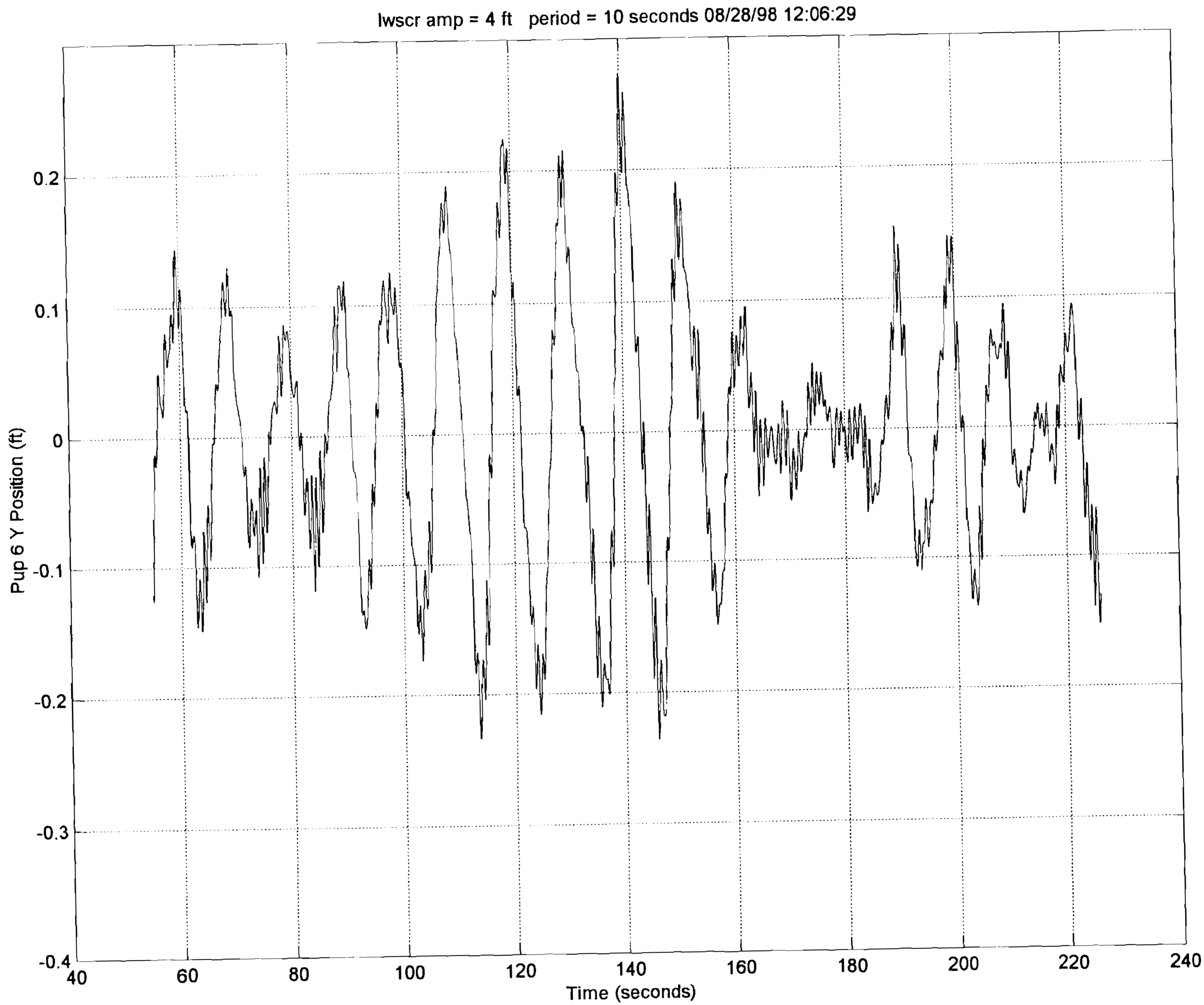
lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29



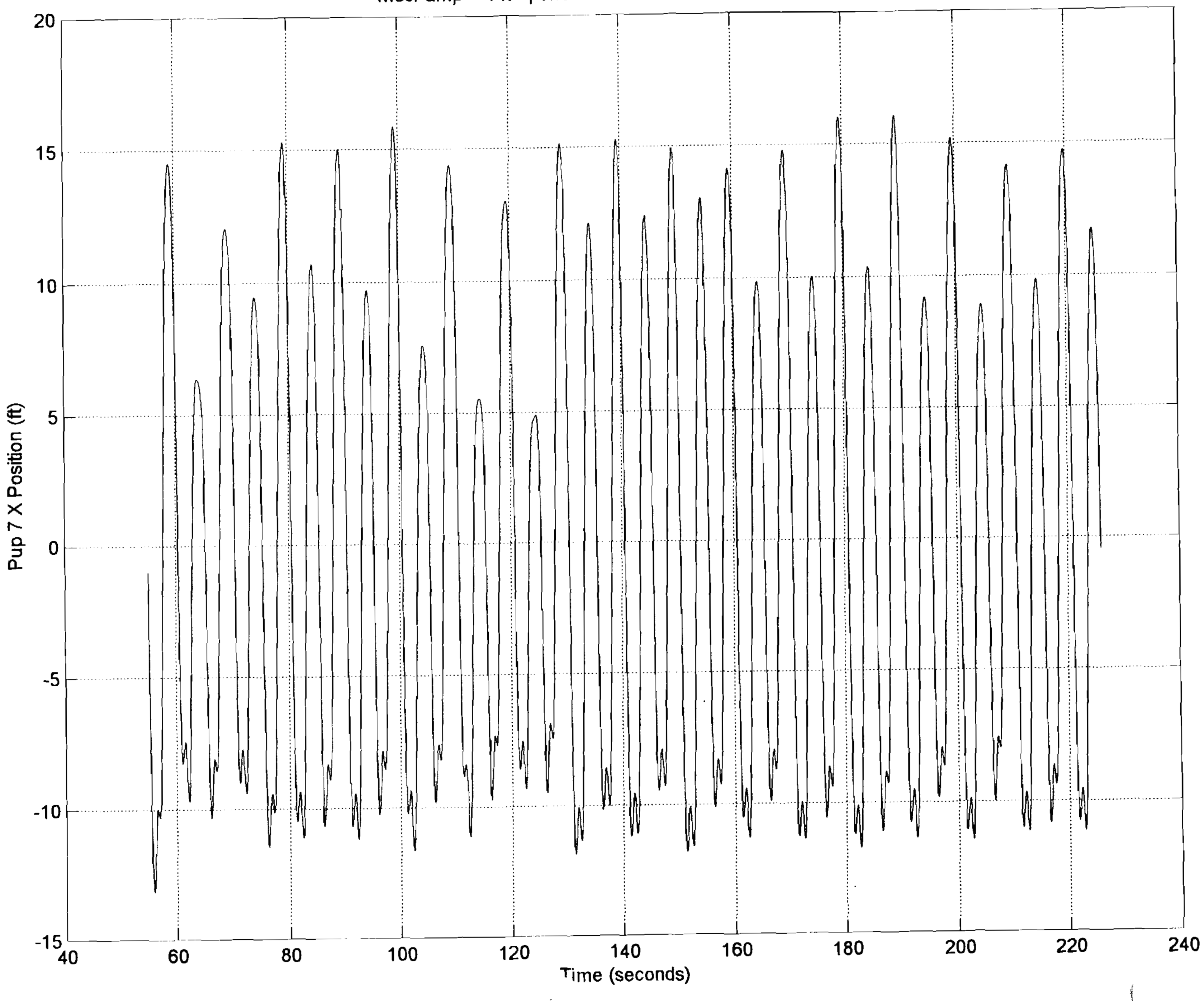

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
Pup 5 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
40
60
80
100
120
140
160
180
200
220
240

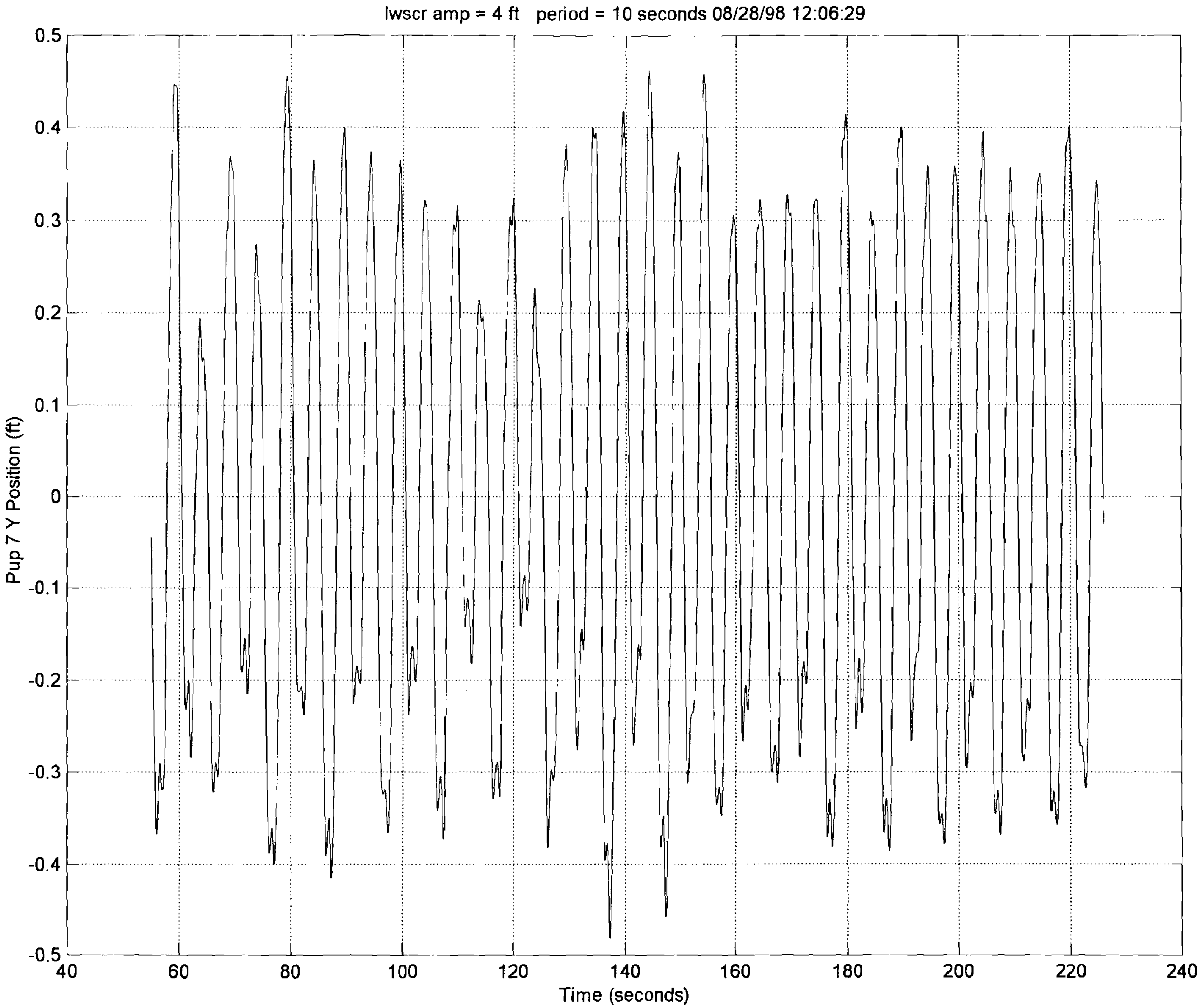

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
Pup 5 Y Position (ft)
Time (seconds)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
40
60
80
100
120
140
160
180
200
220
240

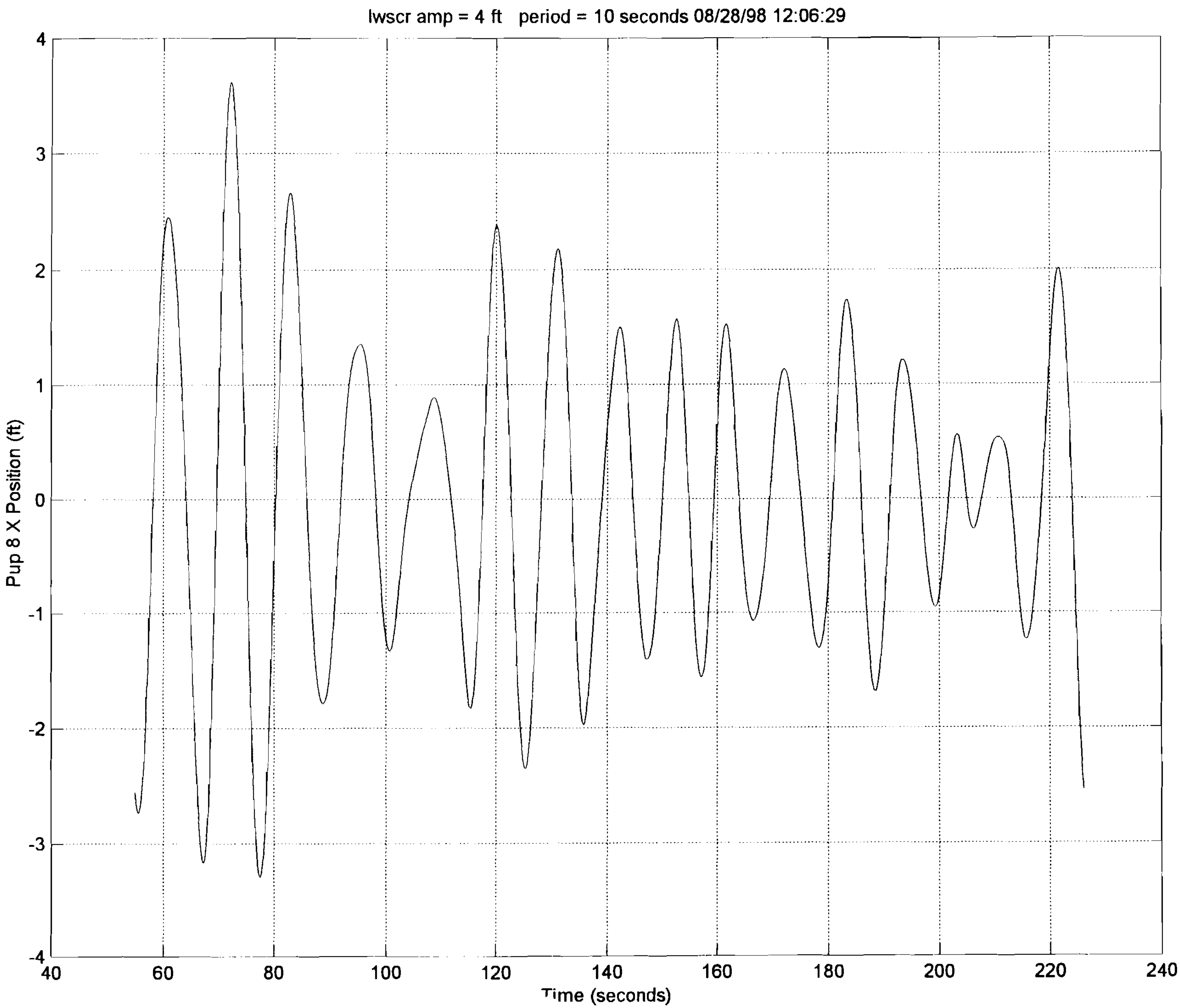

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 6 X Position (ft)
Time (seconds)
6
4
2
0
-2
-4
-6
40
60
80
100
120
140
160
180
200
220
240

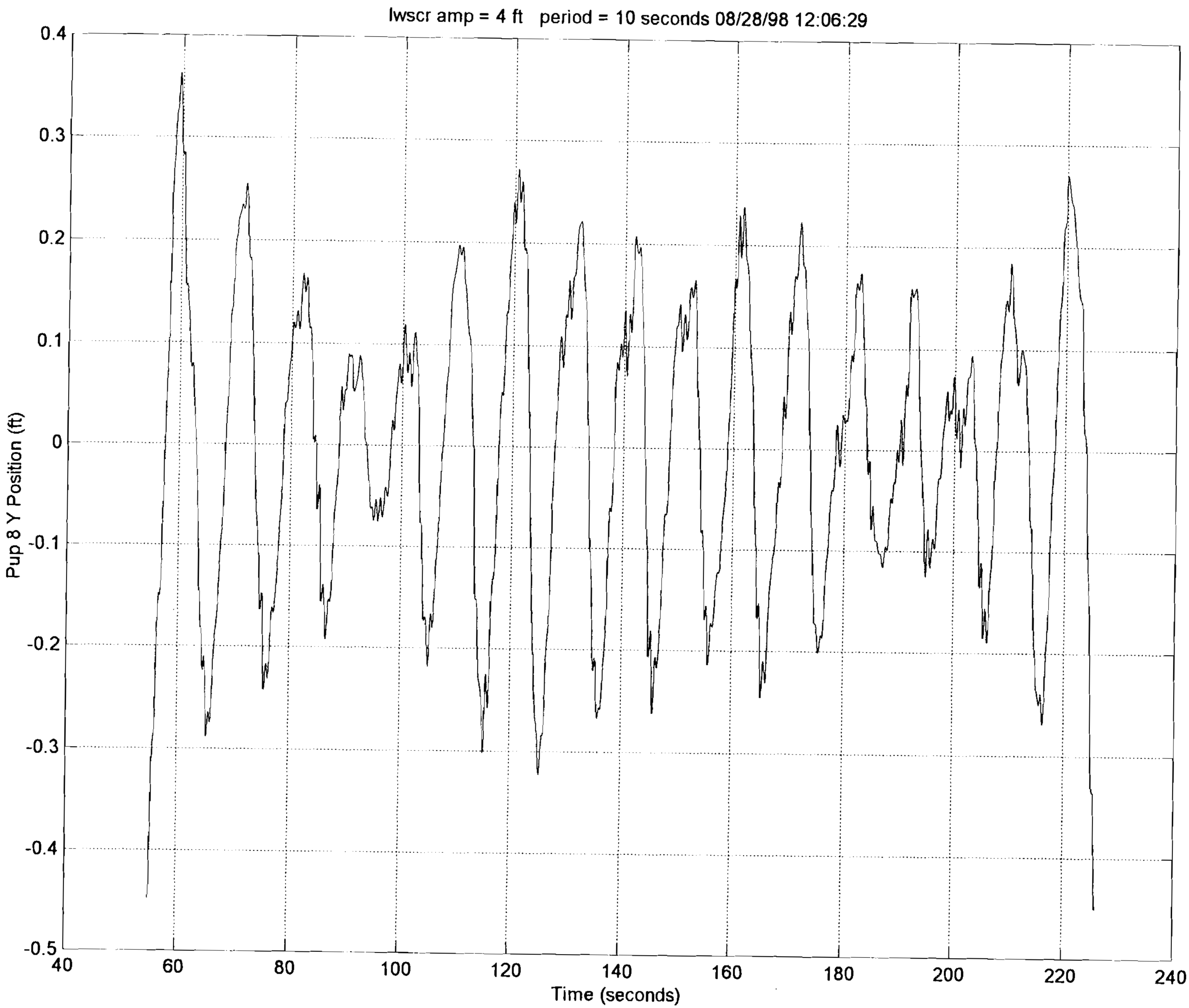

lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29
Pup 6 Y Position (ft)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

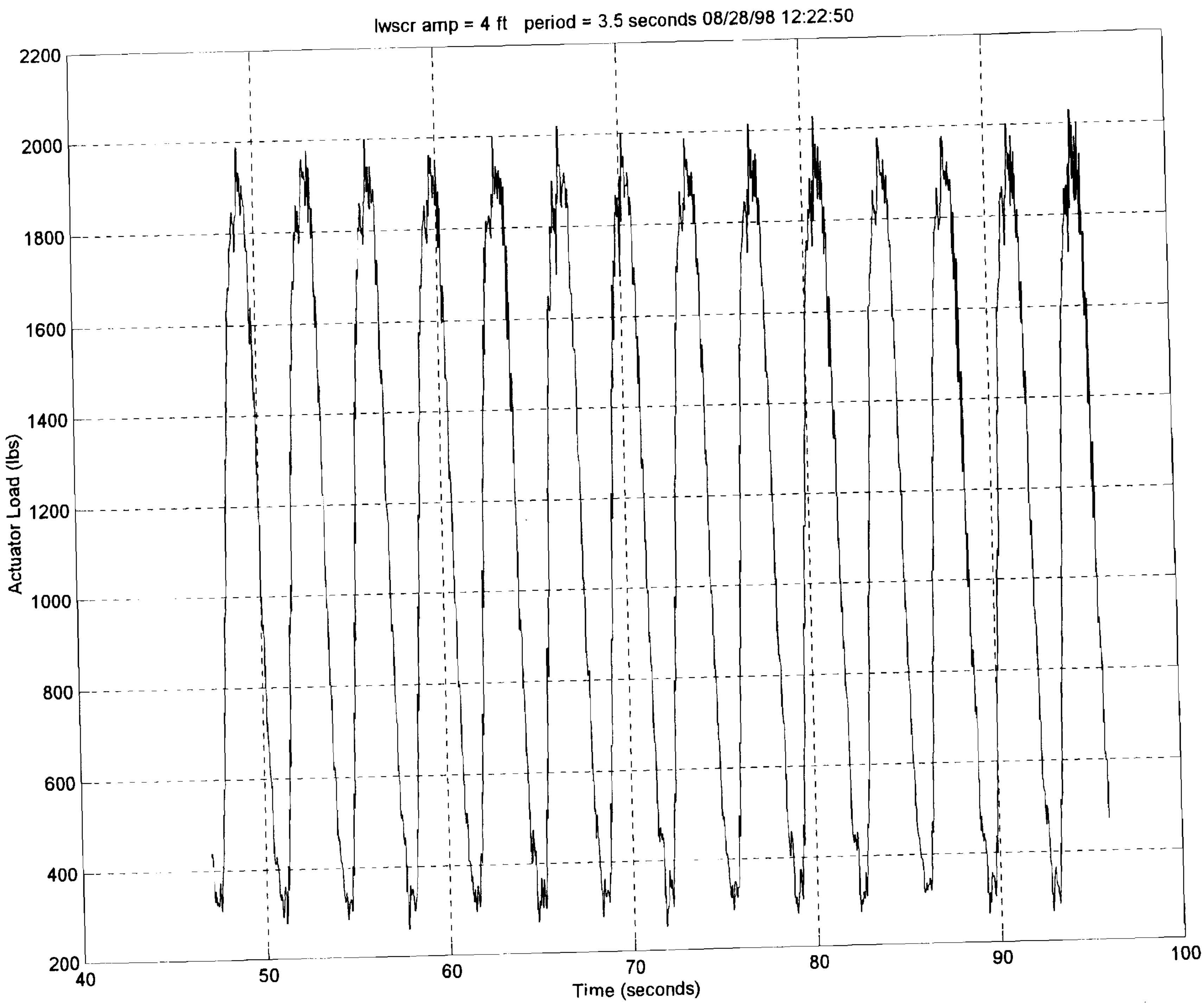
lwscr amp = 4 ft   period = 10 seconds 08/28/98 12:06:29

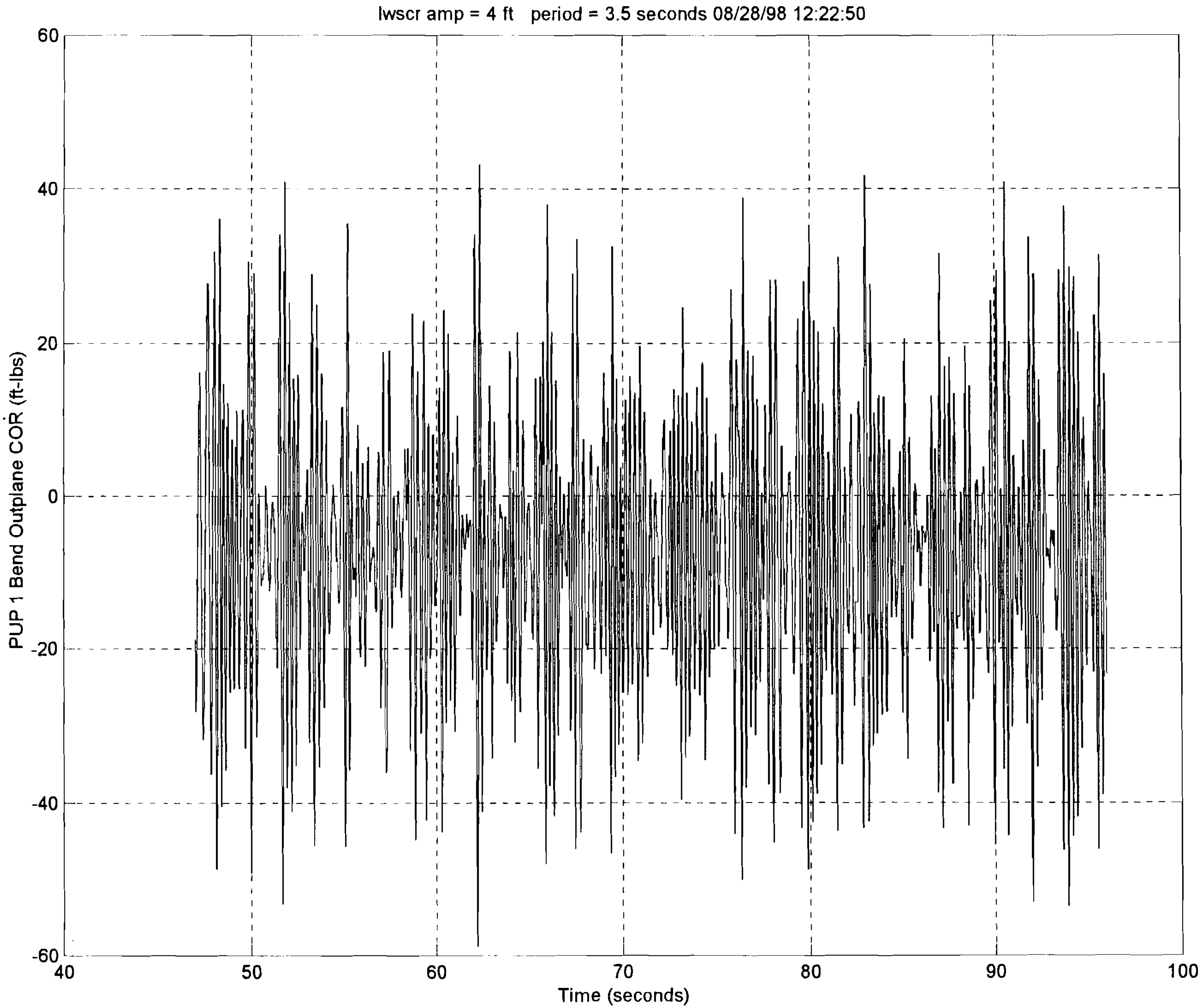


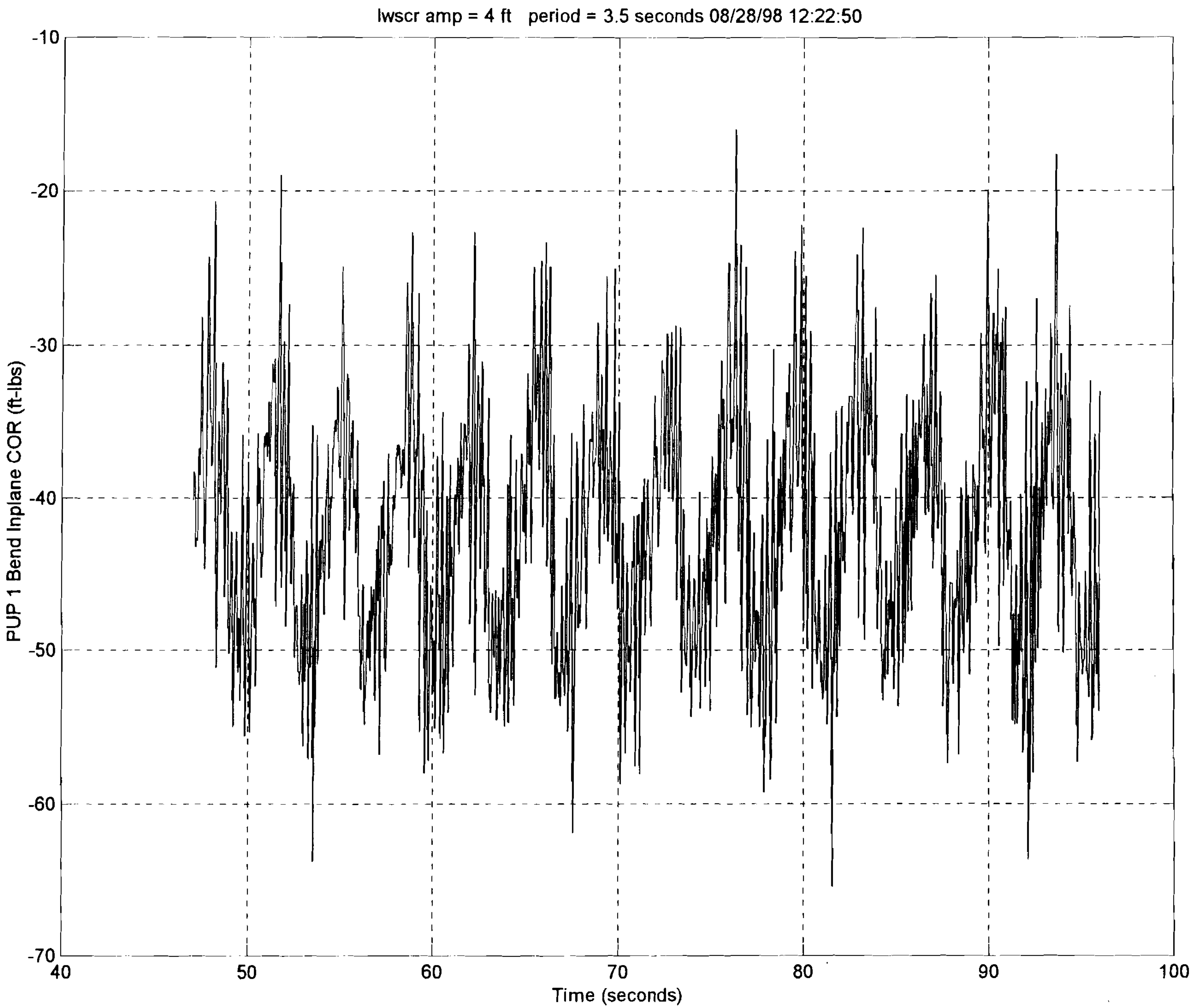

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 7 Y Position (ft)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

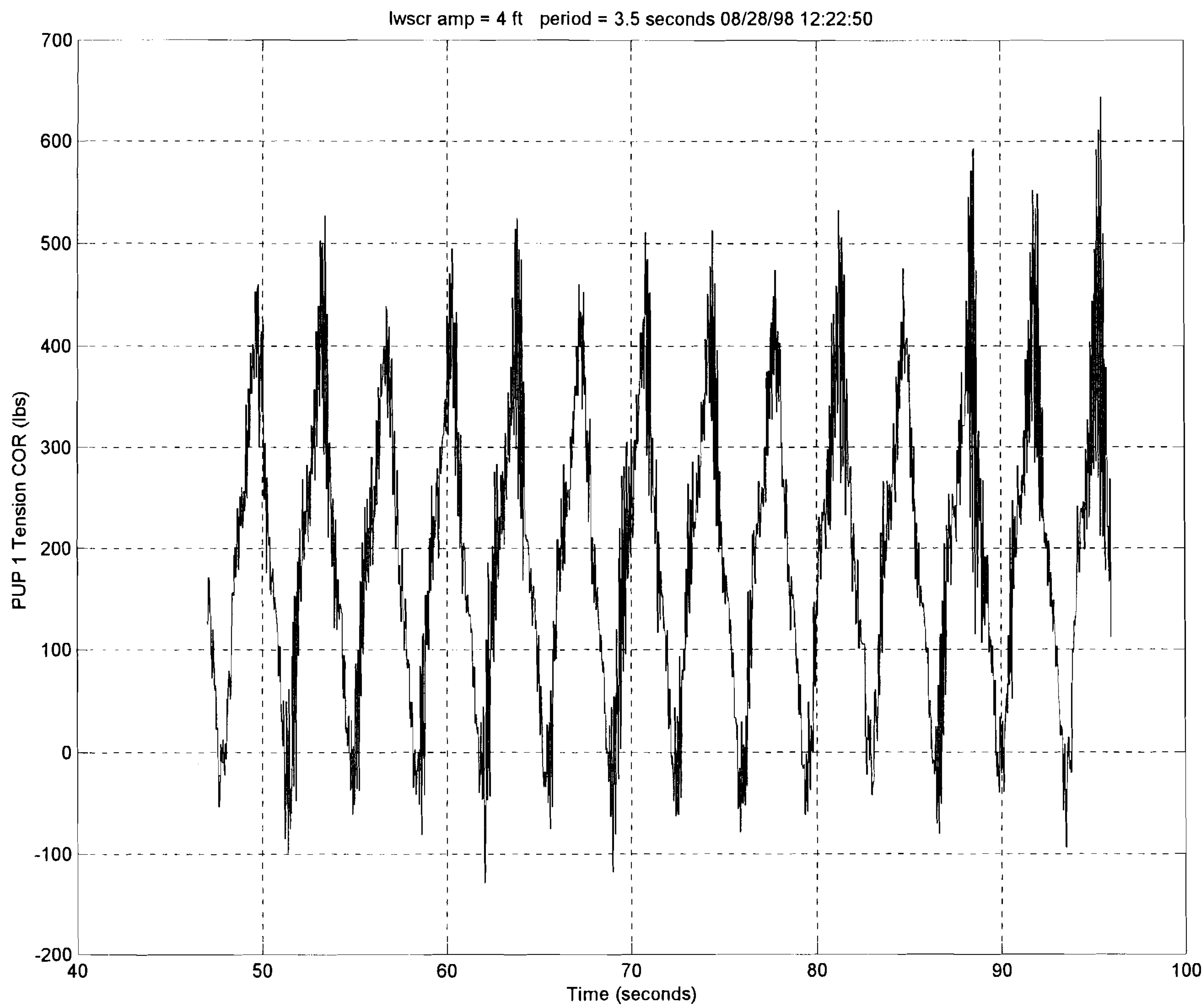

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 8 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
40
60
80
100
120
140
160
180
200
220
240

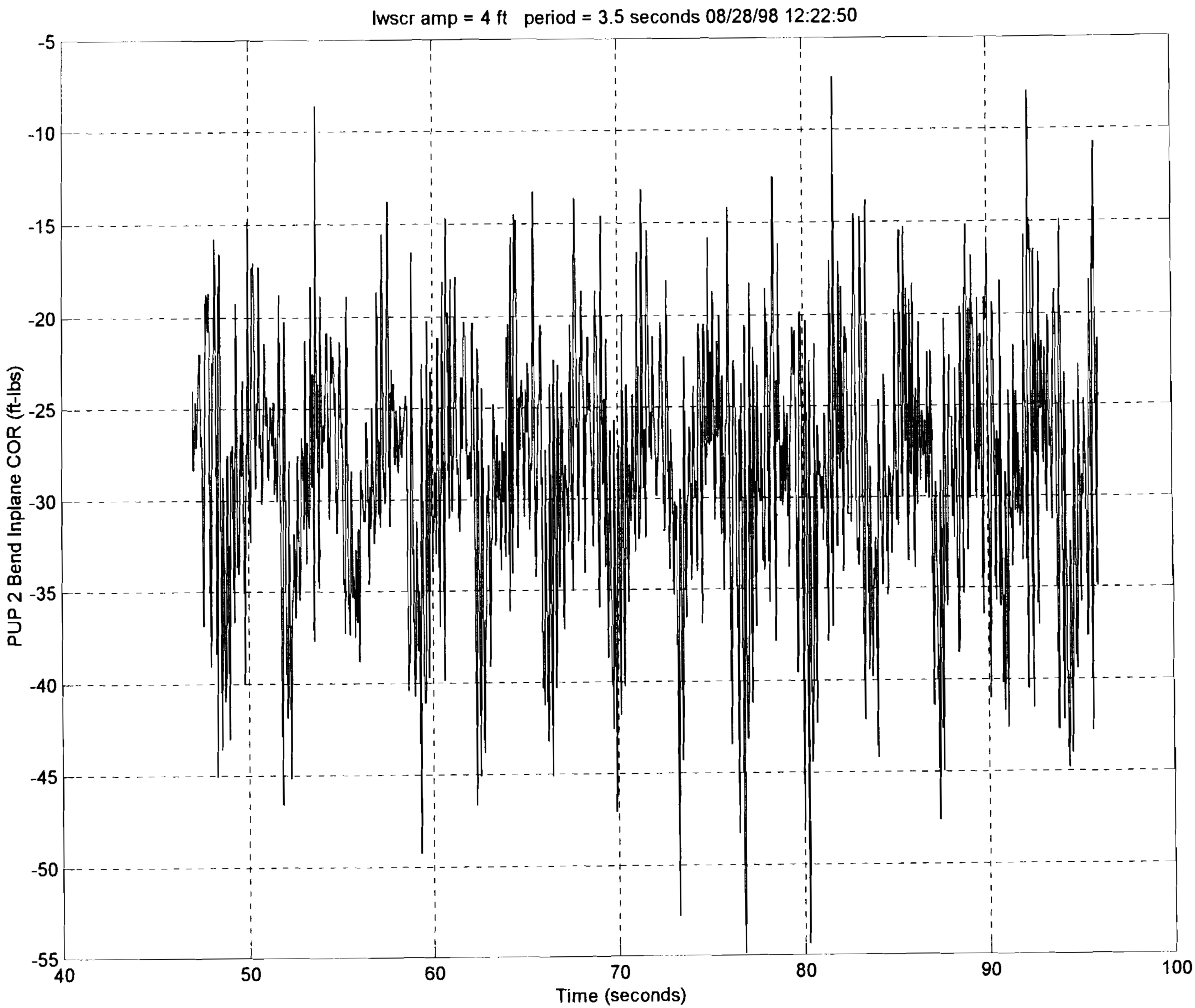

lwscr amp = 4 ft period = 10 seconds 08/28/98 12:06:29
Pup 8 Y Position (ft)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
40
60
80
100
120
140
160
180
200
220
240
Time (seconds)

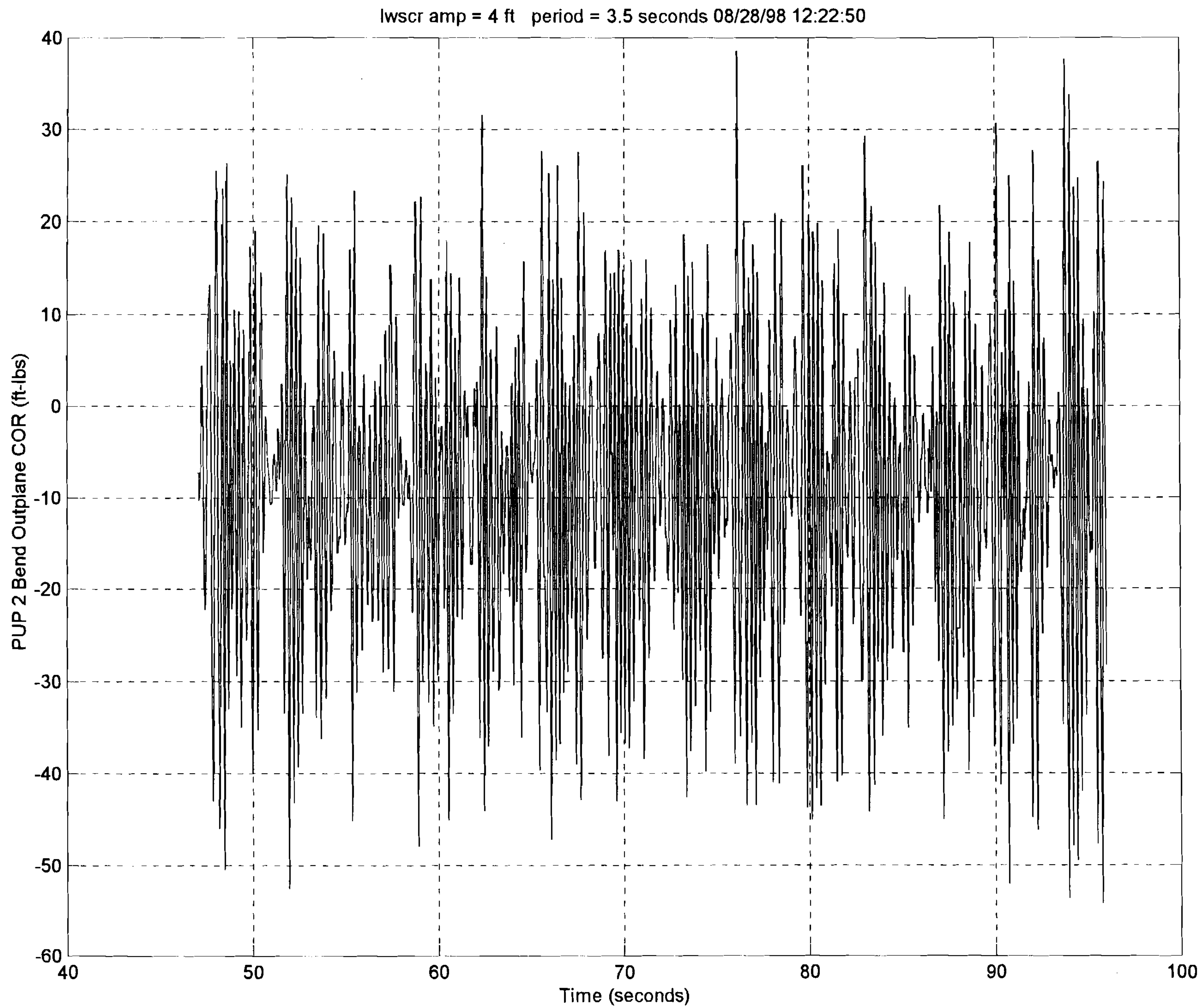

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Actuator Load (lbs)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
40
50
60
70
80
90
100
Time (seconds)


lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 1 Bend Outplane COR (ft-lbs)
60
40
20
0
-20
-40
-60
40
50
60
70
80
90
100
Time (seconds)

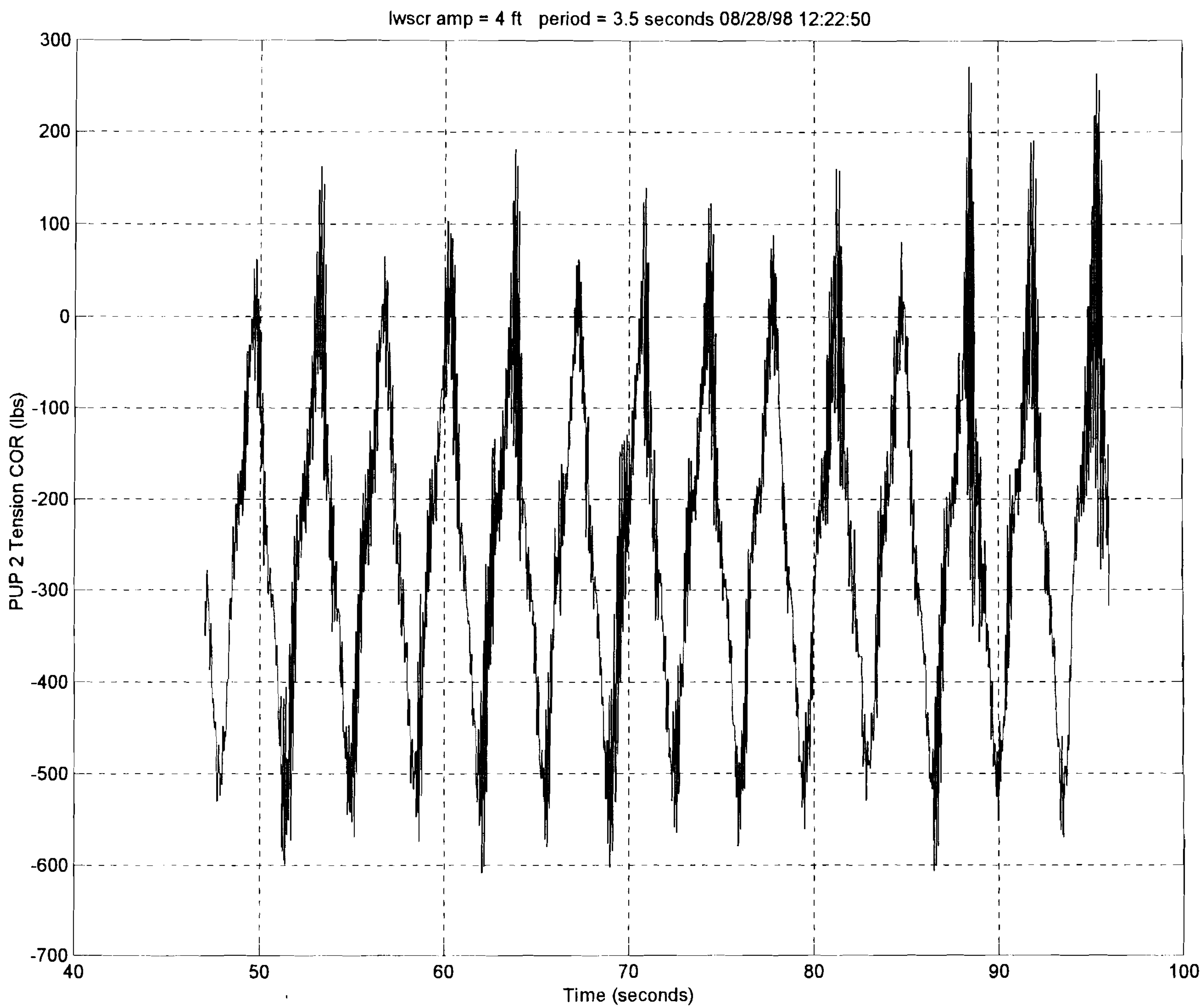

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 1 Bend Inplane COR (ft-lbs)
-10
-20
-30
-40
-50
-60
-70
40
50
60
70
80
90
100
Time (seconds)

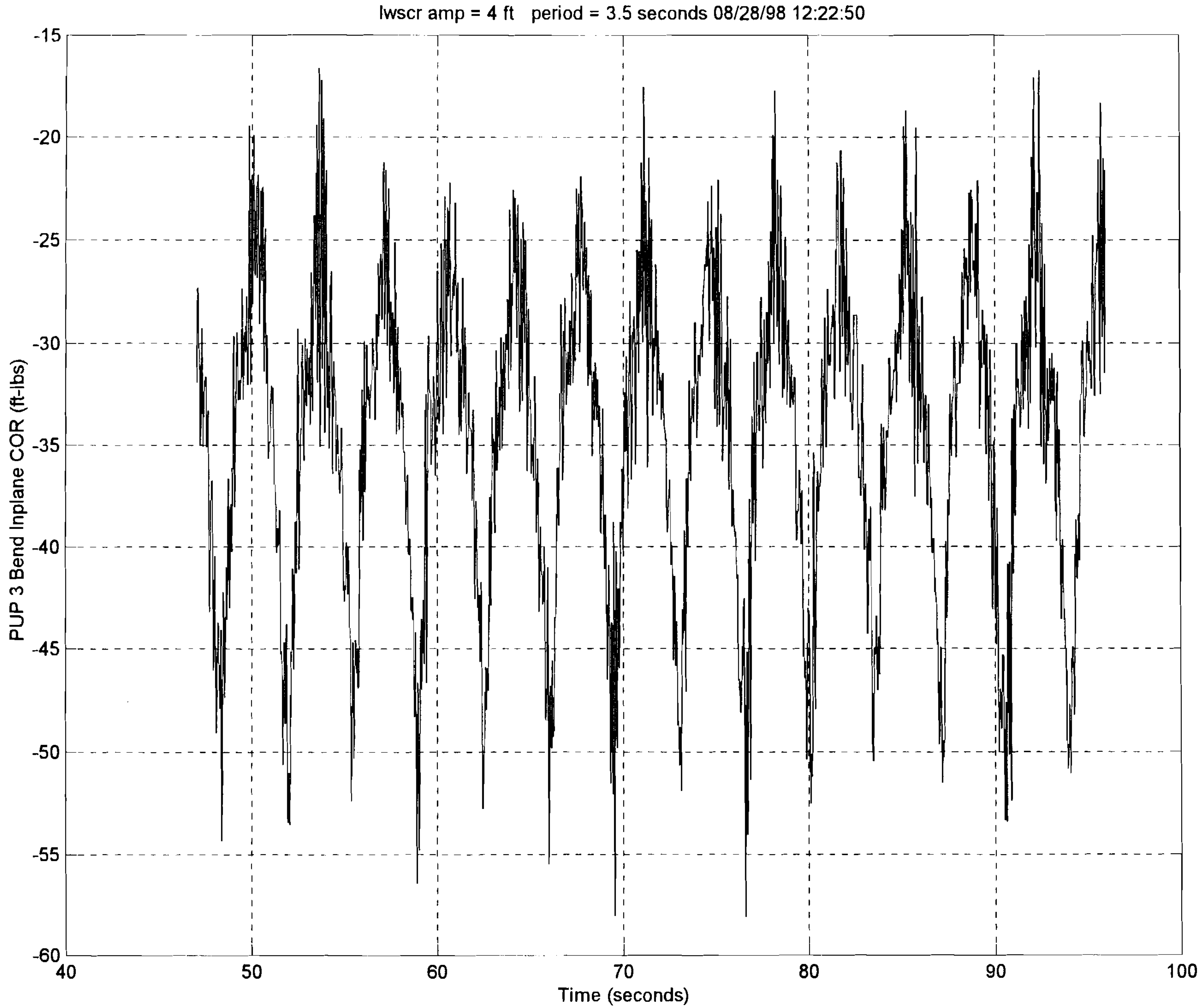

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 1 Tension COR (lbs)
700
600
500
400
300
200
100
0
-100
-200
40
50
60
70
80
90
100
Time (seconds)

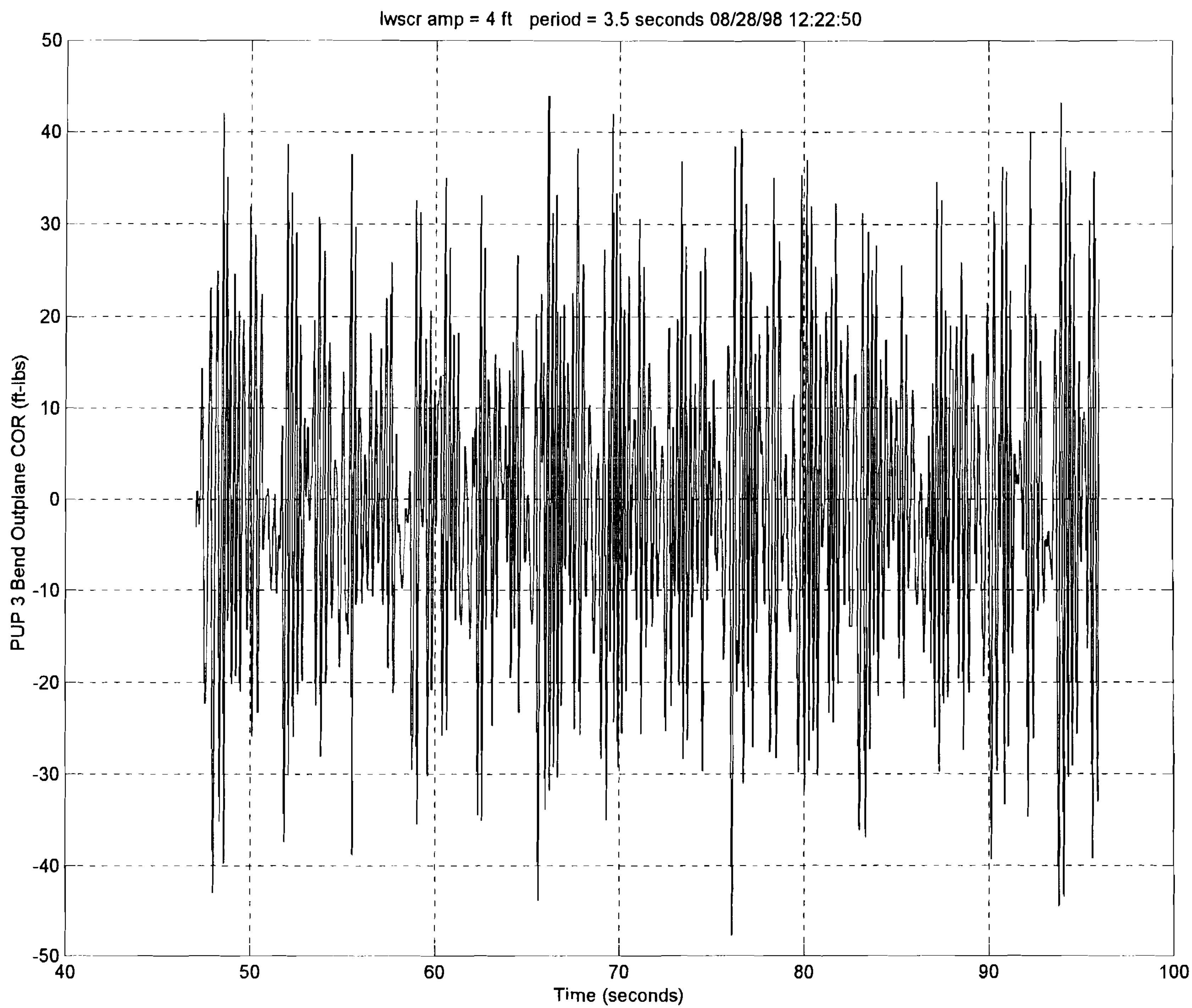

lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 2 Bend Inplane COR (ft-lbs)
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
40
50
60
70
80
90
100
Time (seconds)

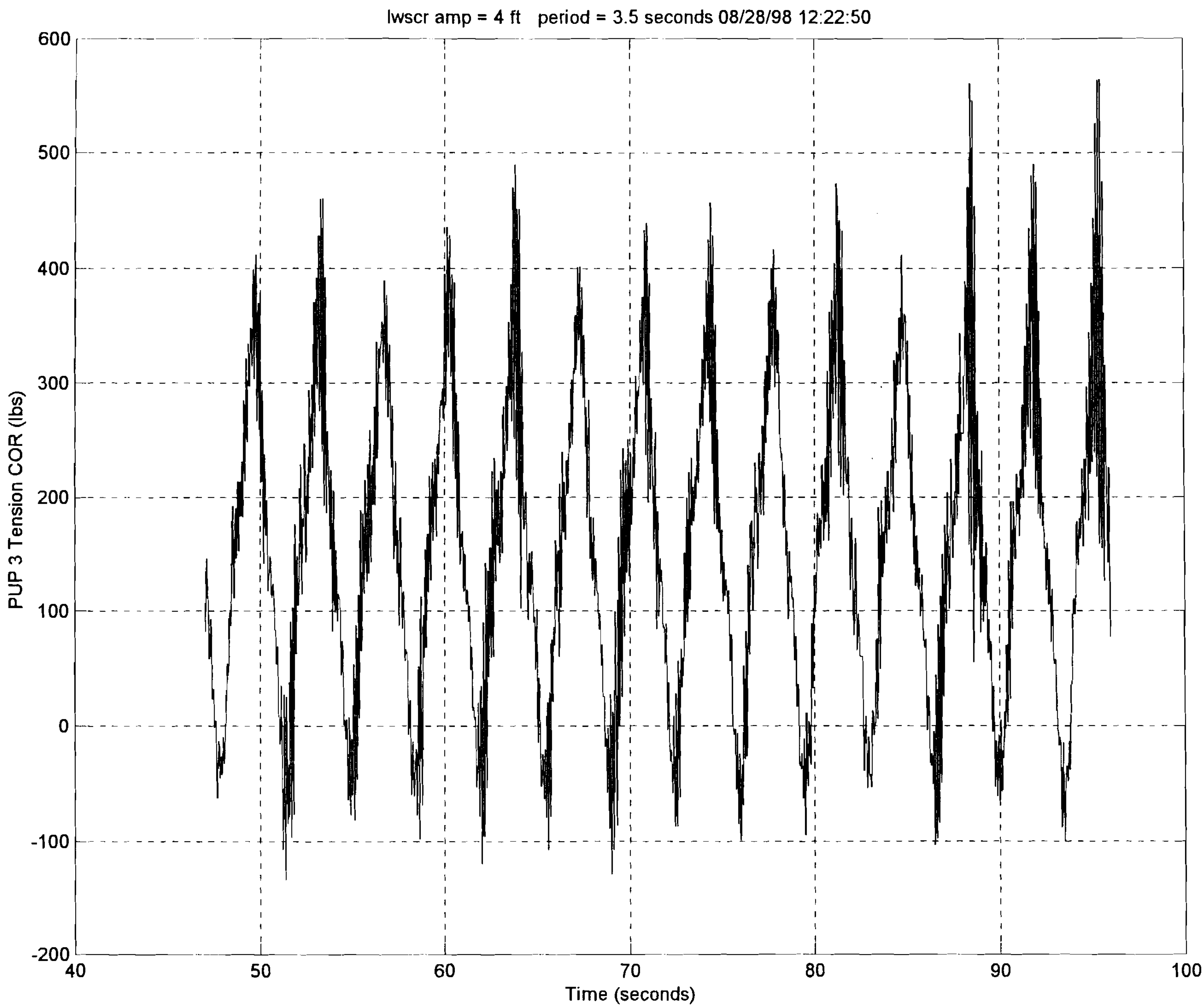


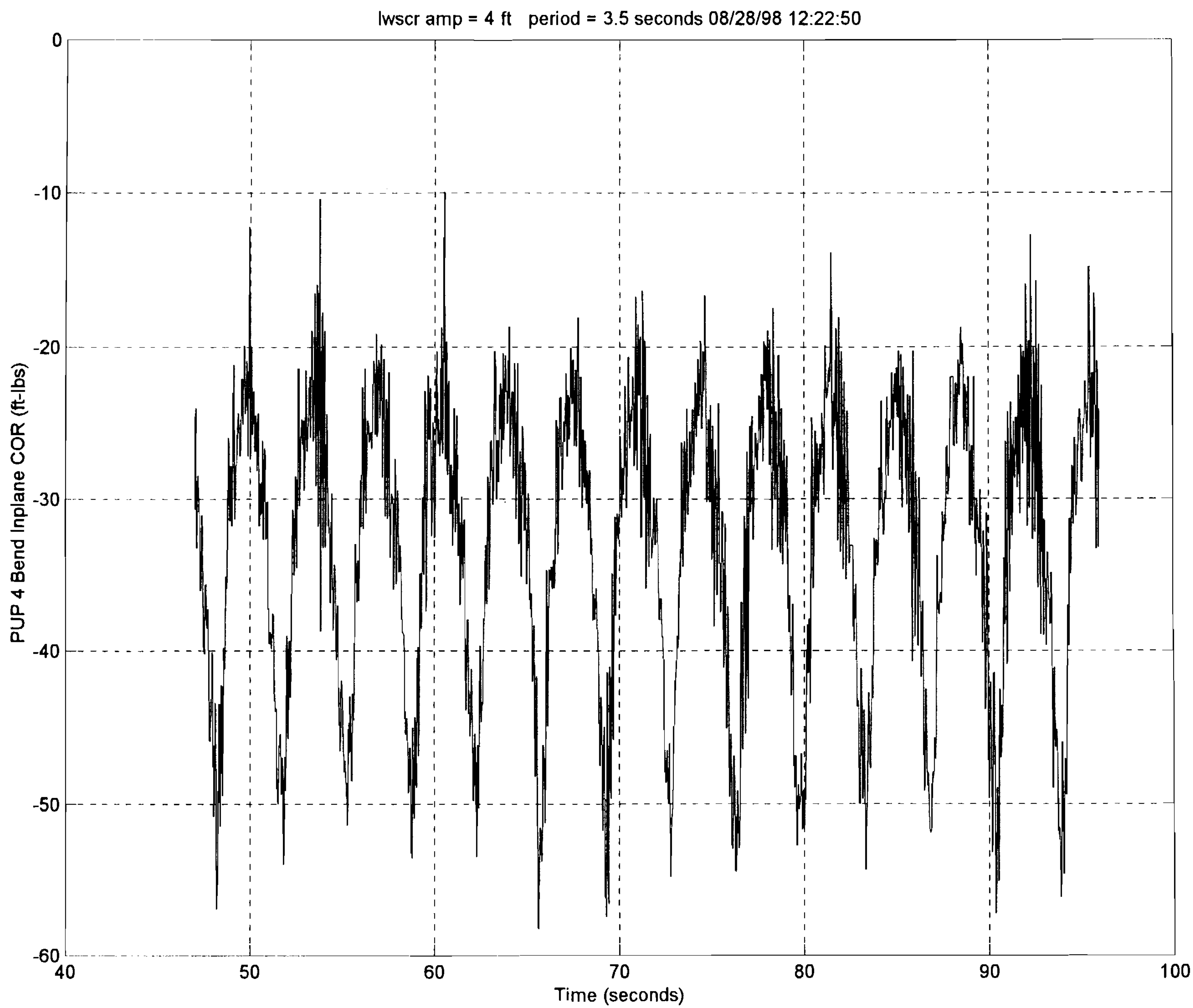
lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 2 Bend Outplane COR (ft-lbs)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
40
50
60
70
80
90
100
Time (seconds)

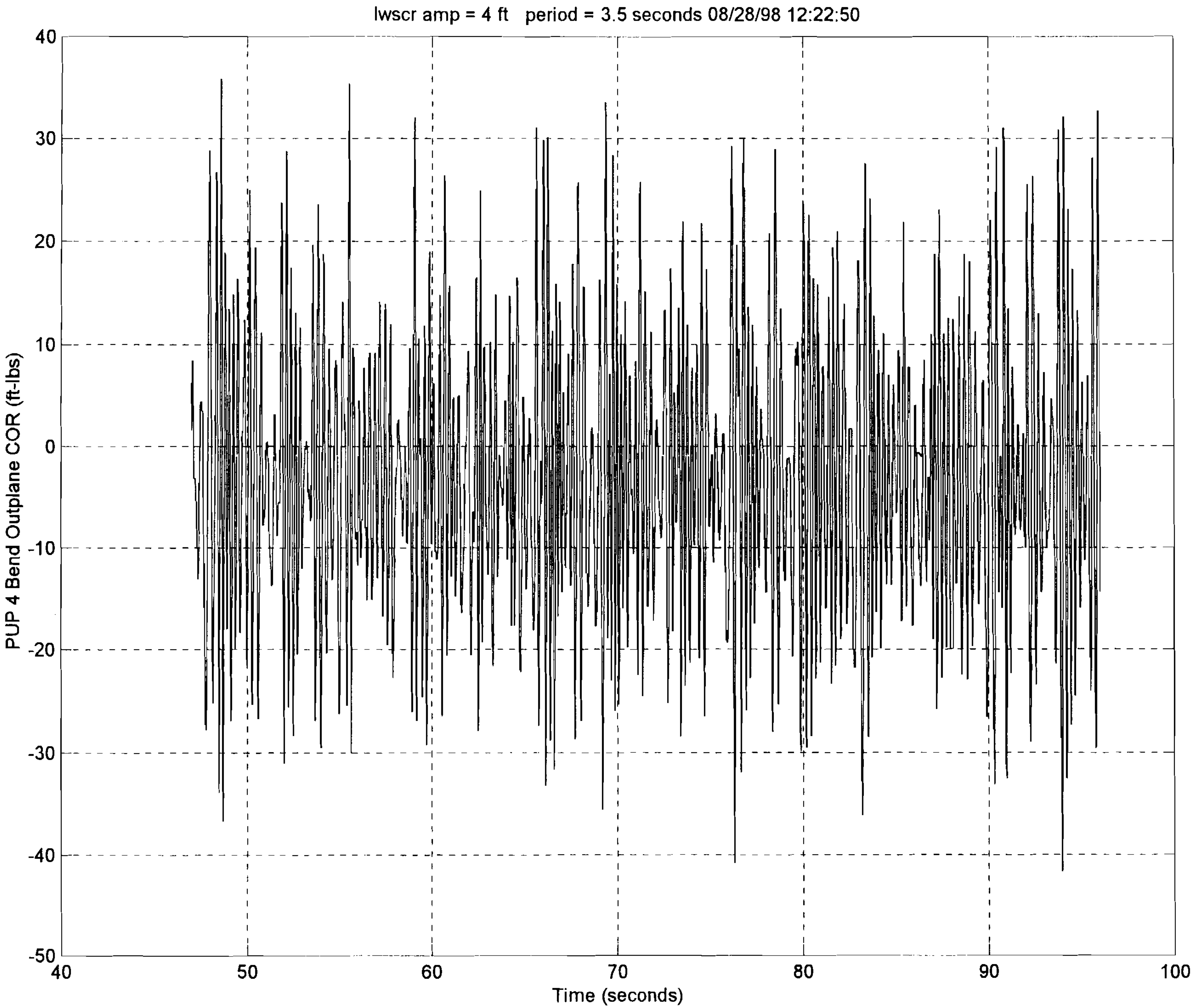

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 2 Tension COR (lbs)
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
40
50
60
70
80
90
100
Time (seconds)

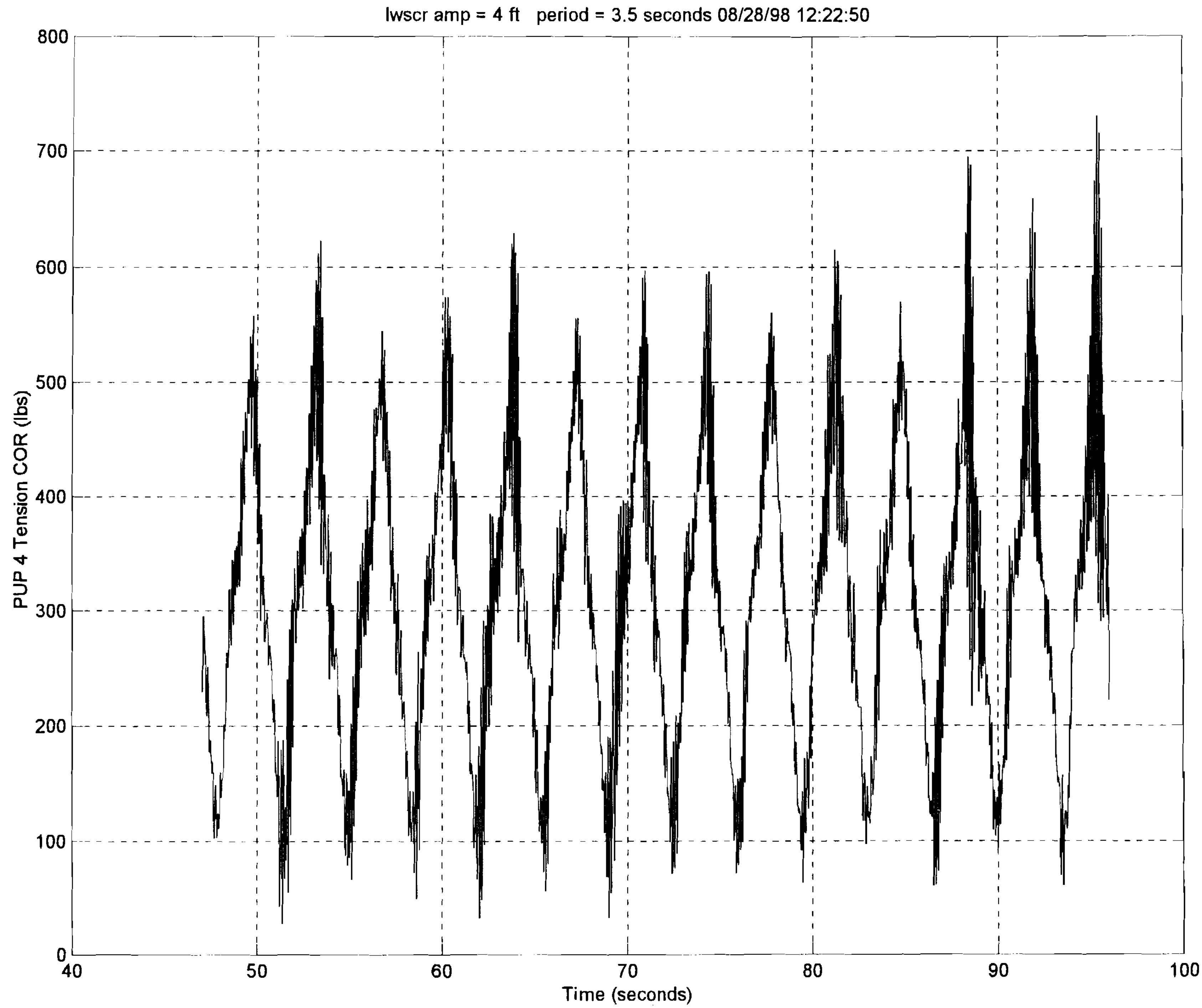

lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 3 Bend Inplane COR (ft-lbs)
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
40
50
60
70
80
90
100
Time (seconds)


lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 3 Bend Outplane COR (ft-lbs)
50
40
30
20
10
0
-10
-20
-30
-40
-50
40
50
60
70
80
90
100
Time (seconds)

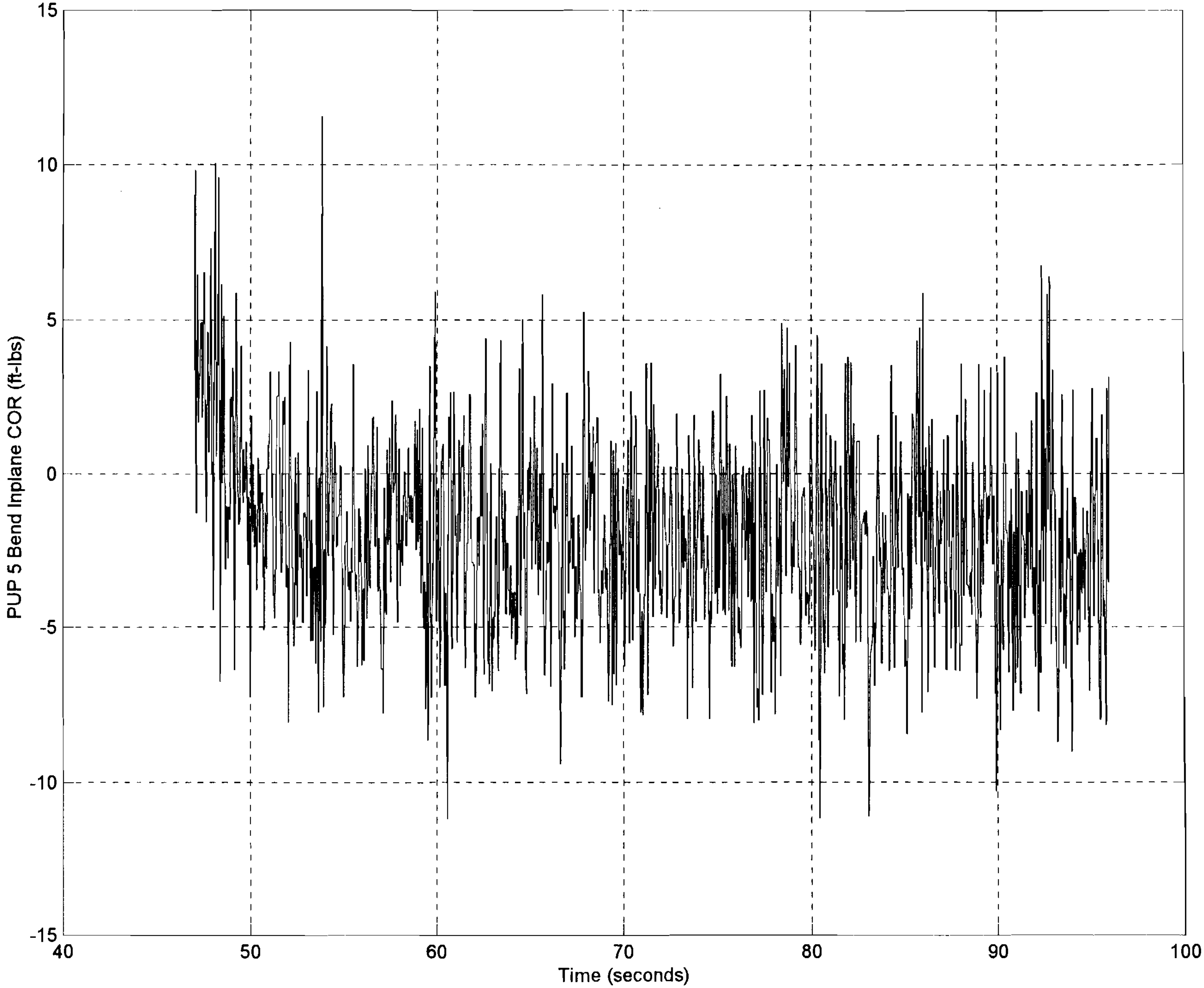

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 3 Tension COR (lbs)
600
500
400
300
200
100
0
-100
-200
40
50
60
70
80
90
100
Time (seconds)

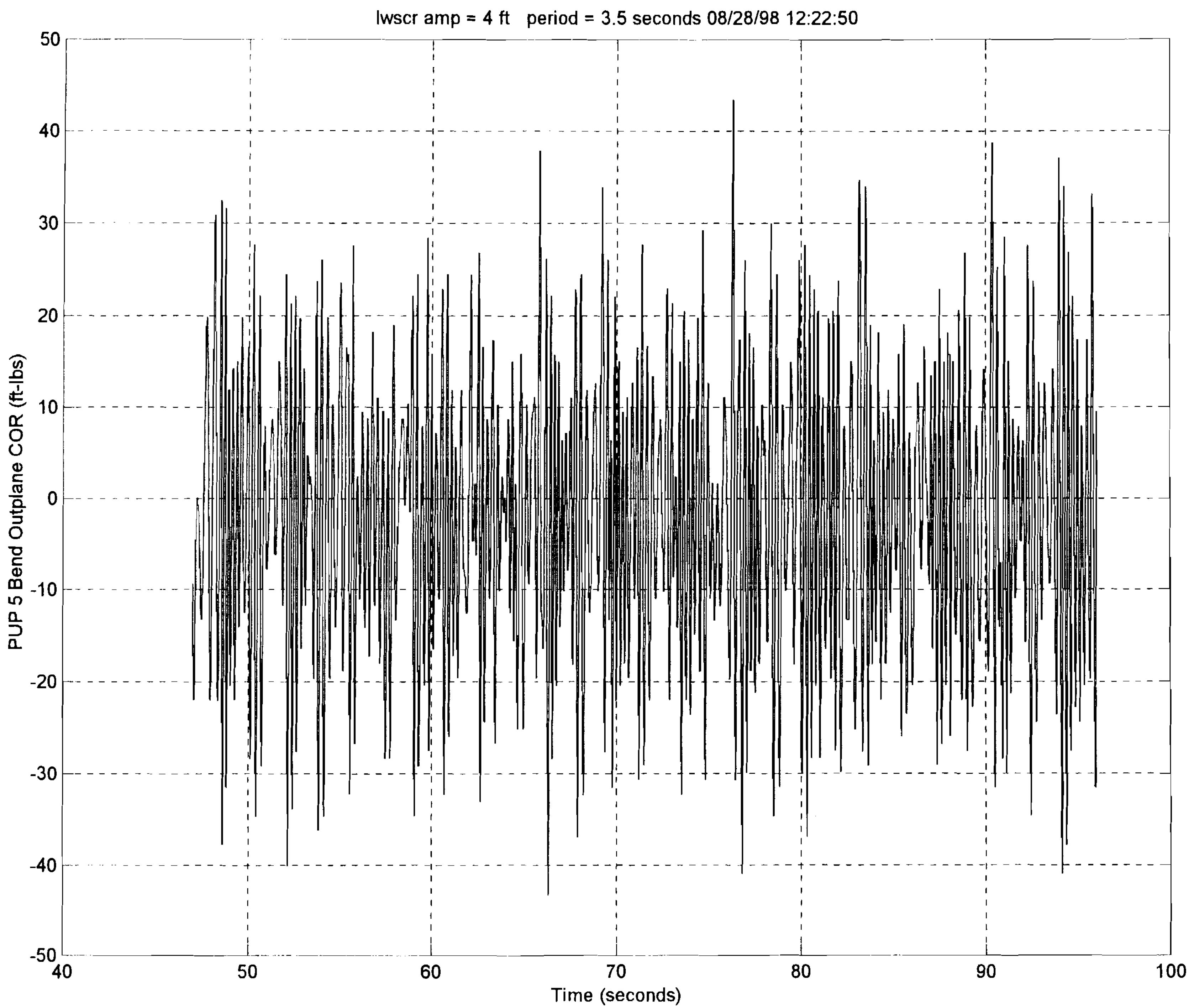

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 4 Bend Inplane COR (ft-lbs)
0
-10
-20
-30
-40
-50
-60
40
50
60
70
80
90
100
Time (seconds)

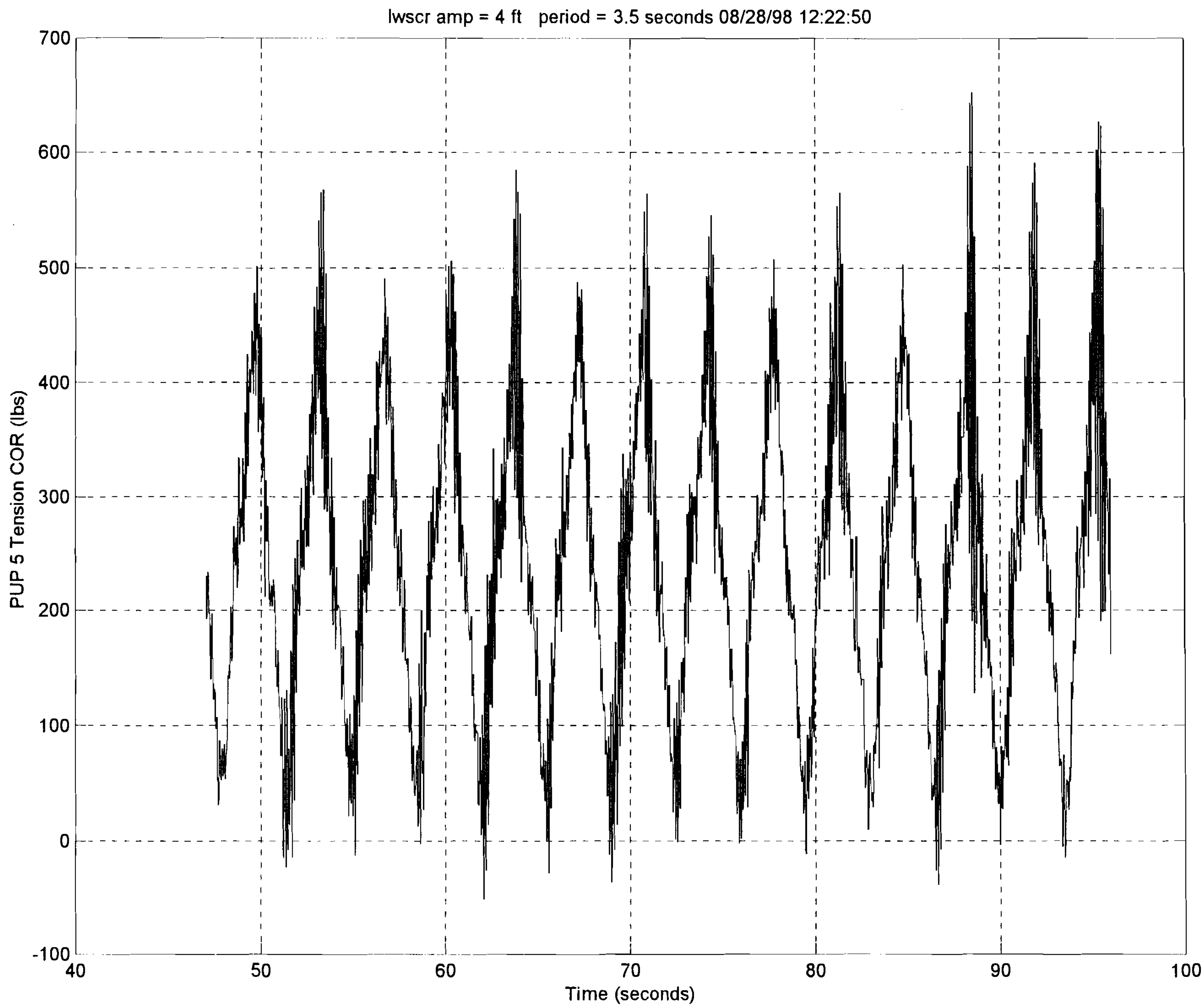

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 4 Bend Outplane COR (ft-lbs)
40
30
20
10
0
-10
-20
-30
-40
-50
40
50
60
70
80
90
100
Time (seconds)


lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 4 Tension COR (lbs)
800
700
600
500
400
300
200
100
0
40
50
60
70
80
90
100
Time (seconds)

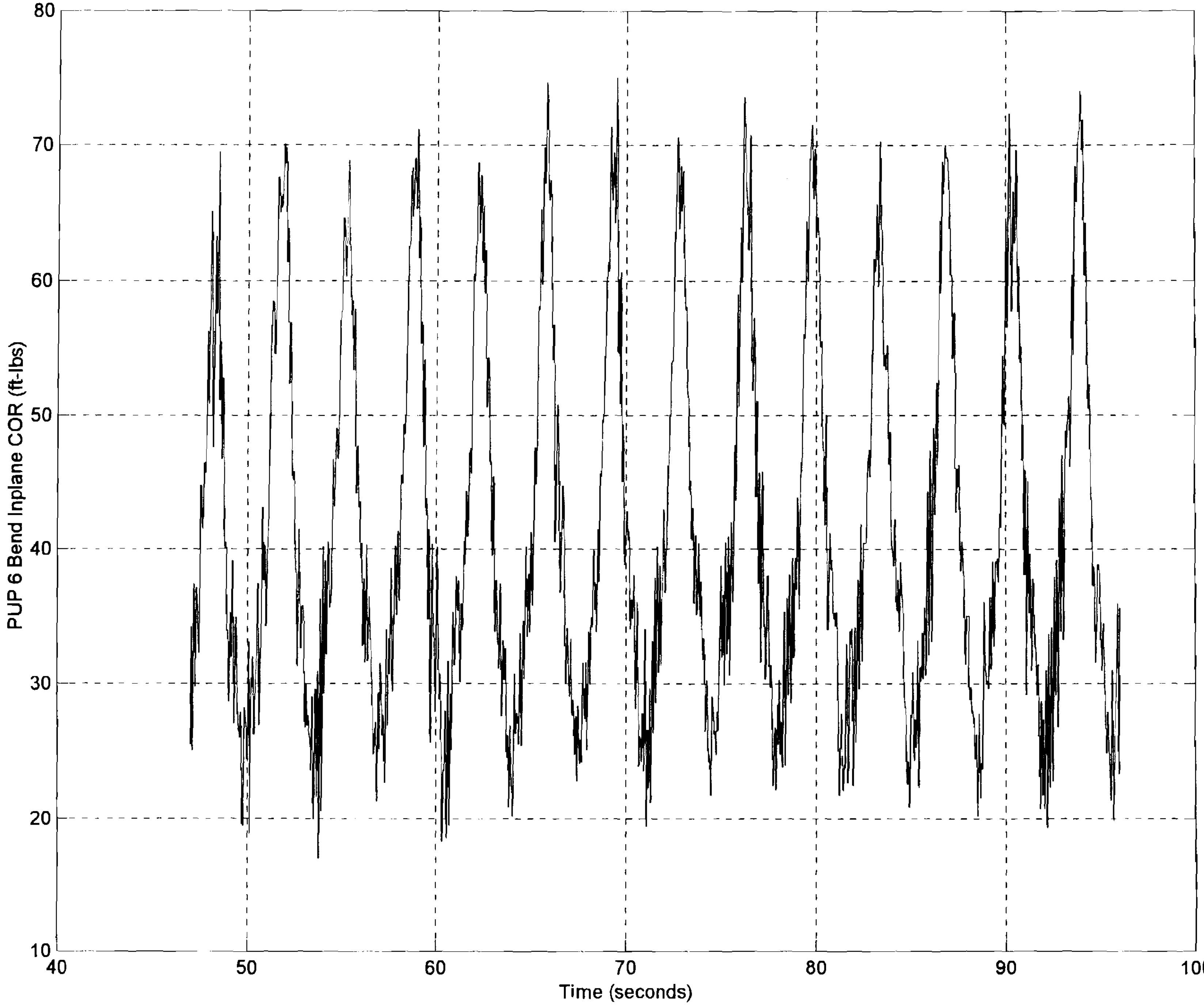
lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50

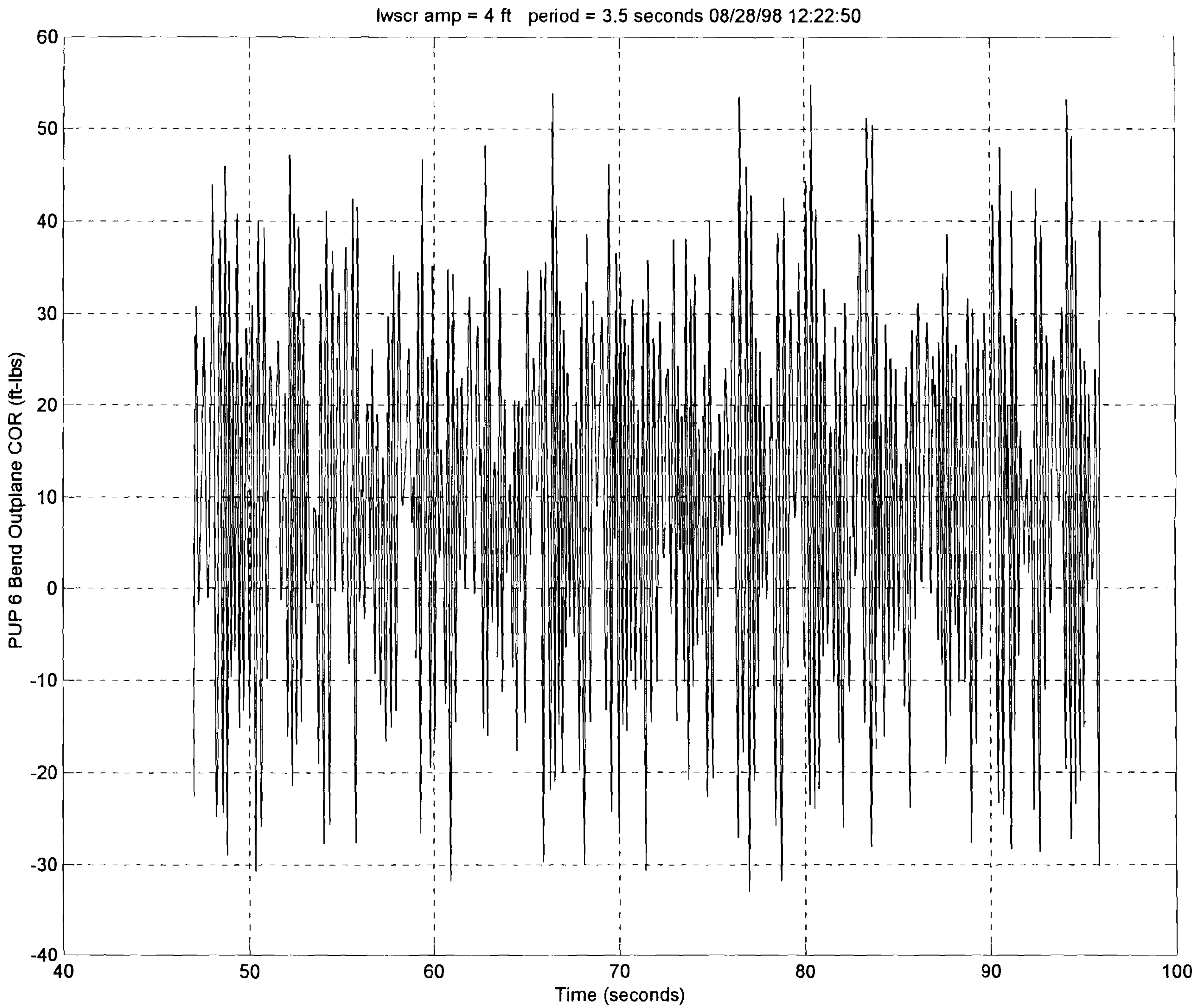


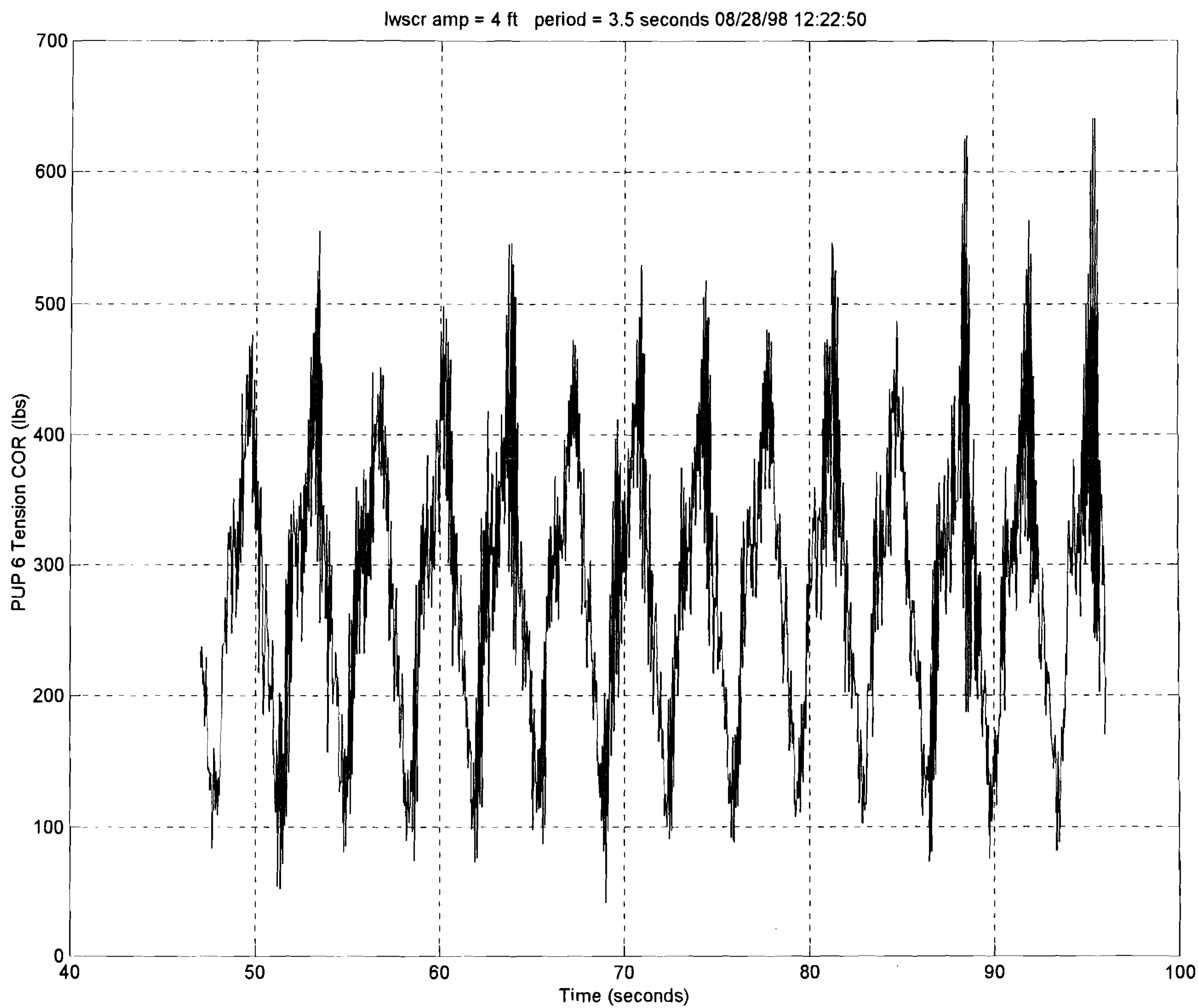

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 5 Bend Outplane COR (ft-lbs)
Time (seconds)
50
40
30
20
10
0
-10
-20
-30
-40
-50
40
50
60
70
80
90
100

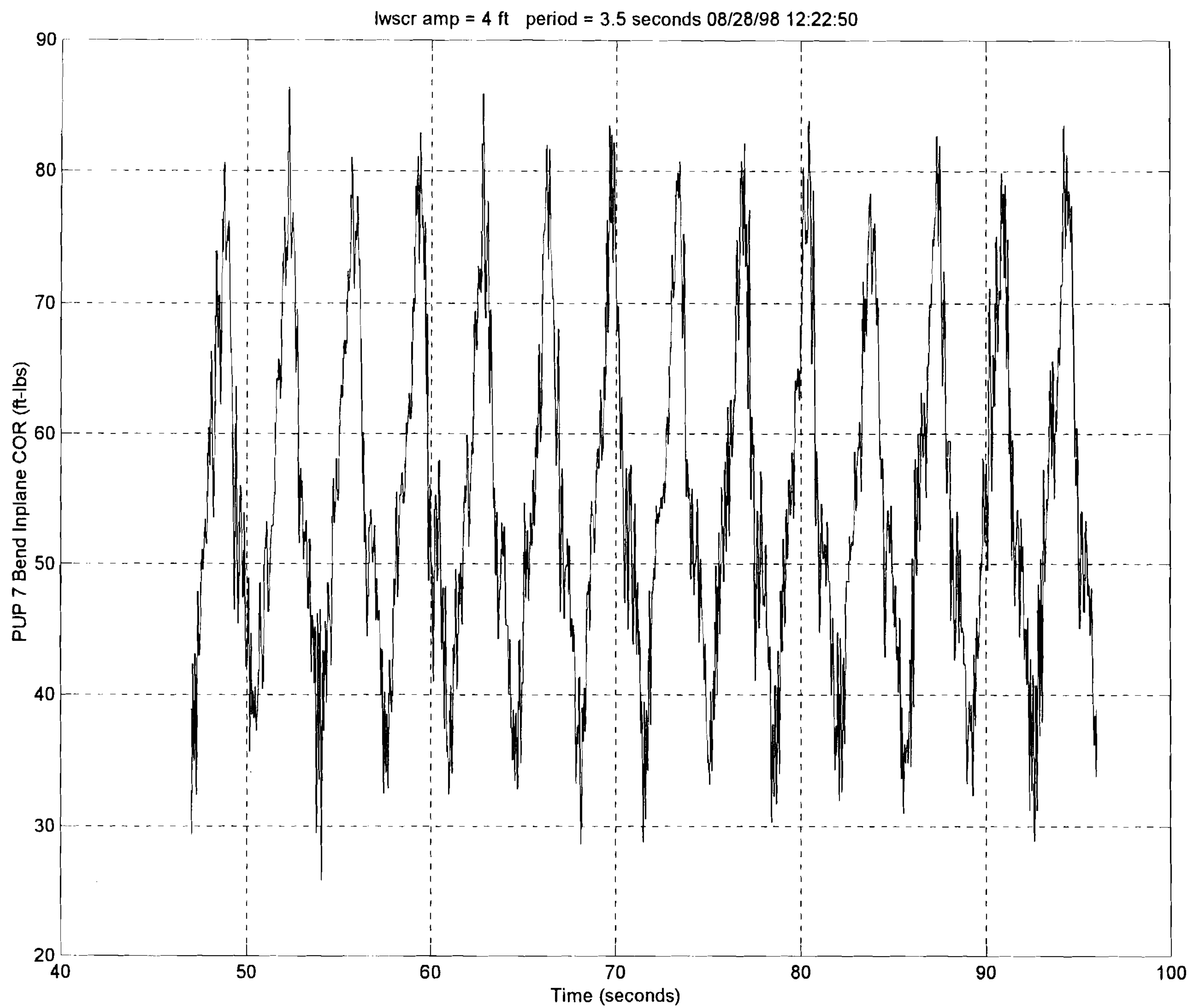

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 5 Tension COR (lbs)
Time (seconds)
700
600
500
400
300
200
100
0
-100
40
50
60
70
80
90
100

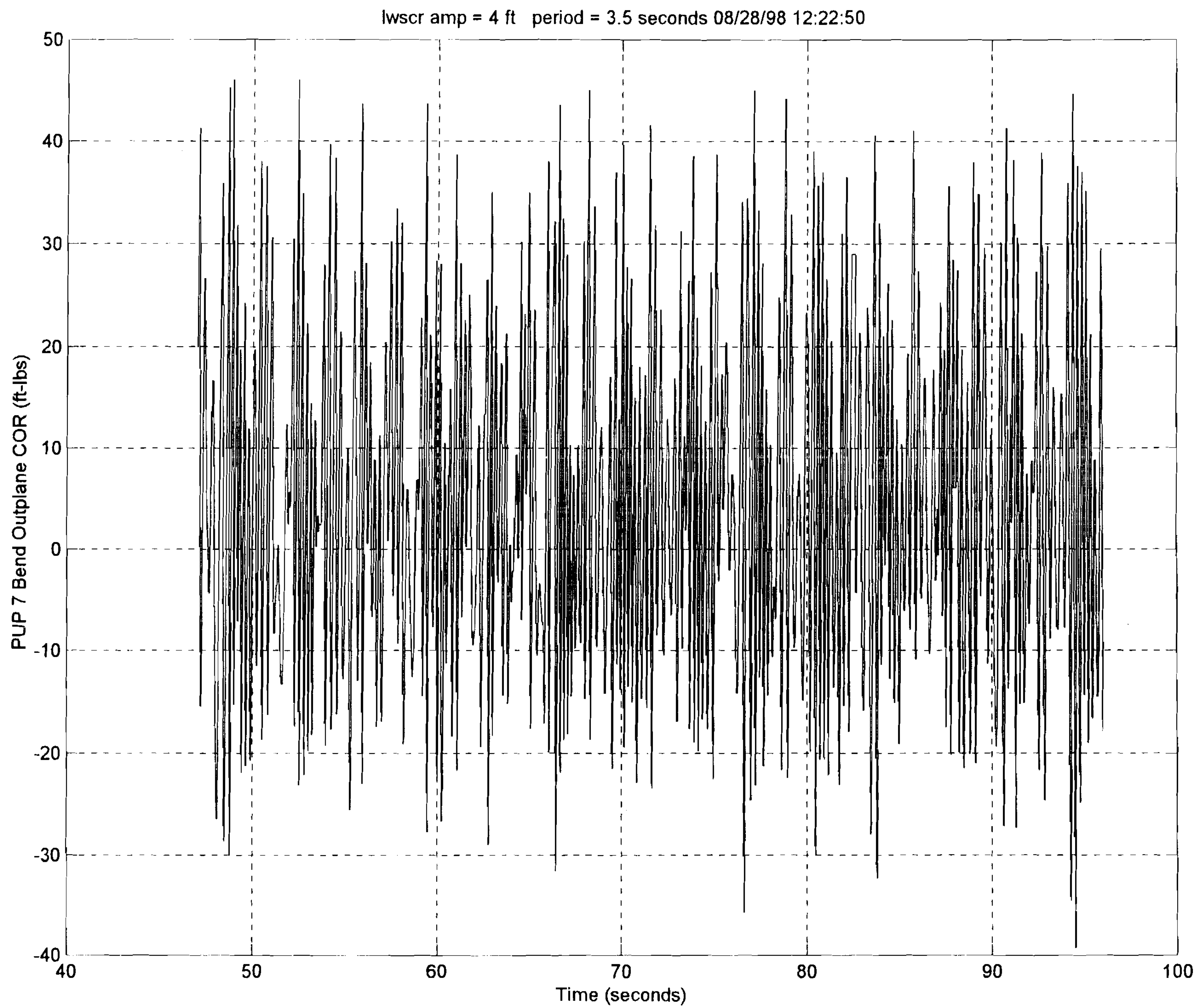
lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50

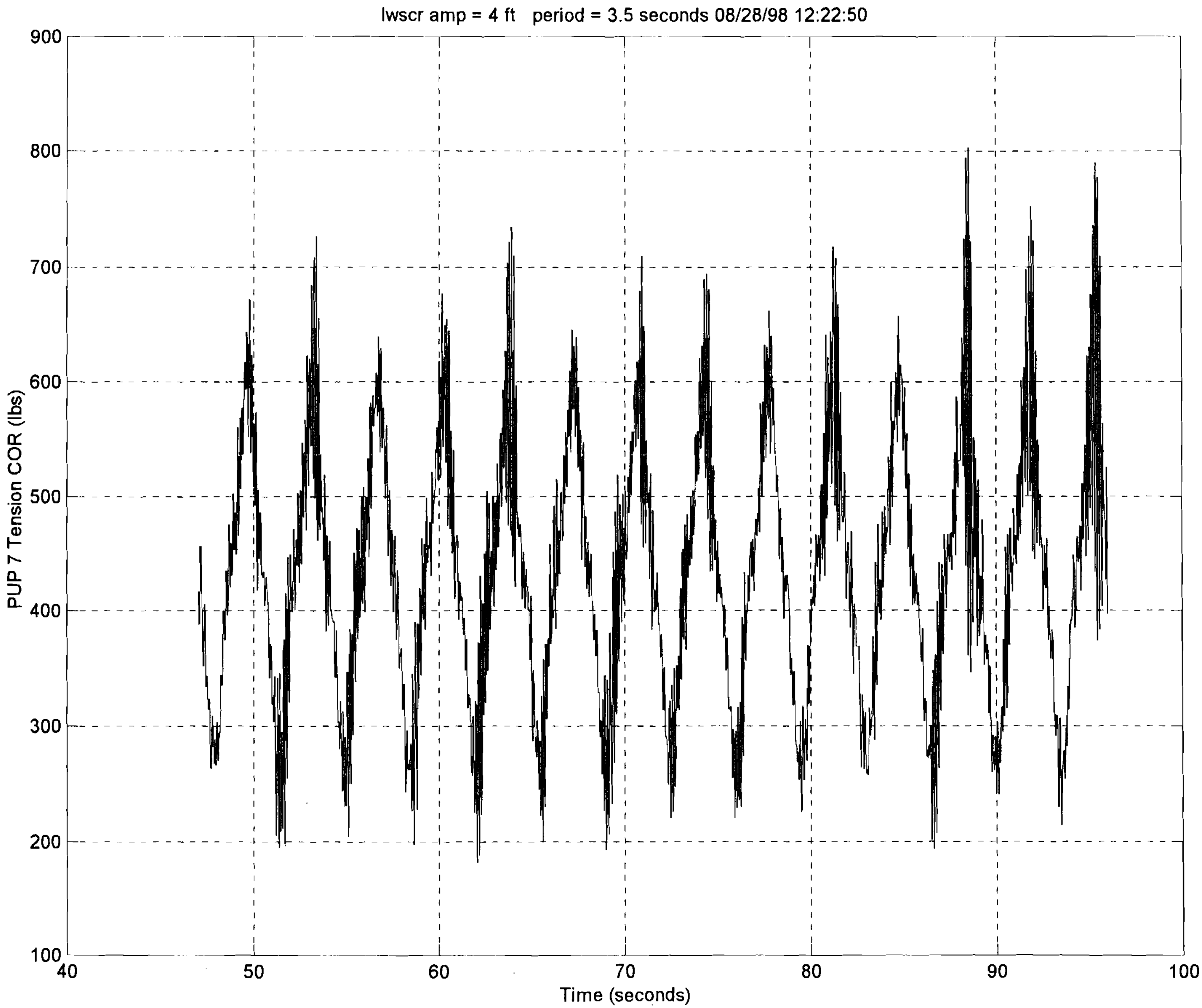


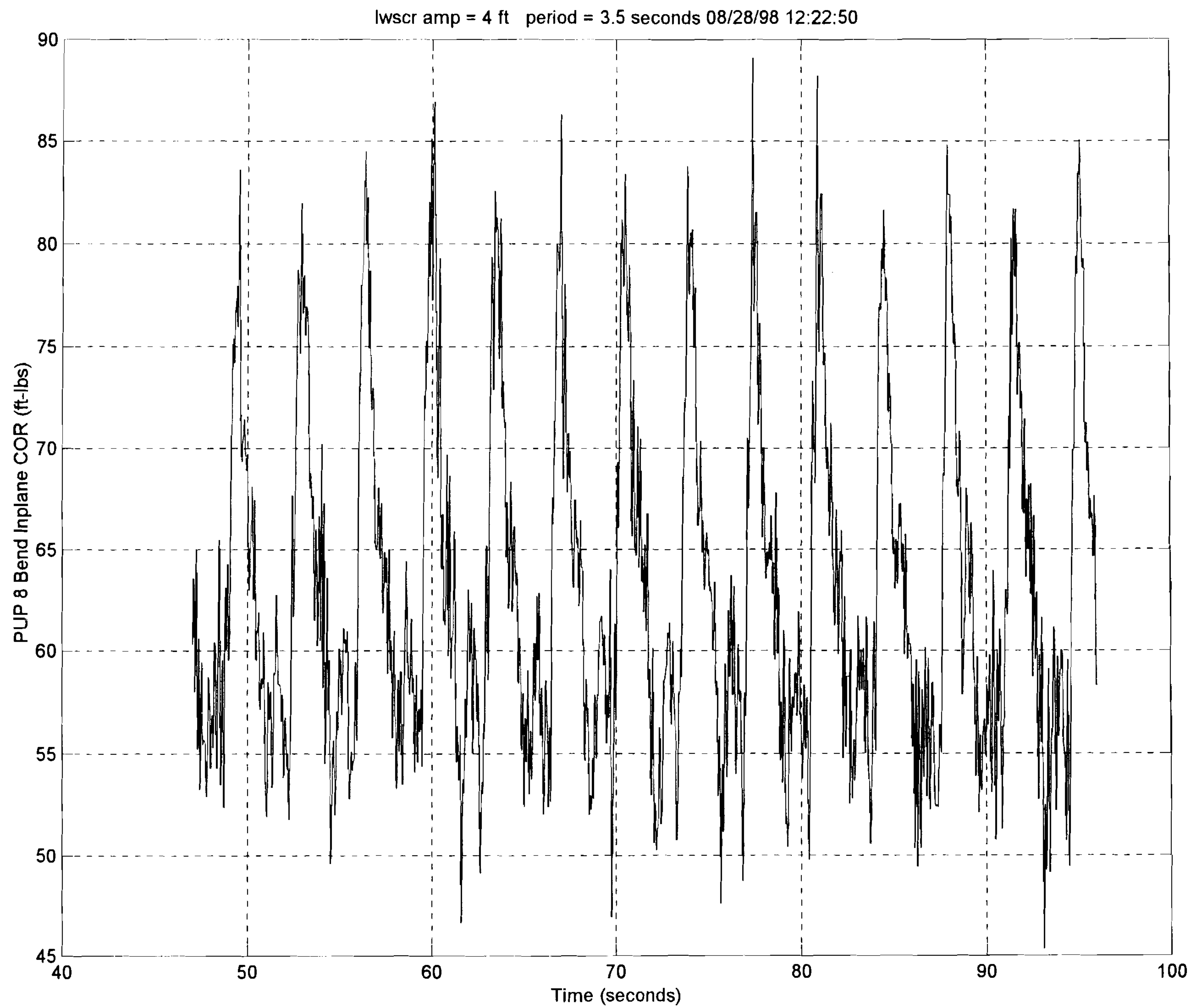

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 6 Bend Outplane COR (ft-lbs)
60
50
40
30
20
10
0
-10
-20
-30
-40
40
50
60
70
80
90
100
Time (seconds)

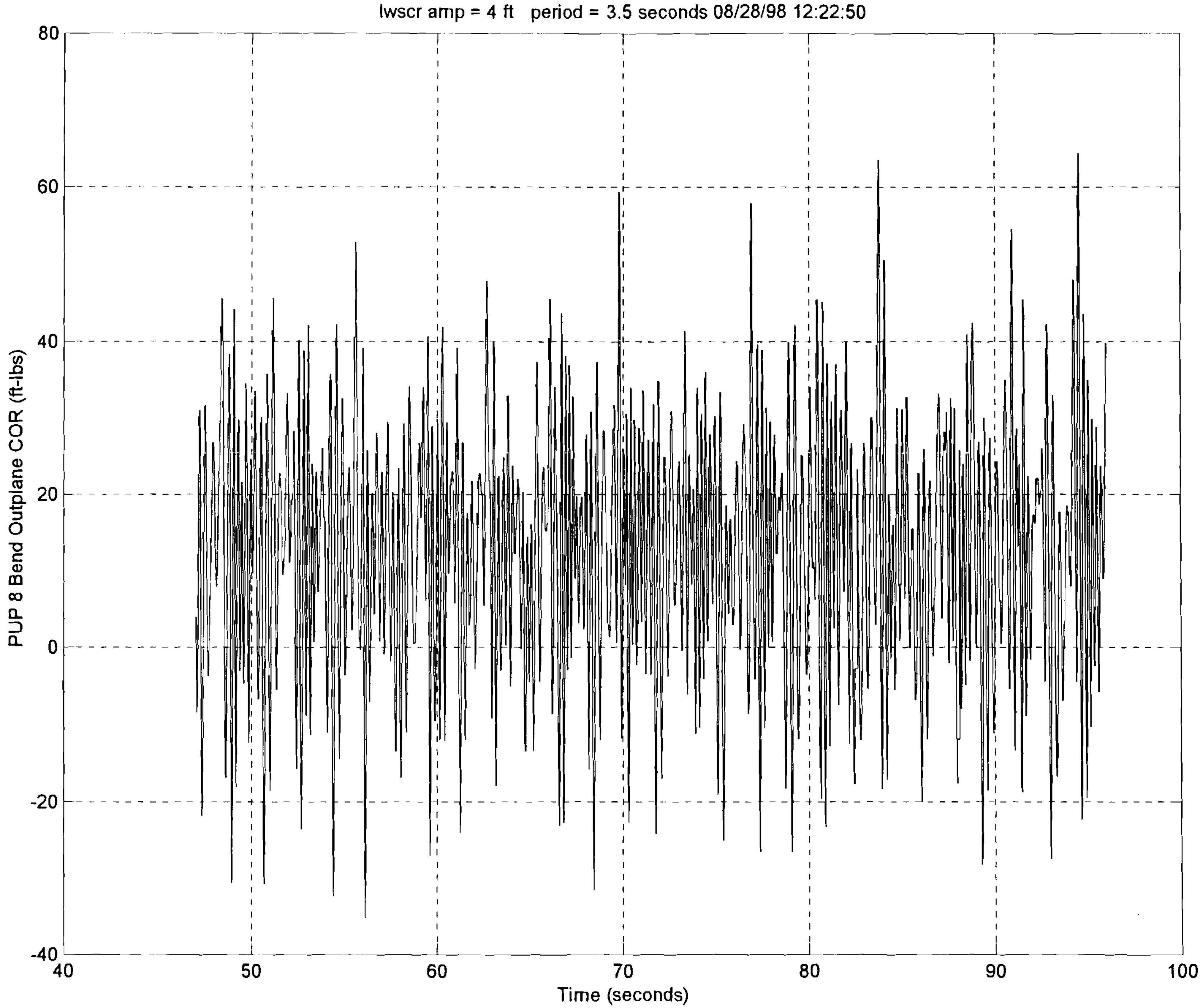

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 6 Tension COR (lbs)
0
100
200
300
400
500
600
700
40
50
60
70
80
90
100
Time (seconds)

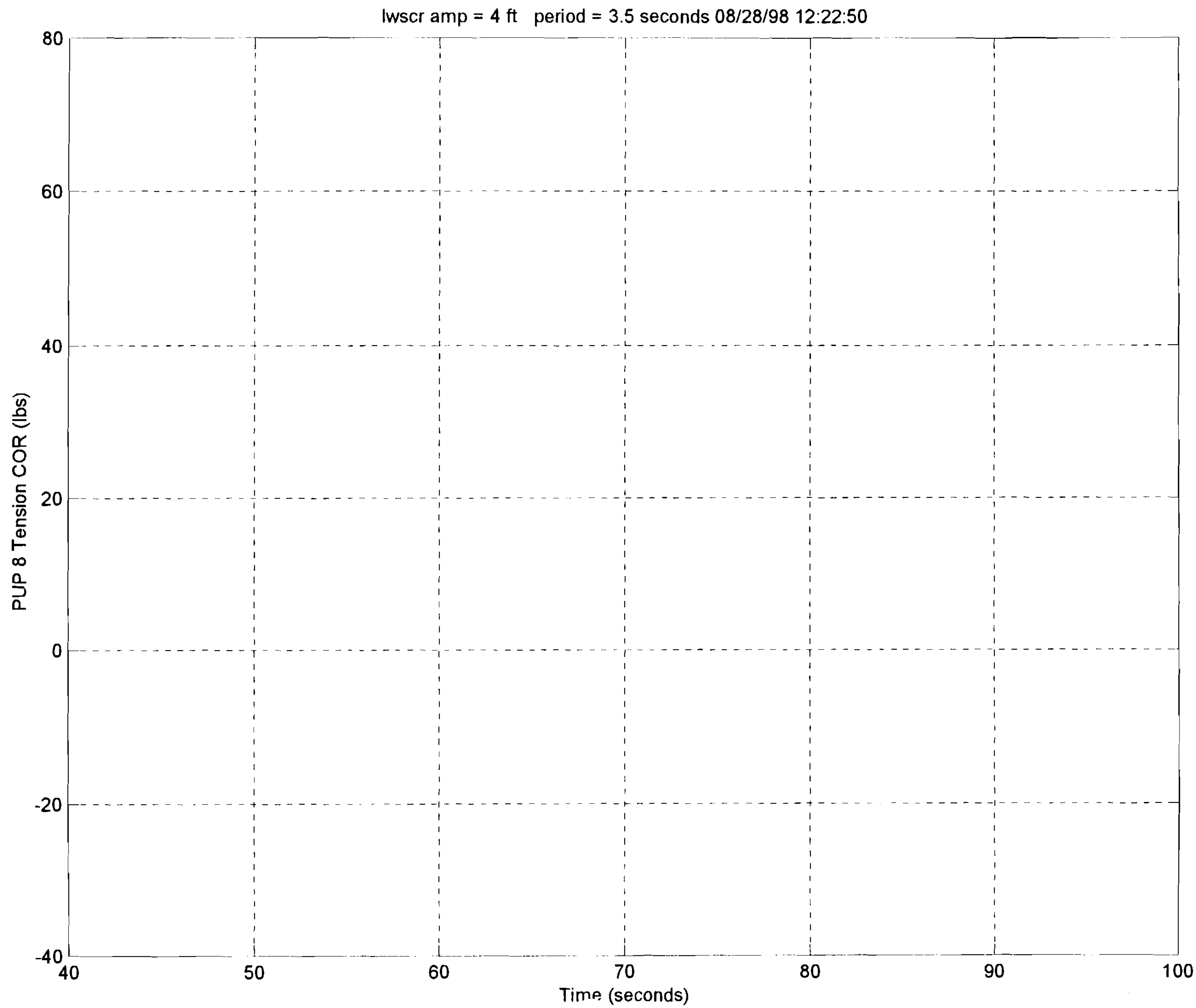

lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 7 Bend Inplane COR (ft-lbs)
90
80
70
60
50
40
30
20
40
50
60
70
80
90
100
Time (seconds)

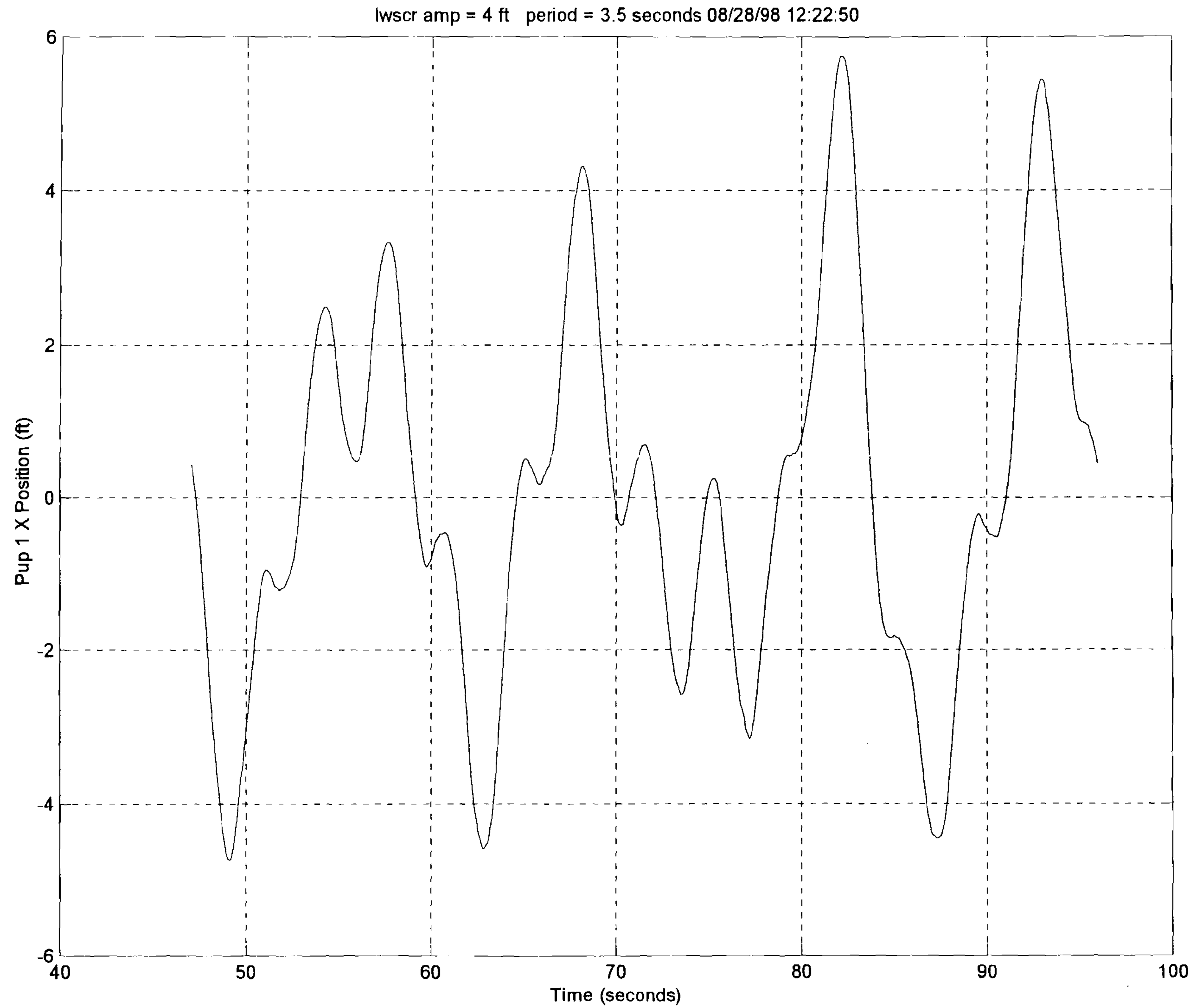

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 7 Bend Outplane COR (ft-lbs)
Time (seconds)
50
40
30
20
10
0
-10
-20
-30
-40
40
50
60
70
80
90
100

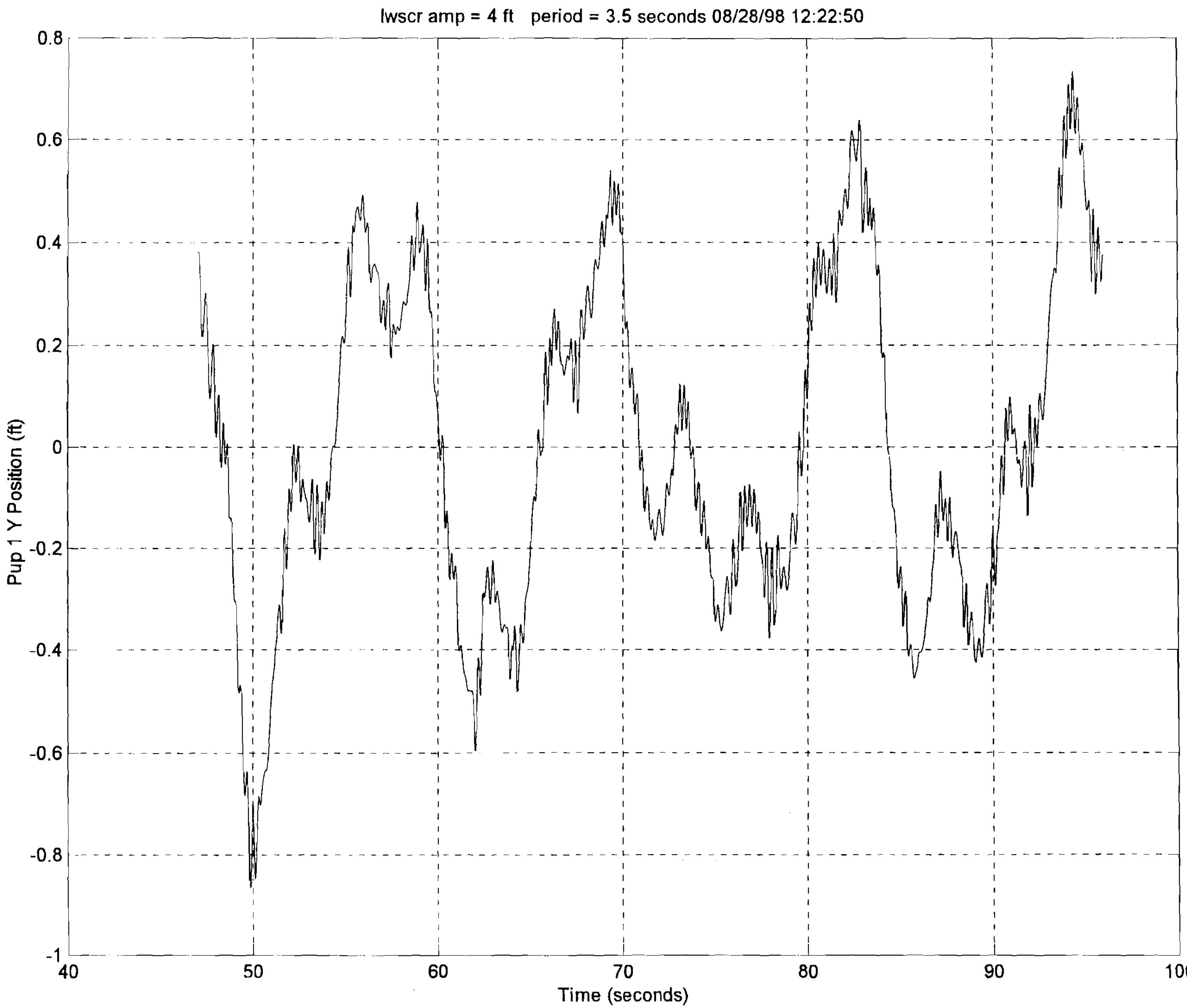

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 7 Tension COR (lbs)
900
800
700
600
500
400
300
200
100
40
50
60
70
80
90
100
Time (seconds)

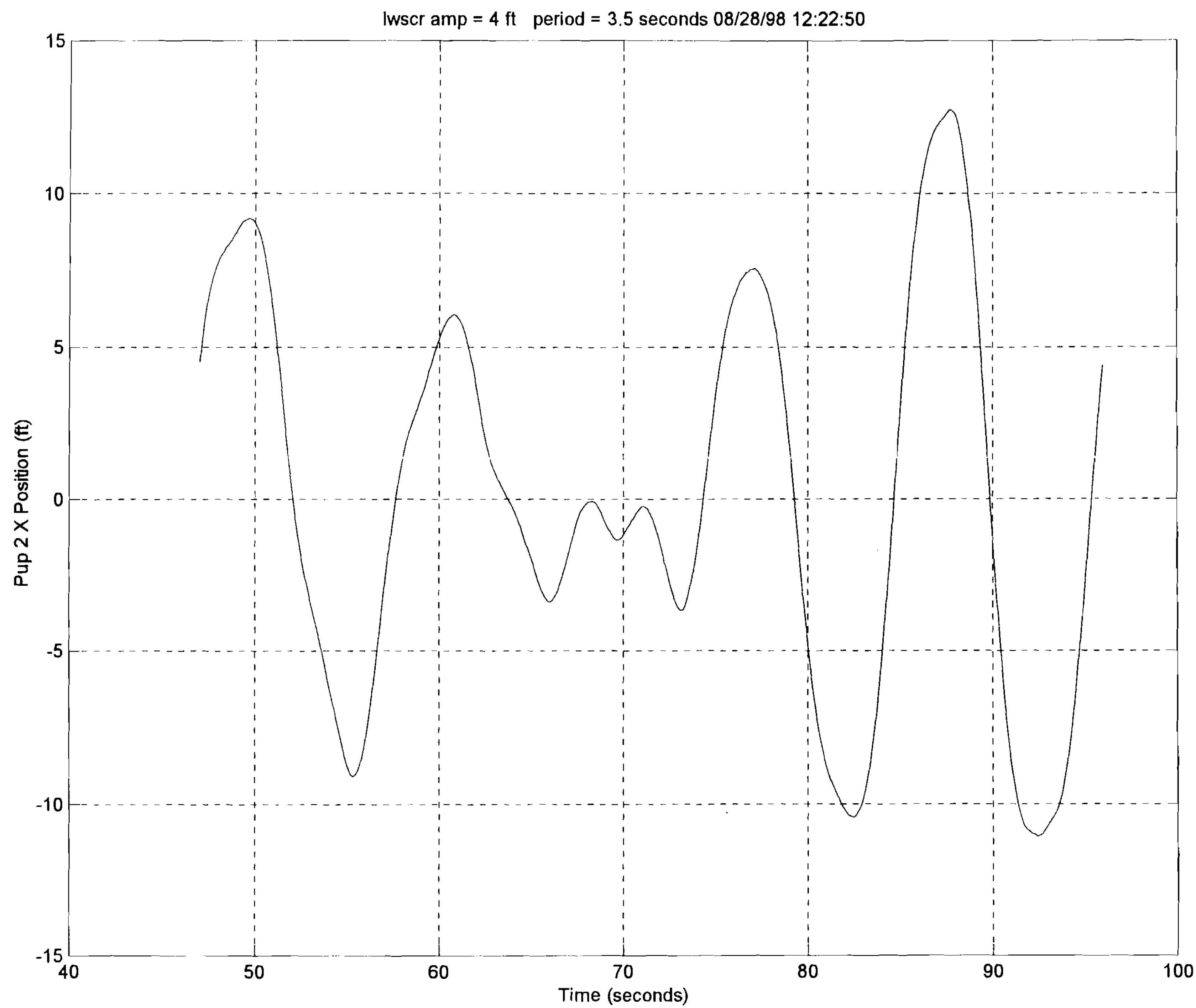

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 8 Bend Inplane COR (ft-lbs)
Time (seconds)
90
85
80
75
70
65
60
55
50
45
40
50
60
70
80
90
100


lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
PUP 8 Bend Outplane COR (ft-lbs)
80
60
40
20
0
-20
-40
40
50
60
70
80
90
100
Time (seconds)

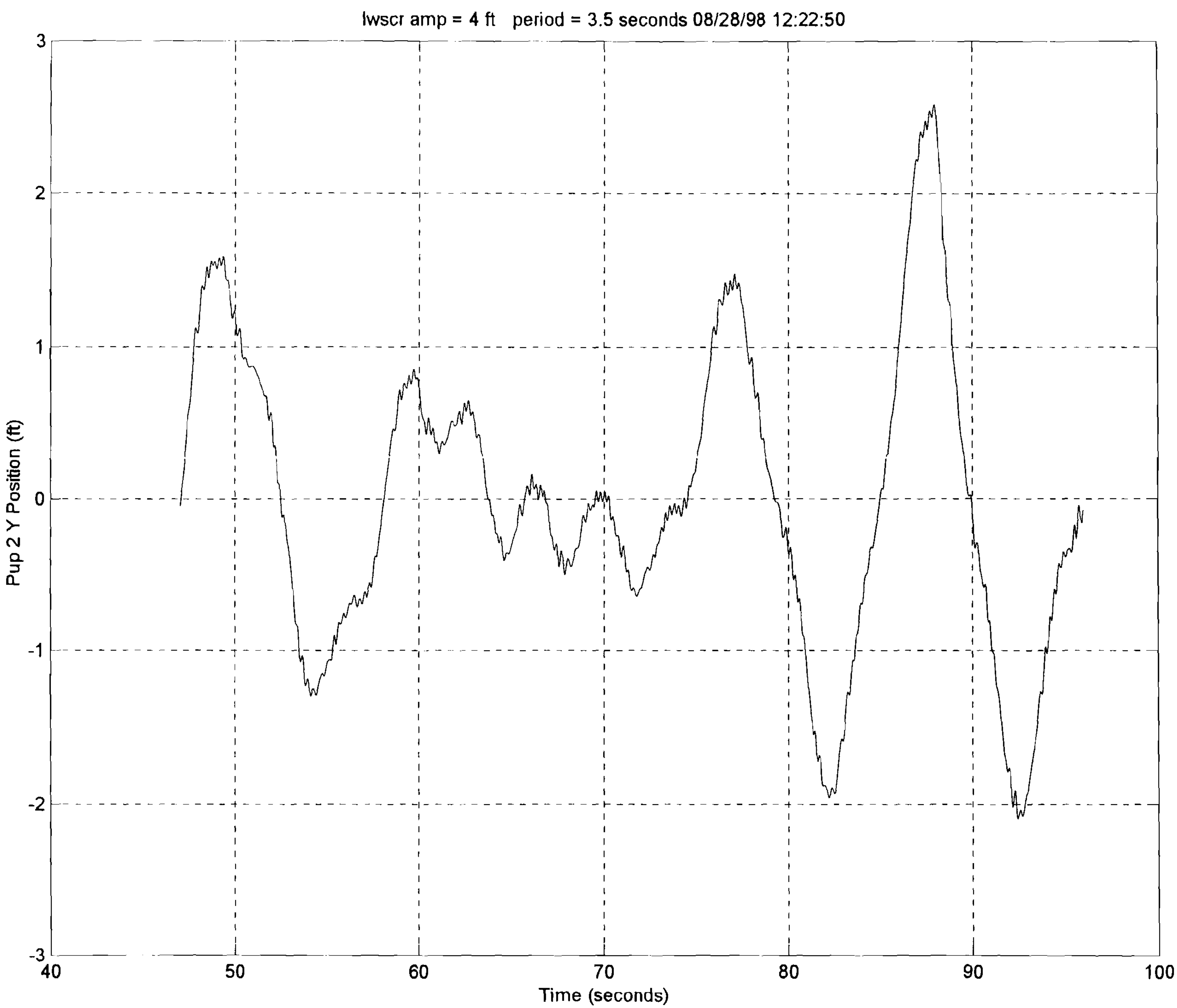

lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
PUP 8 Tension COR (lbs)
80
60
40
20
0
-20
-40
40
50
60
70
80
90
100
Time (seconds)

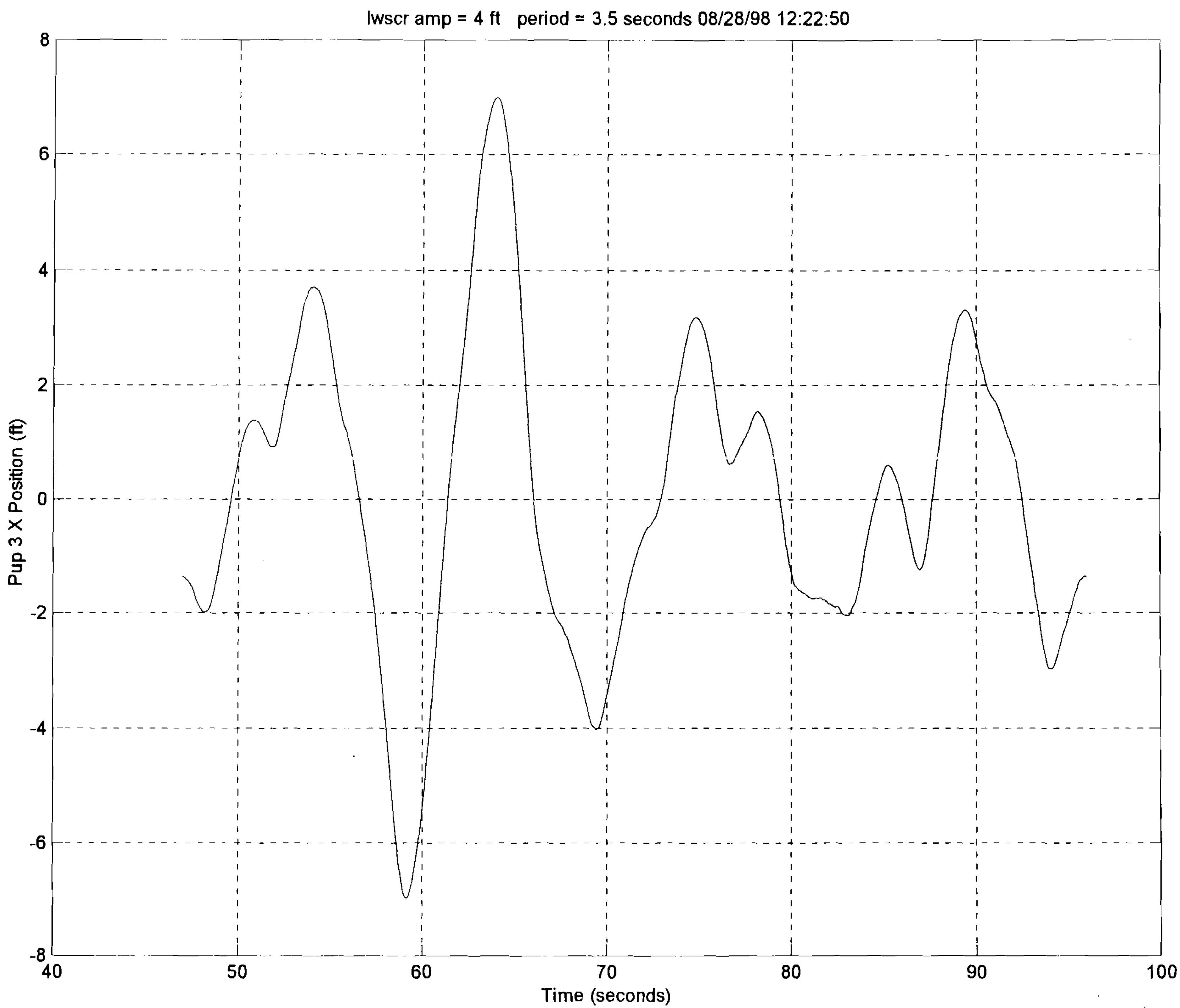

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 1 X Position (ft)
Time (seconds)
6
4
2
0
-2
-4
-6
40
50
60
70
80
90
100

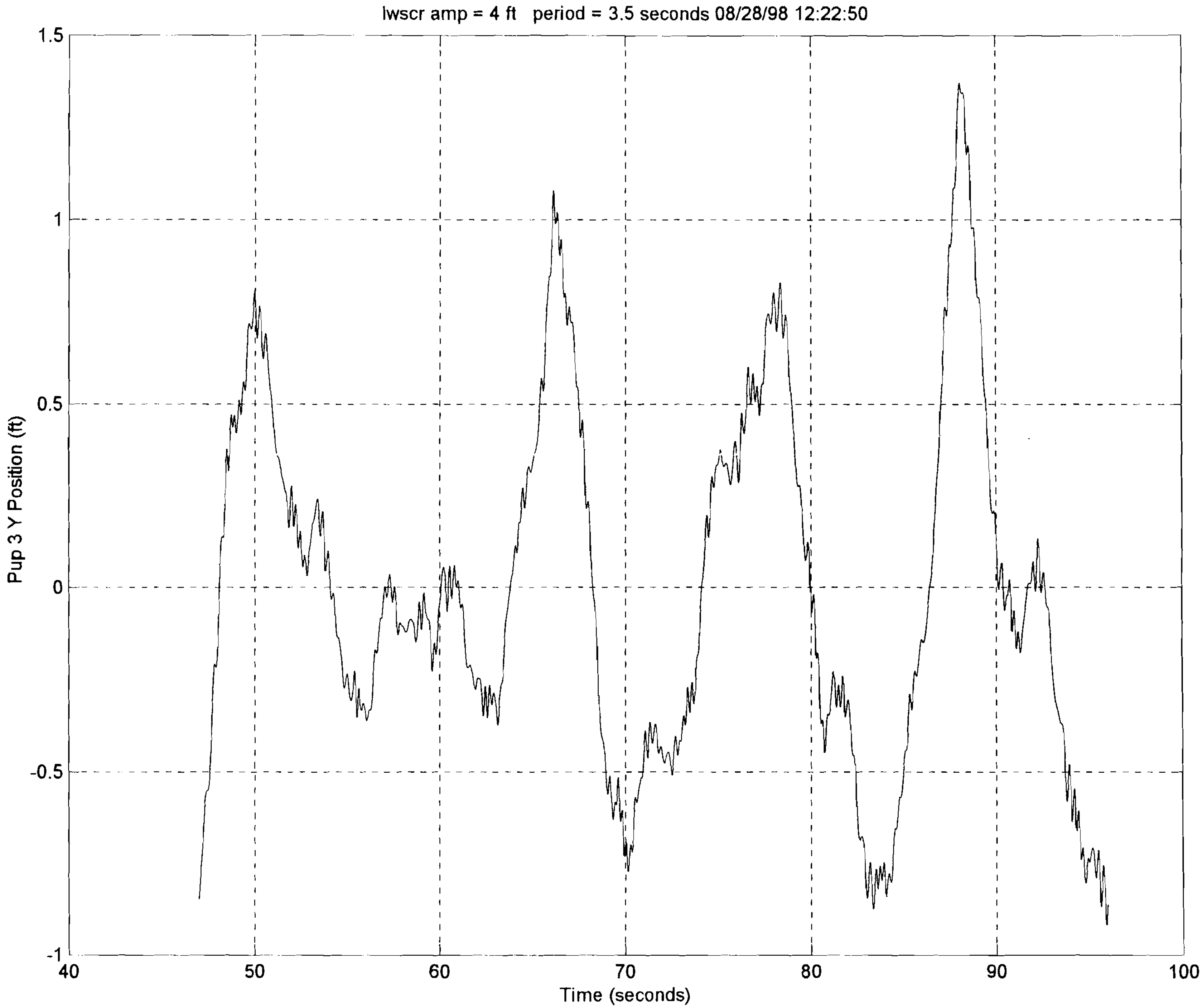

lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
Pup 1 Y Position (ft)
Time (seconds)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
40
50
60
70
80
90
100

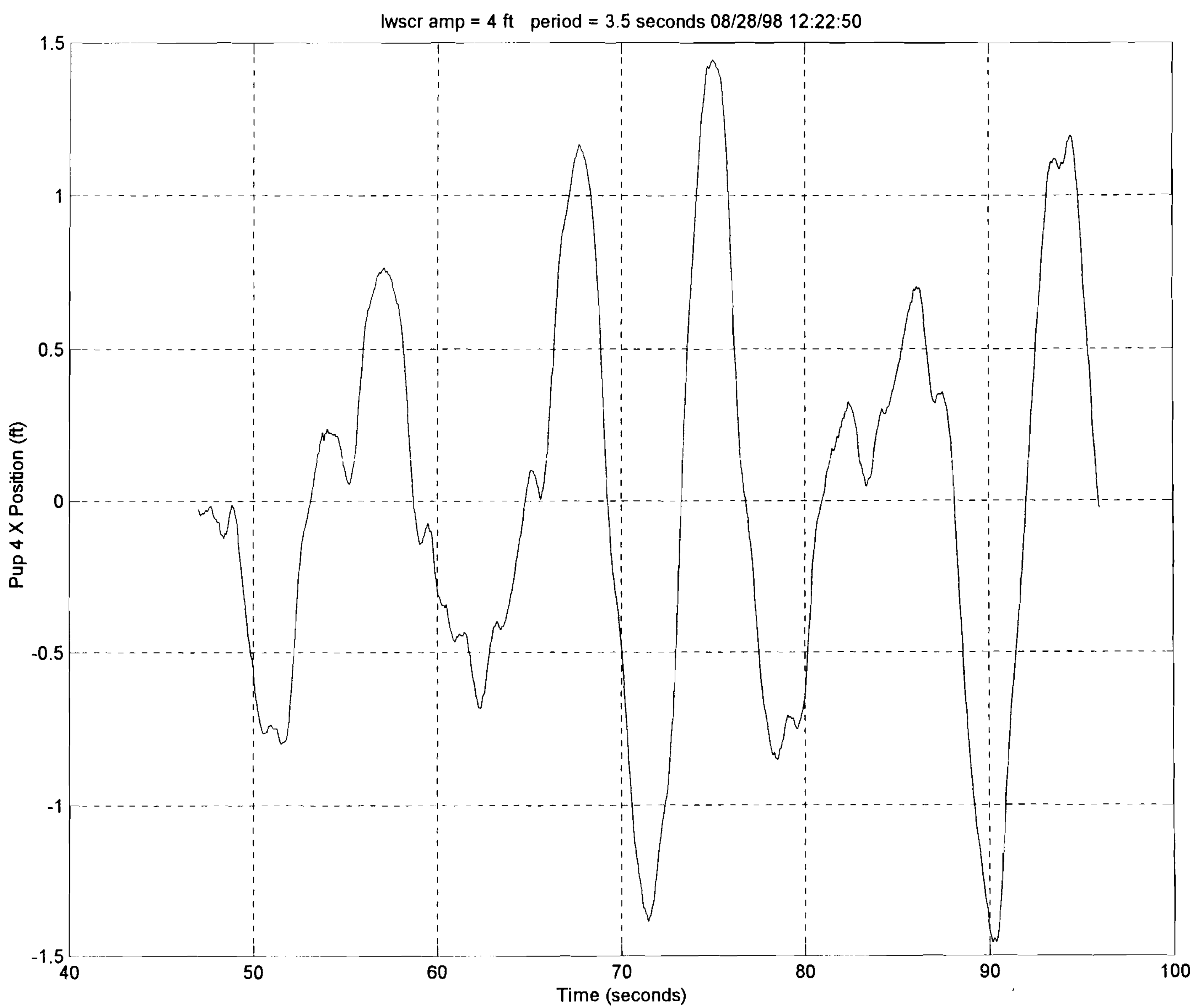


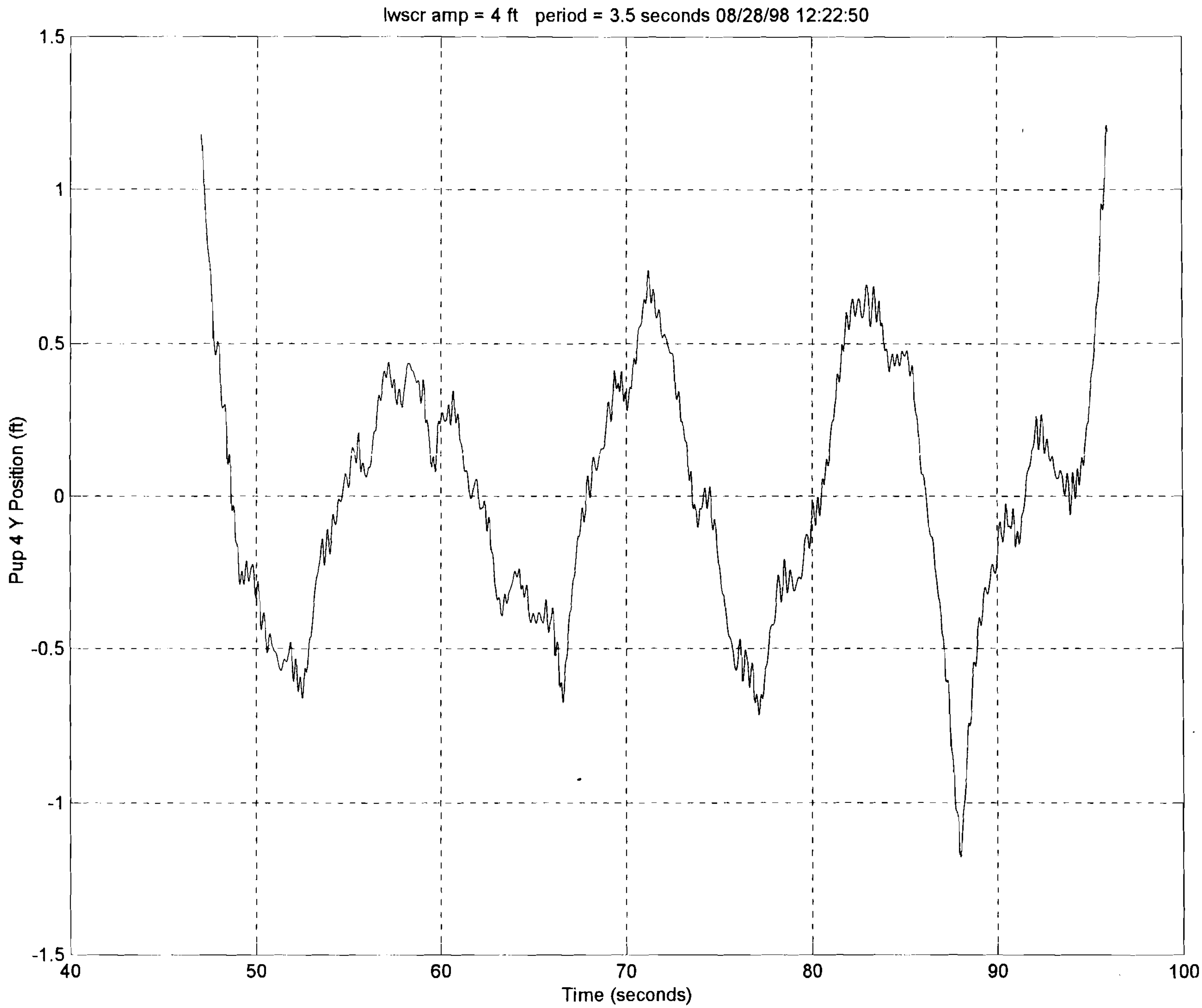
lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
Pup 2 X Position (ft)
Time (seconds)
15
10
5
0
-5
-10
-15
40
50
60
70
80
90
100


lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 2 Y Position (ft)
3
2
1
0
-1
-2
-3
40
50
60
70
80
90
100
Time (seconds)

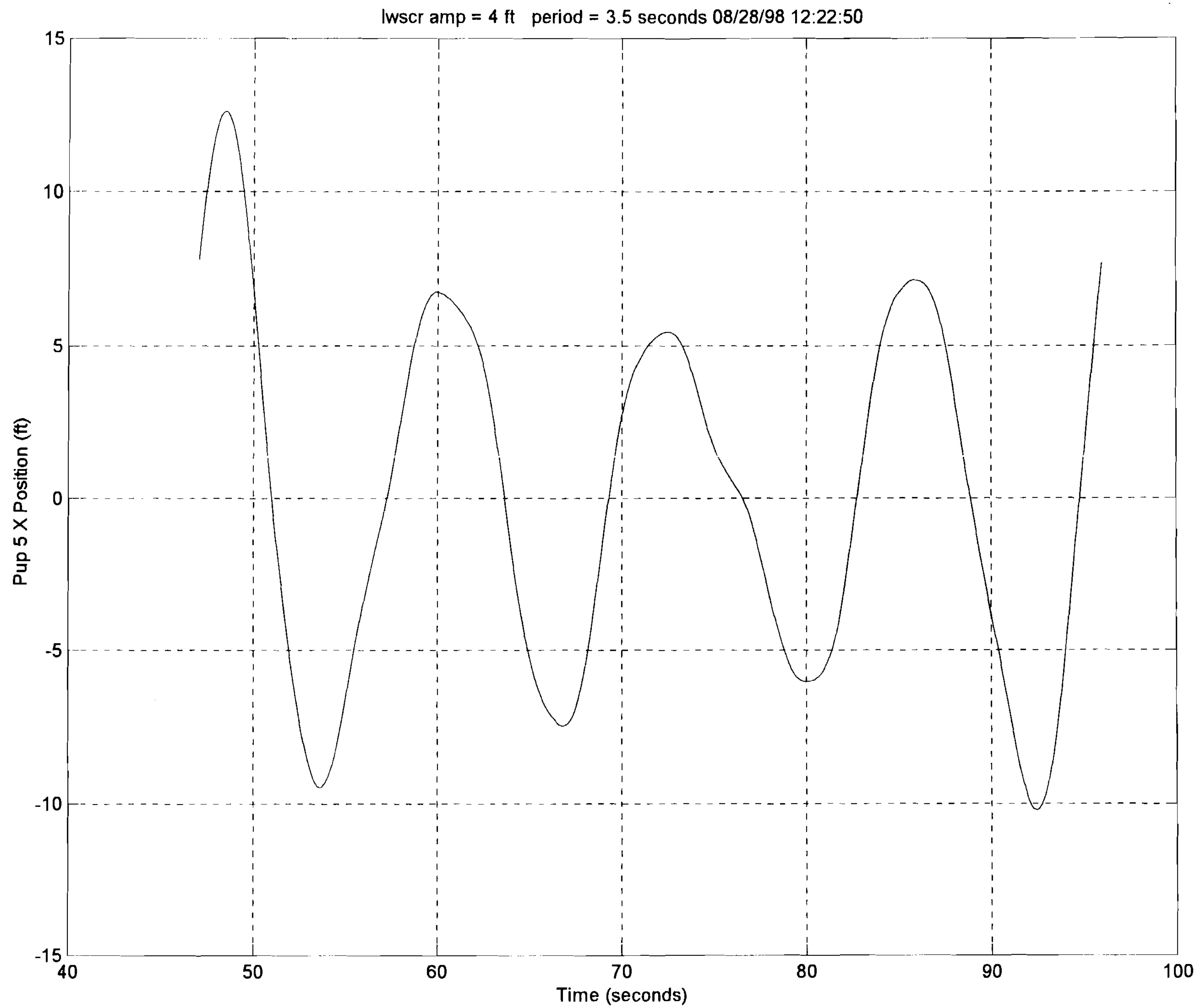

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 3 X Position (ft)
Time (seconds)
8
6
4
2
0
-2
-4
-6
-8
40
50
60
70
80
90
100

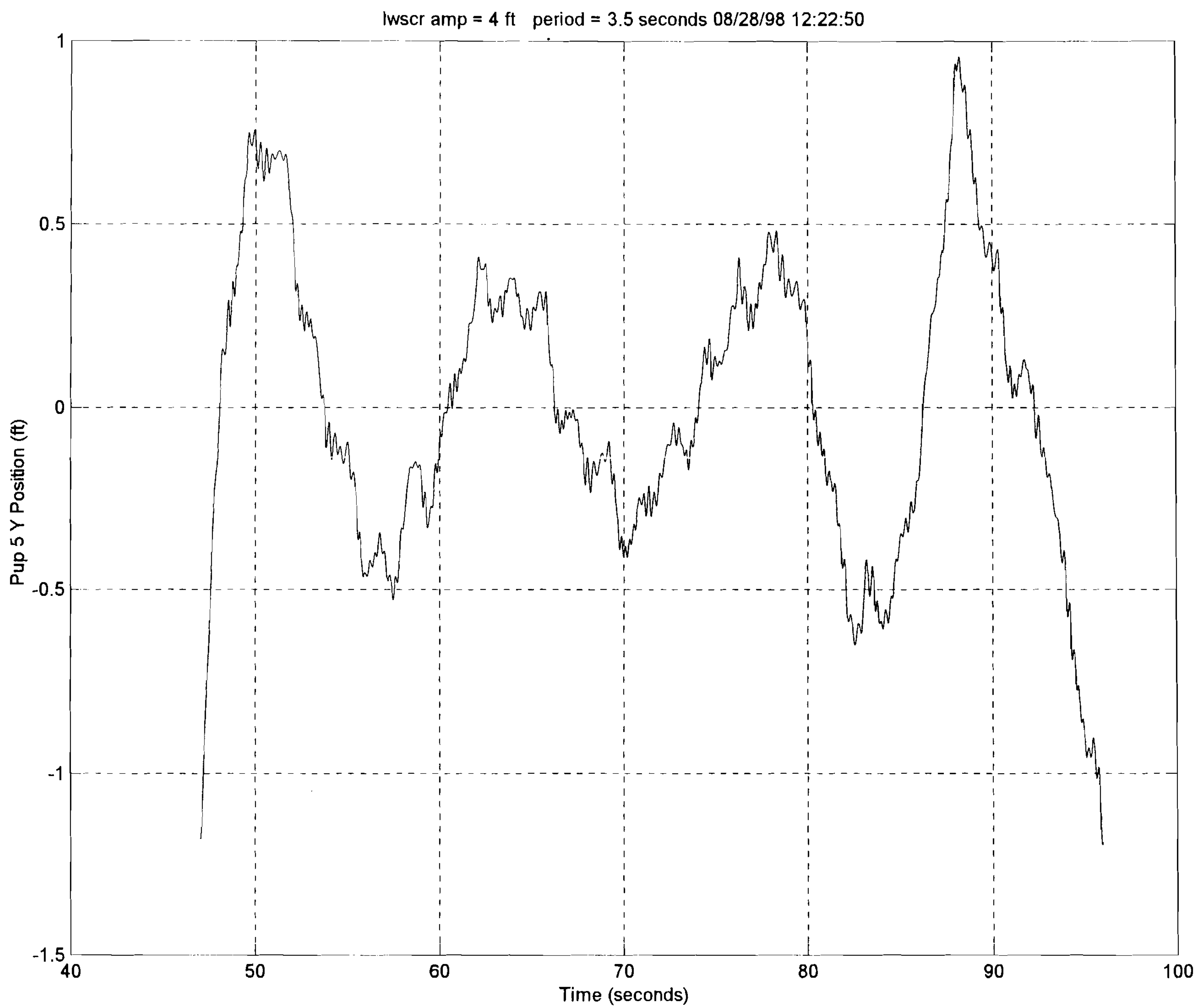

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 3 Y Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
40
50
60
70
80
90
100

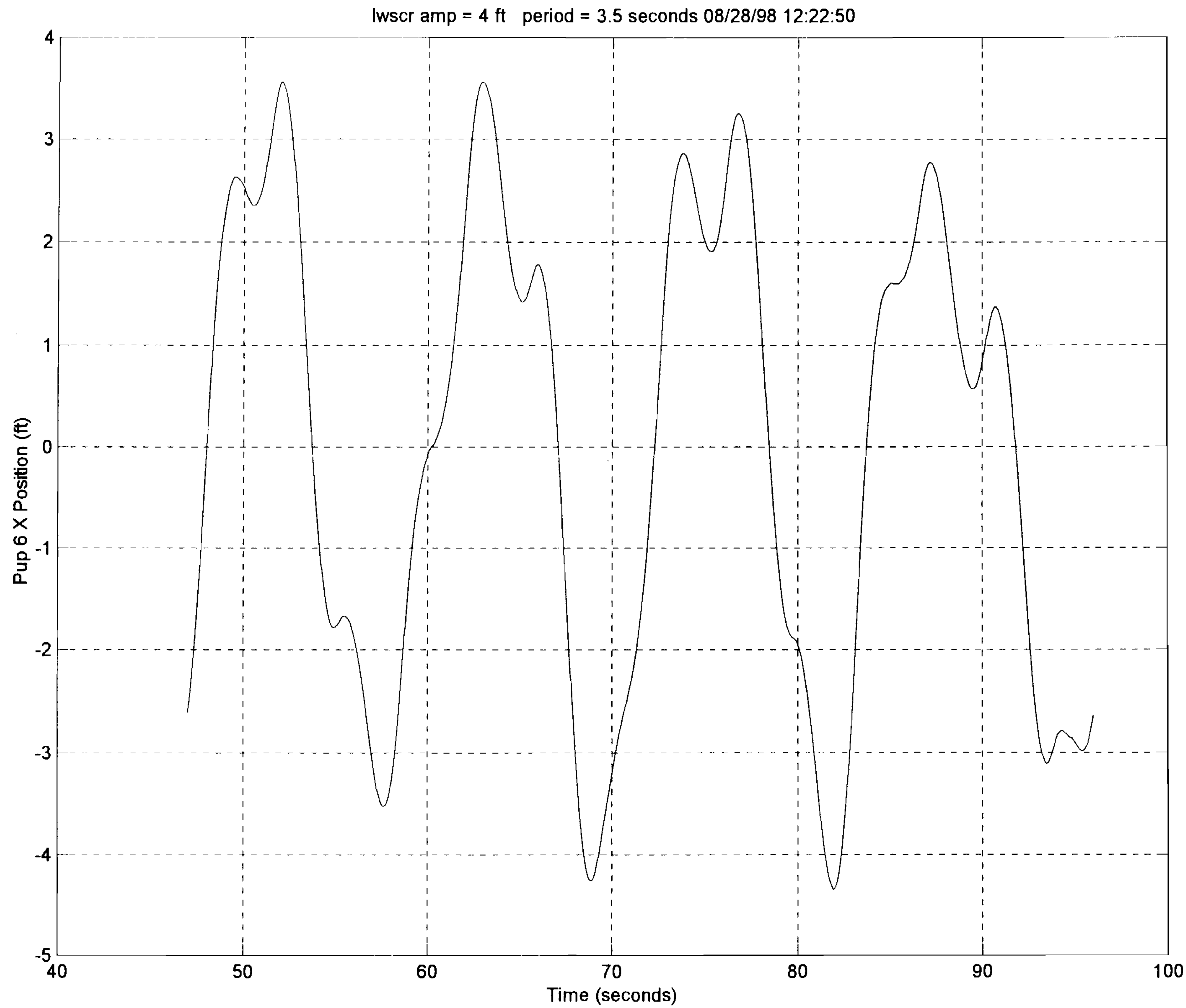

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 4 X Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
-1.5
40
50
60
70
80
90
100

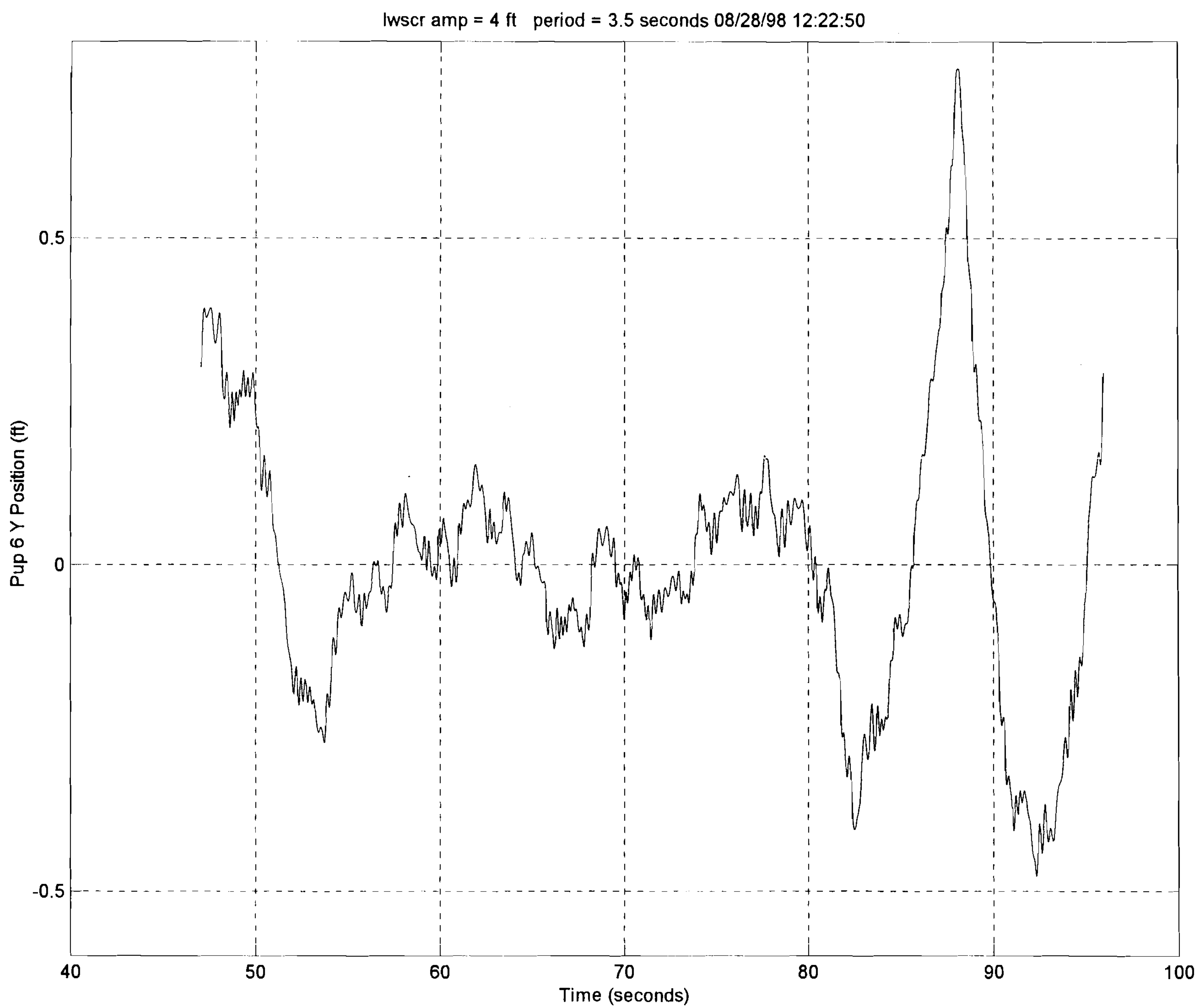


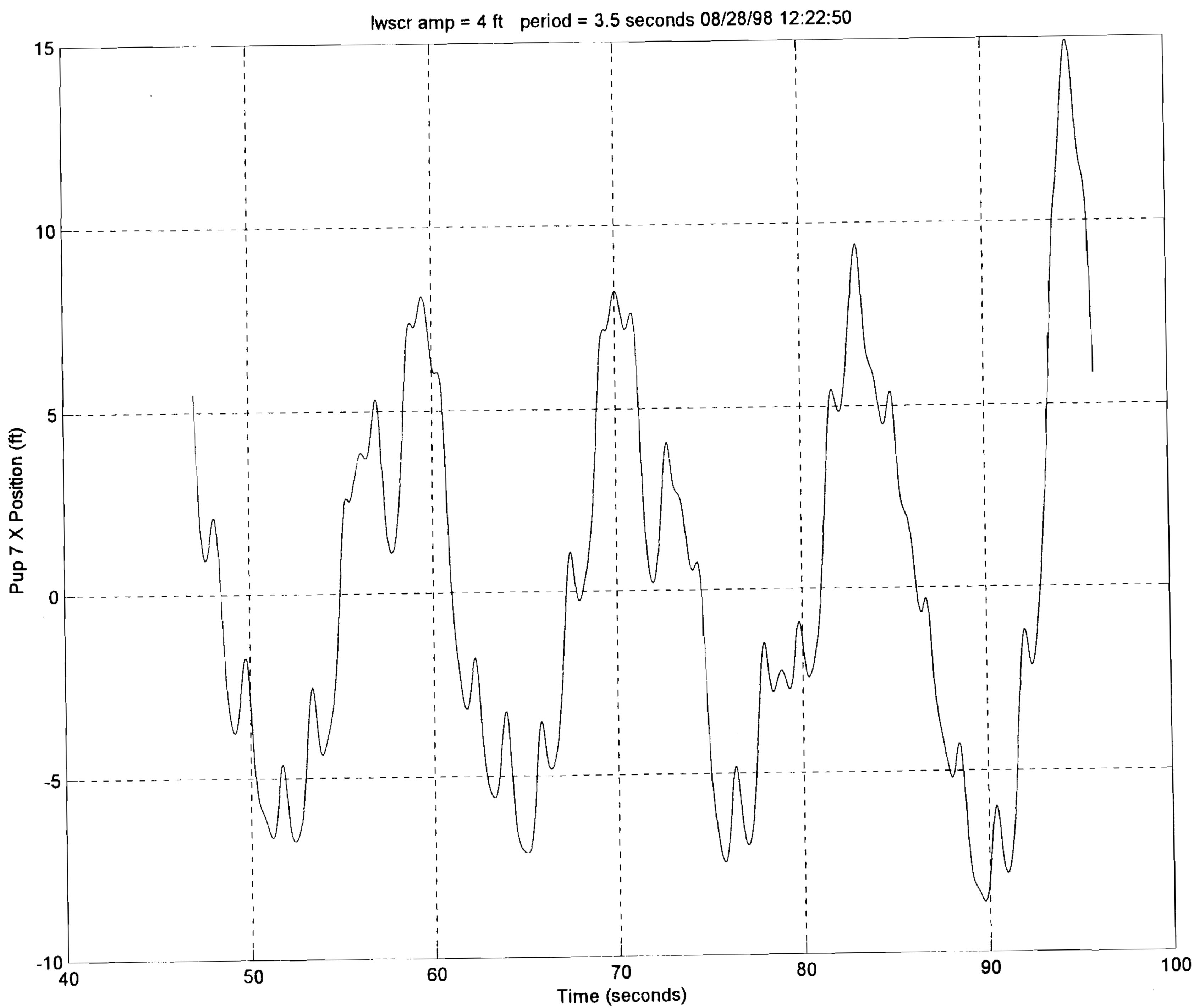
lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
Pup 4 Y Position (ft)
Time (seconds)
1.5
1
0.5
0
-0.5
-1
-1.5
40
50
60
70
80
90
100

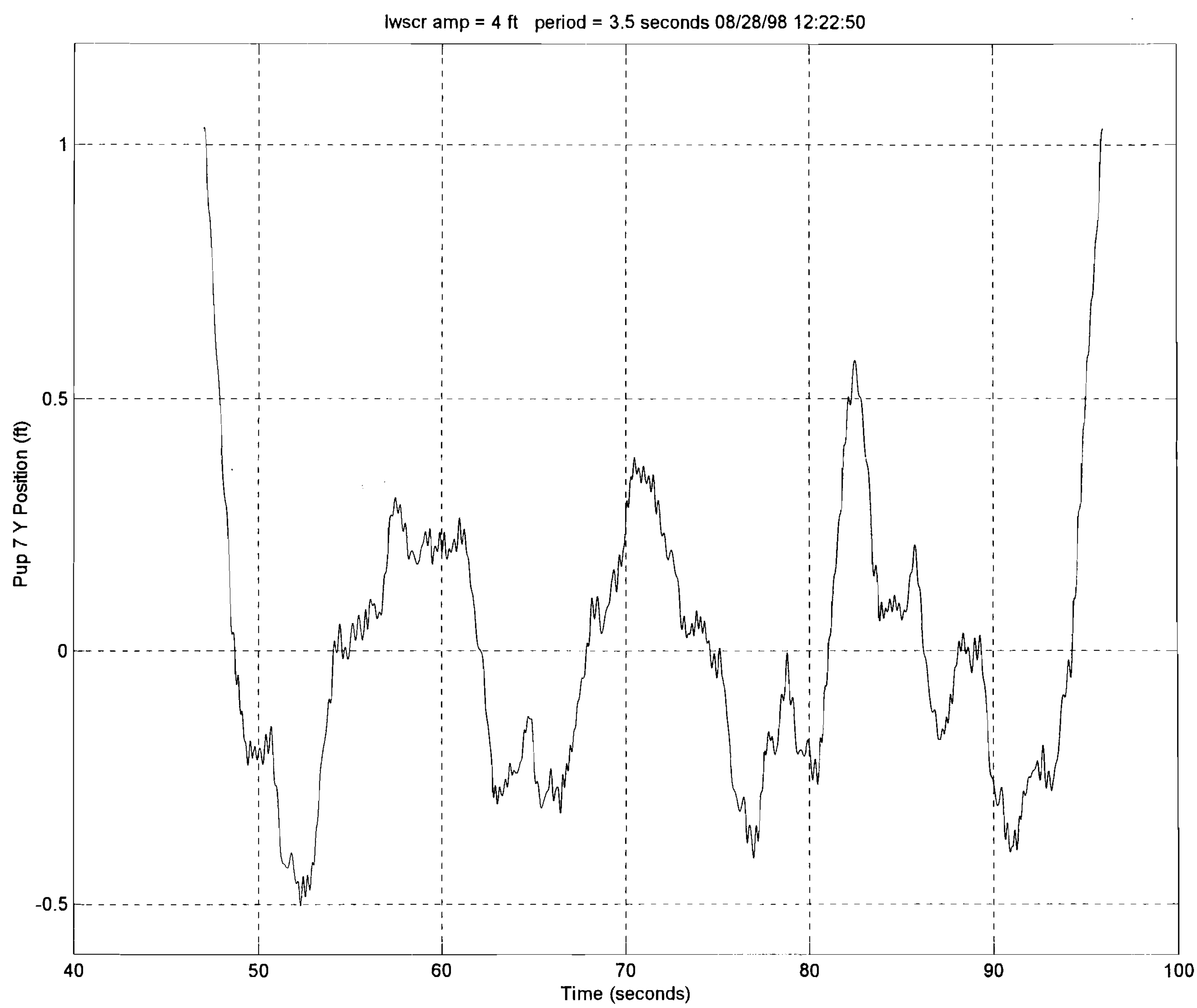

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 5 X Position (ft)
Time (seconds)
15
10
5
0
-5
-10
-15
40
50
60
70
80
90
100

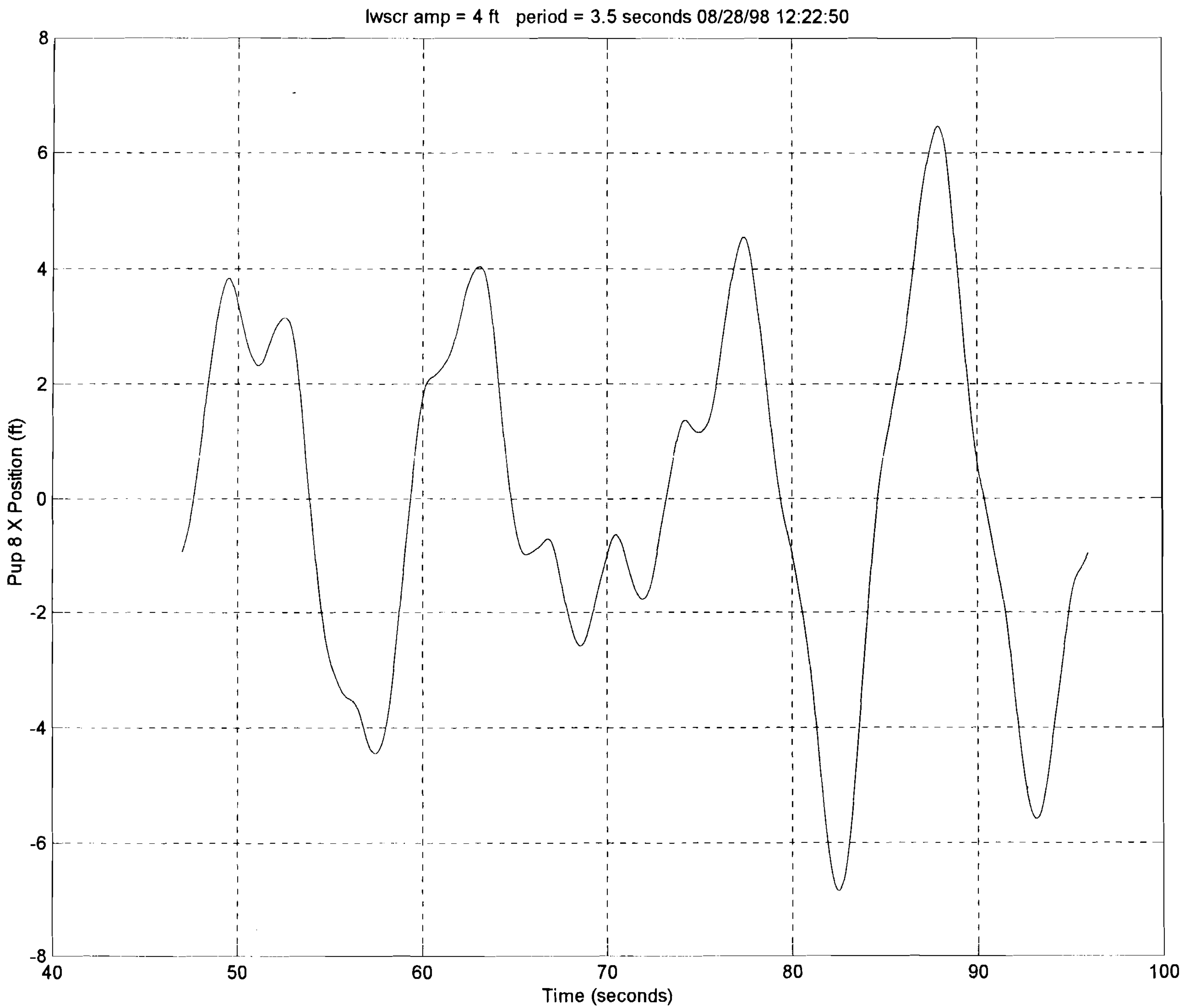

lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 5 Y Position (ft)
1
0.5
0
-0.5
-1
-1.5
40
50
60
70
80
90
100
Time (seconds)

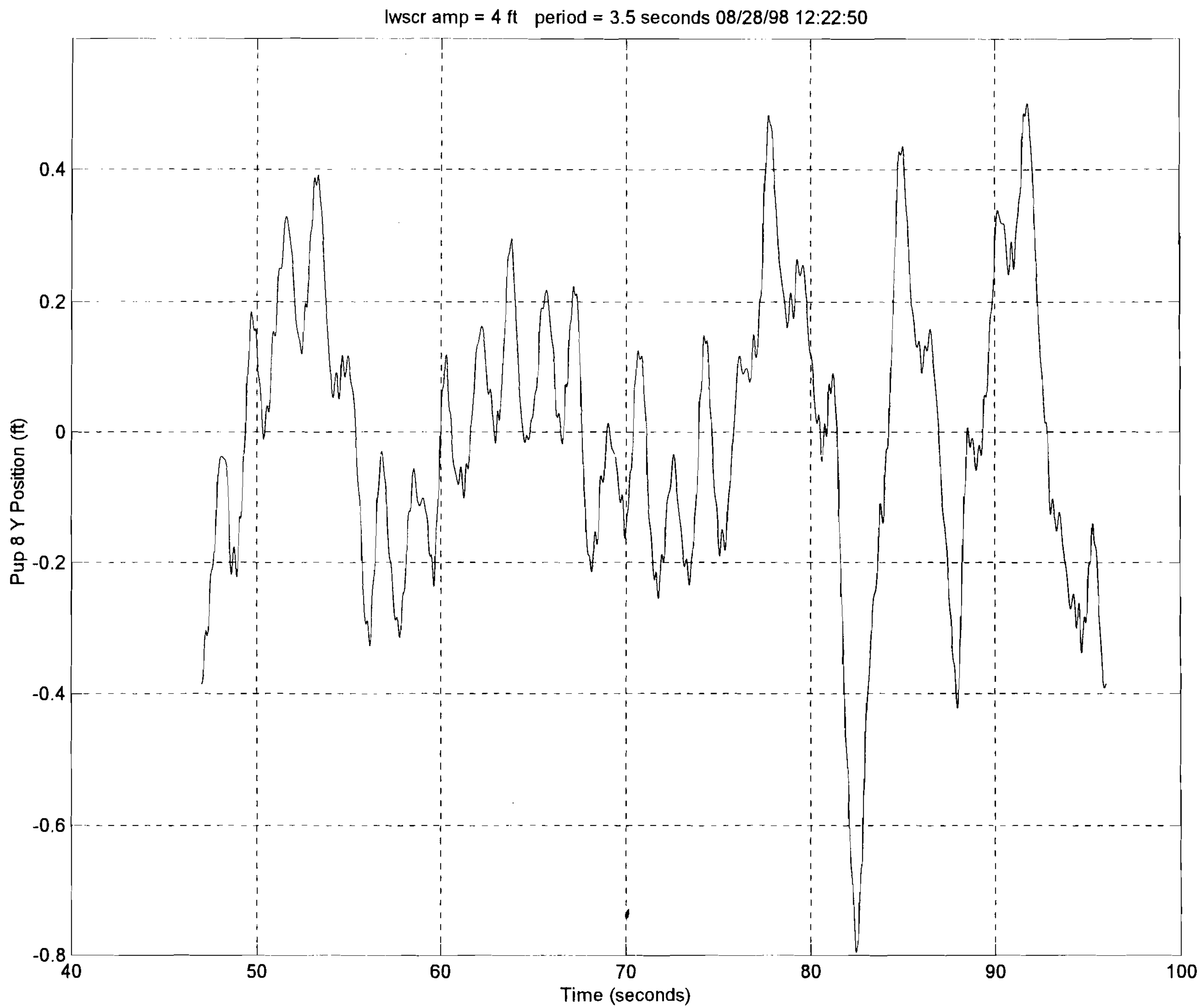

lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
Pup 6 X Position (ft)
Time (seconds)
4
3
2
1
0
-1
-2
-3
-4
-5
40
50
60
70
80
90
100


lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
Pup 6 Y Position (ft)
0.5
0
-0.5
40
50
60
70
80
90
100
Time (seconds)


lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 7 X Position (ft)
Time (seconds)
15
10
5
0
-5
-10
40
50
60
70
80
90
100


lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
Pup 7 Y Position (ft)
Time (seconds)
1
0.5
0
-0.5
40
50
60
70
80
90
100


lwscr amp = 4 ft   period = 3.5 seconds 08/28/98 12:22:50
8
6
4
2
0
-2
-4
-6
-8
Pup 8 X Position (ft)
40
50
60
70
80
90
100
Time (seconds)


lwscr amp = 4 ft period = 3.5 seconds 08/28/98 12:22:50
Pup 8 Y Position (ft)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
40
50
60
70
80
90
100
Time (seconds)

Appendix E

Calibration File Example

```
HCR JIP Monitoring System
CIO-DAS08 14 300 IRQ7 8.319735 330 Y
1                         <-- Number of Secondary Devices Following
SER-STIM 64 COM2 57600 nodeid.txt chancdw.txt
126                       <-- Number of Derived Channels
40.000000                         <-- SampleRate (Hz)
S                         <-- Storage Mode: (C)ontinuous; (T)hreshold; (O)p Control; (I)nterval; (S)tart/Stop
0                         <-- Storage Length (minutes): Threshold & Operator Control Storage Mode only
0                         <-- Interval Modulus (every Nth Process Interval) - Interval Storage mode only
Y                         <-- Statistical Calculations - (Y)es or (N)o
N                         <-- Statistical Threshold Checking - (Y)es or (N)o - Continue & Interval mode only
0                         <-- Number of sample to skip when plotting (0 for no skips)
5                         <-- Process Interval (1,2,3,4,5,6,10,12,15,20,30,60)
N                         <-- Transmit Data COM2 - (Y)es or (N)o
0                         <-- Number of samples to skip when transmitting (0 for no skips)
Y                         <-- Store SYSTEM log entries - (Y)es or (N)o
c:\hcrdata       <-- Data Storage Path
```

CH#	<-CHANNEL NAME----------->	<UNITS-->	<-SLOPE	INTERCEPT	MAXSCALE	MINSCALE	DELTA	STAT	TX	THRESHOLD	TRIGGER
1	Actuator Load	lbs	-2.65350000	5450.800000	5500.0	-5500.0	10.000	DA	0	0.000	
2	Pipe Pitch	deg	0.01488969	-30.145012	30.0	-30.0	2.000	DA	0	0.000	
3	Pipe Pitch Rate	deg/s	0.01488969	-30.145012	30.0	-30.0	2.000	DA	0	0.000	
4	Pipe Roll	deg	-0.01495879	29.774636	30.0	-30.0	2.000	DA	0	0.000	
5	Pipe Roll Rate	deg/s	-0.01495879	29.774636	30.0	-30.0	2.000	DA	0	0.000	
6	Accuator Heave Acc	ft/s^2	0.03322709	-100.065923	64.3	-64.3	10.000	DA	0	0.000	
7	Barge Roll	deg	0.01471440	-30.198833	30.0	-30.0	5.000	DA	0	0.000	
8	Barge Roll Rate	deg/s	0.01471440	-30.198833	100.0	-100.0	2.000	DA	0	0.000	
9	Barge Pitch	deg	-0.01476448	29.852142	30.0	-30.0	5.000	DA	0	0.000	
10	Barge Pitch Rate	deg/s	-0.01476448	29.852142	30.0	-30.0	2.000	DA	0	0.000	
11	Barge Surge Acc	ft/s^2	-0.03368494	69.222543	64.3	-64.3	10.000	DA	0	0.000	
12	Barge Sway Acc	ft/s^2	-0.03390770	69.111356	64.3	-64.3	10.000	DA	0	0.000	
13	Barge Heave Acc	ft/s^2	0.03402365	-101.797669	64.3	-64.3	10.000	DA	0	0.000	
14	Empty Channel	lbs	1.00000000	0.000000	4096.0	0.0	2.000	DA	0	0.000	
15	PUP 1 Acc Y Top	ft/s^2	-0.05453500	112.390000	120.0	-120.0	2.000	DA	0	0.000	
16	PUP 1 Acc X Top	ft/s^2	0.05331600	-111.920000	120.0	-120.0	2.000	DA	0	0.000	
17	PUP 1 Bending X	ft-lbs	-0.19290430	394.480030	600.0	-600.0	2.000	DA	0	0.000	
18	PUP 1 Bending Y	ft-lbs	-0.19452980	398.832440	600.0	-600.0	2.000	DA	0	0.000	
19	PUP 1 Tension	lbs	-2.28124350	4779.162600	1000.0	-1000.0	2.000	DA	0	0.000	
20	PUP 1 Acc Y Bot	ft/s^2	0.05552800	-113.450000	120.0	-120.0	2.000	DA	0	0.000	
21	PUP 1 Acc X Bot	ft/s^2	0.05370400	-109.810000	120.0	-120.0	2.000	DA	0	0.000	
22	PUP 1 Temperature	degC	-0.01679936	60.138535	59.4	-9.4	2.000	DA	0	0.000	
23	PUP 2 Acc Y Top	ft/s^2	-0.05443600	110.940000	120.0	-120.0	2.000	DA	0	0.000	
24	PUP 2 Acc X Top	ft/s^2	0.05254200	-110.940000	120.0	-120.0	2.000	DA	0	0.000	
25	PUP 2 Bending X	ft-lbs	-0.19612230	402.003900	600.0	-600.0	2.000	DA	0	0.000	
26	PUP 2 Bending Y	ft-lbs	-0.19929140	408.936500	600.0	-600.0	2.000	DA	0	0.000	
27	PUP 2 Tension	lbs	-2.28819440	4725.140470	1000.0	-1000.0	2.000	DA	0	0.000	
28	PUP 2 Acc Y Bot	ft/s^2	0.05340300	-108.840000	120.0	-120.0	2.000	DA	0	0.000	
29	PUP 2 Acc X Bot	ft/s^2	0.05355900	-108.270000	120.0	-120.0	2.000	DA	0	0.000	
30	PUP 2 Temperature	degC	-0.01685304	60.733866	59.4	-9.4	2.000	DA	0	0.000	
31	PUP 3 Acc Y Top	ft/s^2	0.05483300	-112.050000	120.0	-120.0	2.000	DA	0	0.000	
32	PUP 3 Acc X Top	ft/s^2	0.05557200	-114.520000	120.0	-120.0	2.000	DA	0	0.000	
33	PUP 3 Bending X	ft-lbs	-0.19100180	389.925700	600.0	-600.0	2.000	DA	0	0.000	
34	PUP 3 Bending Y	ft-lbs	-0.19487710	401.057000	600.0	-600.0	2.000	DA	0	0.000	
35	PUP 3 Tension	lbs	-2.21248070	4529.233500	1000.0	-1000.0	2.000	DA	0	0.000	
36	PUP 3 Acc Y Bot	ft/s^2	-0.05426500	111.930000	120.0	-120.0	2.000	DA	0	0.000	
37	PUP 3 Acc X Bot	ft/s^2	0.05379700	-110.560000	120.0	-120.0	2.000	DA	0	0.000	
38	PUP 3 Temperature	degC	-0.01679936	59.802548	59.4	-9.4	2.000	DA	0	0.000	
39	PUP 4 Acc Y Top	ft/s^2	0.05278000	-108.480000	120.0	-120.0	2.000	DA	0	0.000	
40	PUP 4 Acc X Top	ft/s^2	0.05532100	-112.600000	120.0	-120.0	2.000	DA	0	0.000	
41	PUP 4 Bending X	ft-lbs	-0.19956840	409.124700	600.0	-600.0	2.000	DA	0	0.000	
42	PUP 4 Bending Y	ft-lbs	-0.19634320	399.371500	600.0	-600.0	2.000	DA	0	0.000	
43	PUP 4 Tension	lbs	-2.31351650	4813.546000	1000.0	-1000.0	2.000	DA	0	0.000	
44	PUP 4 Acc Y Bot	ft/s^2	-0.05350500	109.510000	120.0	-120.0	2.000	DA	0	0.000	
45	PUP 4 Acc X Bot	ft/s^2	0.05260600	-107.100000	120.0	-120.0	2.000	DA	0	0.000	
46	PUP 4 Temperature	degC	-0.01697506	59.609010	59.4	-9.4	2.000	DA	0	0.000	
47	PUP 5 Acc Y Top	ft/s^2	0.05349100	-109.660000	120.0	-120.0	2.000	DA	0	0.000	
48	PUP 5 Acc X Top	ft/s^2	0.05488100	-112.700000	120.0	-120.0	2.000	DA	0	0.000	
49	PUP 5 Bending X	ft-lbs	-0.19660670	401.967100	600.0	-600.0	2.000	DA	0	0.000	
50	PUP 5 Bending Y	ft-lbs	-0.19710000	402.816100	600.0	-600.0	2.000	DA	0	0.000	
51	PUP 5 Tension	lbs	-2.37081810	4995.134000	1000.0	-1000.0	2.000	DA	0	0.000	
52	PUP 5 Acc Y Bot	ft/s^2	-0.05346800	109.450000	120.0	-120.0	2.000	DA	0	0.000	
53	PUP 5 Acc X Bot	ft/s^2	0.05261200	-105.020000	120.0	-120.0	2.000	DA	0	0.000	
54	PUP 5 Temperature	degC	-0.01674603	59.881905	59.4	-9.4	2.000	DA	0	0.000	
55	PUP 6 Acc Y Top	ft/s^2	0.05230500	-106.240000	120.0	-120.0	2.000	DA	0	0.000	
56	PUP 6 Acc X Top	ft/s^2	0.05338800	-110.060000	120.0	-120.0	2.000	DA	0	0.000	
57	PUP 6 Bending X	ft-lbs	-0.19728750	403.913200	600.0	-600.0	2.000	DA	0	0.000	
58	PUP 6 Bending Y	ft-lbs	-0.19604970	403.143600	600.0	-600.0	2.000	DA	0	0.000	
59	PUP 6 Tension	lbs	-2.34090740	4836.960000	1000.0	-1000.0	2.000	DA	0	0.000	
60	PUP 6 Acc Y Bot	ft/s^2	-0.05397300	112.420000	120.0	-120.0	2.000	DA	0	0.000	

61	PUP 6 Acc X Bot	ft/s^2	0.05376100	-110.570000	120.0	-120.0	2.000	DA	0	0.000
62	PUP 6 Temperature	degC	-0.01671949	60.523296	59.4	-9.4	2.000	DA	0	0.000
63	PUP 7 Acc Y Top	ft/s^2	0.05403000	-112.390000	120.0	-120.0	2.000	DA	0	0.000
64	PUP 7 Failed X Top	ft/s^2	0.55259000	-113.210000	120.0	-120.0	2.000	DA	0	0.000
65	PUP 7 Bending X	ft-lbs	-0.21199280	435.251413	600.0	-600.0	2.000	DA	0	0.000
66	PUP 7 Bending Y	ft-lbs	-0.19400710	398.407404	600.0	-600.0	2.000	DA	0	0.000
67	PUP 7 Tension	lbs	-2.28819440	4725.140470	1000.0	-1000.0	2.000	DA	0	0.000
68	PUP 7 Acc Y Bot	ft/s^2	-0.05340300	108.840000	120.0	-120.0	2.000	DA	0	0.000
69	PUP 7 Acc X Bot	ft/s^2	0.05355900	-108.270000	120.0	-120.0	2.000	DA	0	0.000
70	PUP 7 Temperature	degC	-0.01679936	59.466561	59.4	-9.4	2.000	DA	0	0.000
71	PUP 8 Acc Y Top	ft/s^2	0.05434300	-112.160000	120.0	-120.0	2.000	DA	0	0.000
72	PUP 8 Acc X Top	ft/s^2	0.05211100	-107.320000	120.0	-120.0	2.000	DA	0	0.000
73	PUP 8 Bending X	ft-lbs	-0.19479080	399.144930	600.0	-600.0	2.000	DA	0	0.000
74	PUP 8 Bending Y	ft-lbs	-0.20505080	418.713740	600.0	-600.0	2.000	DA	0	0.000
75	PUP 8 Tension	lbs	-2.29675900	4676.315000	1000.0	-1000.0	2.000	DA	0	0.000
76	PUP 8 Acc Y Bot	ft/s^2	-0.05536300	112.920000	120.0	-1200.0	2.000	DA	0	0.000
77	PUP 8 Acc X Bot	ft/s^2	0.05510000	-113.510000	120.0	-1200.0	2.000	DA	0	0.000
78	PUP 8 Temperature	degC	-0.01674603	59.881905	59.4	-9.4	2.000	DA	0	0.000
-1	Actuator Heave Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-2	Barge Surge Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-3	Barge Sway Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-4	Barge Heave Acc NOG	ft/s^2	1.00000000	0.000000	64.3	-64.3	10.000	DA	0	0.000
-5	PUP 1 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-6	PUP 1 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-7	PUP 1 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-8	PUP 1 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-9	PUP 1 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-10	PUP 1 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-11	PUP 1 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-12	PUP 1 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-13	PUP 1 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-14	PUP 1 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-15	PUP 2 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-16	PUP 2 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-17	PUP 2 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-18	PUP 2 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-19	PUP 2 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-20	PUP 2 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-21	PUP 2 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-22	PUP 2 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-23	PUP 2 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-24	PUP 2 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-25	PUP 3 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-26	PUP 3 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-27	PUP 3 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-28	PUP 3 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-29	PUP 3 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-30	PUP 3 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-31	PUP 3 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-32	PUP 3 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-33	PUP 3 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-34	PUP 3 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-35	PUP 4 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-36	PUP 4 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-37	PUP 4 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-38	PUP 4 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-39	PUP 4 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-40	PUP 4 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-41	PUP 4 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-42	PUP 4 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-43	PUP 4 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-44	PUP 4 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-45	PUP 5 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-46	PUP 5 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-47	PUP 5 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-48	PUP 5 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-49	PUP 5 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-50	PUP 5 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-51	PUP 5 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-52	PUP 5 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-53	PUP 5 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-54	PUP 5 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-55	PUP 6 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-56	PUP 6 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-57	PUP 6 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-58	PUP 6 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-59	PUP 6 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-60	PUP 6 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-61	PUP 6 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-62	PUP 6 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000

-63	PUP 6 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-64	PUP 6 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-65	PUP 7 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-66	PUP 7 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-67	PUP 7 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-68	PUP 7 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-69	PUP 7 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-70	PUP 7 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-71	PUP 7 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-72	PUP 7 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-73	PUP 7 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-74	PUP 7 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-75	PUP 8 Top Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-76	PUP 8 Top X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-77	PUP 8 Bot Y Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-78	PUP 8 Bot X Acc COR	ft/s^2	1.00000000	0.000000	120.0	-120.0	1.000	DA	0	0.000
-79	PUP 8 Static Y Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-80	PUP 8 Static X Acc	ft/s^2	1.00000000	0.000000	40.0	-40.0	1.000	DA	0	0.000
-81	PUP 8 Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-82	PUP 8 Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-83	PUP 8 Bend Inplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-84	PUP 8 Bend Outplane	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-85	Pipe Pitch COR	deg	1.00000000	0.000000	30.0	-30.0	2.000	DA	0	0.000
-86	Pipe Roll COR	deg	1.00000000	0.000000	30.0	-30.0	2.000	DA	0	0.000
-87	PUP 1 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-88	PUP 1 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-89	PUP 1 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-90	PUP 1 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-91	PUP 1 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-92	PUP 2 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-93	PUP 2 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-94	PUP 2 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-95	PUP 2 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-96	PUP 2 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-97	PUP 3 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-98	PUP 3 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-99	PUP 3 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-100	PUP 3 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-101	PUP 3 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-102	PUP 4 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-103	PUP 4 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-104	PUP 4 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-105	PUP 4 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-106	PUP 4 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-107	PUP 5 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-108	PUP 5 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-109	PUP 5 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-110	PUP 5 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-111	PUP 5 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-112	PUP 6 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-113	PUP 6 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-114	PUP 6 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-115	PUP 6 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-116	PUP 6 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-117	PUP 7 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-118	PUP 7 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-119	PUP 7 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-120	PUP 7 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-121	PUP 7 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000
-122	PUP 8 Static Rotation	deg	1.00000000	0.000000	360.0	0.0	1.000	DA	0	0.000
-123	PUP 8 Static Tilt Inplane	deg	1.00000000	0.000000	90.0	-90.0	1.000	DA	0	0.000
-124	PUP 8 Bend Inplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-125	PUP 8 Bend Outplane COR	ft-lbs	1.00000000	0.000000	600.0	-600.0	2.000	DA	0	0.000
-126	PUP 8 Tension COR	lbs	1.00000000	0.000000	1000.0	-1000.0	2.000	DA	0	0.000

```
Notes:
    STAT has the following format: xy where
        x is the processing interval to use
            D - Display Stats
            P - PROCINT Stats
            T - Test Stats
        y is the statistic
            A - Average (mean)
            R - Standard deviation
            X - maXimum
            M - Minimum
            D - Double Amplitude Significant (4 X Stdev)
            S - Single Amplitude Significant (2 X Stdev)
      i.e. PA is the Average over the PROCINT processing interval
```

```
THRESHOLD is used for Threshold Storage Mode and Statistical Threshold
   Checking. When using Threshold Storage Mode, any channel that should
   be compared against the THRESHOLD needs to be followed by the letter
   'T'. When using Statistical Threshold Checking, any channel's statistics
   that should be compared against the THRESHOLD needs to be followed by a
   letter corresponding to the desired statistic (A,R,X,M,D and S). When
   more than one channel in selected, any one channel above the THRESHOLD
   will cause all channels to be saved.
```

Appendix F

Constants File Example

```
YTempSlope YTempRef XTempSlope XTempRef AxisAlign KeyAlign
0.0000     20.00    0.0000     20.00     1.0      -0.5          PUP 1 TOP
0.0000     20.00    0.0000     20.00     4.3       0.5        PUP 1 BOT
0.0000     20.00    0.0000     20.00    -3.2       2.3          PUP 2 TOP
0.0000     20.00    0.0000     20.00     0.0       0.1        PUP 2 BOT
0.0000     20.00    0.0000     20.00    -3.2       2.3          PUP 3 TOP
0.0000     20.00    0.0000     20.00     0.0       0.1        PUP 3 BOT
0.0000     20.00    0.0000     20.00    -0.6       1.2          PUP 4 TOP
0.0000     20.00    0.0000     20.00     3.0       0.0        PUP 4 BOT
0.0000     20.00    0.0000     20.00    -0.7       3.2          PUP 5 TOP
0.0000     20.00    0.0000     20.00     2.9      -1.9        PUP 5 BOT
0.0000     20.00    0.0000     20.00    -2.3       3.3          PUP 6 TOP
0.0000     20.00    0.0000     20.00     2.6      -0.5        PUP 6 BOT
0.0000     20.00    0.0000     20.00     0.7      -2.3          PUP 7 TOP
0.0000     20.00    0.0000     20.00     4.6      -2.5        PUP 7 BOT
0.0000     20.00    0.0000     20.00    -0.7       1.8          PUP 8 TOP
0.0000     20.00    0.0000     20.00     2.8      -2.7        PUP 8 BOT
7      Number of Filter Coefficients (B, A)
3.1607013395440475e-009  1.8964208037264285e-008  4.7410520093160713e-008
6.3214026790880951e-008  4.7410520093160713e-008  1.8964208037264285e-008
3.1607013395440475e-009
1.0000000000000000e+000 -5.6965607253643142e+000  1.3528498994105977e+001 -
1.7144063240960975e+001  1.2227073155879221e+001 -4.6531383854961224e+000
7.3819040412109871e-001
10.0    Pipe Top Rotation (deg)
Depth(feet) Rotation(deg) Tilt(deg)
101.0        351.0          41.0         PUP 1
102.0        352.0          42.0         PUP 2
103.0        353.0          43.0         PUP 3
104.0        354.0          44.0         PUP 4
105.0        355.0          45.0         PUP 5
106.0        356.0          46.0         PUP 6
107.0        357.0          47.0         PUP 7
108.0        358.0          48.0         PUP 8
```