APPENDIX D

BORING GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION PROCEDURES AND CALIBRATION RECORDS

GEOVision SUSPENSION PS SEISMIC LOGGER/RECORDER

CALIBRATION PROCEDURE

Reviewed 7/21/08

Objective

The timing/sampling accuracy of seismic recorders or data loggers is required for several GEOVision field procedures including Seismic Refraction, Downhole P-S Seismic Velocity Logging, and Suspension P-S Seismic Velocity Logging. This procedure describes the method for measuring the timing accuracy of a seismic data logger, such as the OYO Model 170 or OYO/Robertson Model 3403. The objective of this procedure is to verify that the timing accuracy of the recorder is accurate to within 1%.

Frequency of Calibration

The calibration of each GEOVision seismic data logger is twelve (12) months. In the case of rented seismic logger/recorders, calibration must be performed prior to use.

Test Equipment Required

The following equipment is required. Item #2 must have current NIST traceable calibration.

1. Function generator, Krohn Hite 5400B or equivalent
2. Frequency counter, HP 5315A or equivalent
3. Test cables, from item 1 to item 2, and from item 1 to subject data logger.

Procedure

This procedure is designed to be performed using the accompanying Suspension P-S Seismic Logger/Recorder Calibration Data Form with the same revision number. All data must be entered and the procedure signed by the technician performing the test.

1. Record all identification data on the form provided.
2. Connect function generator to data logger (such as OYO Model 170) using test cable
3. Connect the function generator to the frequency counter using test cable.
4. Set signal generator to target frequency specified on data form, 0.25 volt (amplitude is approximate, modify as necessary to yield less than full scale waveforms on

logger display) peak sine wave. Verify frequency using the counter and note actual frequency on the data form.

5. Set data logger to file length specified on data form and record a data file to disk. Note file name on data form.

6. Measure the duration of 9 complete sine wave cycles on the data file. This measurement must be made using the analysis program PSLOG.EXE version 1.00, and saved as a .sps pick file. Note the duration in milliseconds in the spaces provided on the data form. Calculate average recorded sine wave frequency for each channel pair (Hn, Hr, V) by dividing the duration by 9. Note the average frequency of each channel pair on the data form.

7. Repeat steps 4 through 6 until all target frequencies have been recorded, producing 6 separate data and pick files.

Criteria

The average frequency for the nine cycles (obtained by dividing 9 cycles by the duration in seconds) must be within plus or minus 1% of the actual frequency for each of the 6 records.

If the results are outside this range, the data logger must be marked with a GEOVision REJECT tag until it can be repaired and retested.

If results are acceptable affix label indicating the initials of the person performing the calibration, the date of calibration, and the due date for the next calibration (12 months).

Procedure Approval

Approved by:

John G. Diehl	President
Name	Title
Signature	July 21, 2008
	Date

Calibration Laboratory Approval (if required):

Name	Title
Signature	Date

EDISON ESI℠

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Calibration Report

TEST NUMBER 573794

Metrology
7300 Fenwick Lane
Westminster, CA 92683
Toll Free: 866-723-2257

GEOVision Geophysical Services
1124 Olympic Drive
Corona, CA 92881-3390

NVLAP®
Lab Code: 105014-0

Manufacturer:	Oyo
Model Number:	3403
Description:	Unit, Suspension Telemetry
Asset Number:	160023
Serial Number:	160023
Cal. Procedure:	Customer
PO Number:	9200-090716-01

Ambient Temperature:	23° C
Ambient Humidity:	56% RH
Condition As Found:	In Tolerance
Condition As Left:	In Tolerance - No Adjustment
Calibration Date:	07/17/2009
Calibration Due Date:	07/17/2010
Calibration Interval:	12 Months

Remarks:
The unit was calibrated with the customer's procedure and specification's which have been reviewed by Metrology Engineering and documented in SCE Document M013987. The data can be found on pages 2 and 3 of this report with the original observation data on page 4.

Standards Utilized

I.D. No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal	01/29/2009	07/29/2009
S1-01347	Hewlett Packard	3325A	Generator, Function, Synthesizer	05/04/2009	11/04/2009
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/24/2009	01/24/2010

Calibration Performed By:			Quality Reviewer:	
Branson, Craig A CXB	Metrologist	714-895-0714	Clarence E Stinson	7/17/09
Name	Title	Phone	Name	Date

This report may not be reproduced, except in full, without written permission of this laboratory. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government. The results stated in this report relate only to the items tested or calibrated. Measurements reported herein are traceable to SI units via national standards maintained by NIST. This laboratory and calibration are in compliance with NVLAP laboratory accreditation criteria established by NIST/NVLAP under the specific scope of accreditation for lab code 105014-0, and in compliance with ISO/IEC 17025:2005, ANSI/NCSL Z540-1-1994 and 10CFR50, Appendix B. Where uncertainties are provided, the uncertainty stated is the expanded uncertainty of the measurement, where k=2.

Custom Specification Report

Test No. 573794
Asset No. 160023

Oyo 3403 Unit, Suspension Telemetry,

Page 2 of 4

STEP NUM	FUNCTION TESTED	NOMINAL VALUE	AS FOUND	AS LEFT	Out of Tol	CALIBRATION TOLERANCE
	CH HN Frequency Sine Wave	50.00 Hz	50.00	Same		49.50 to 50.50 Hz [EMU 0.000250]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500]
	|	200.0 Hz	200.0	Same		198.0 to 202.0 Hz [EMU 0.001000]
	|	500.0 Hz	500.0	Same		495.0 to 505.0 Hz [EMU 0.002500]
	|	1000 Hz	1000	Same		990 to 1010 Hz [EMU 0.005000]
	|	2000 Hz	2000	Same		1980 to 2020 Hz [EMU 0.010000]
	CH HR Frequency Sine Wave	50.00 Hz	50.00	Same		49.50 to 50.50 Hz [EMU 0.000250]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500]
	|	200.0 Hz	200.0	Same		198.0 to 202.0 Hz [EMU 0.001000]
	|	500.0 Hz	500.0	Same		495.0 to 505.0 Hz [EMU 0.002500]
	|	1000 Hz	1000	Same		990 to 1010 Hz [EMU 0.005000]
	|	2000 Hz	2000	Same		1980 to 2020 Hz [EMU 0.010000]
	CH V Frequency Sine Wave	50.00 Hz	50.00	Same		49.50 to 50.50 Hz [EMU 0.000250]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500]
	|	200.0 Hz	200.0	Same		198.0 to 202.0 Hz [EMU 0.001000]
	|	500.0 Hz	500.0	Same		495.0 to 505.0 Hz [EMU 0.002500]

Remarks:

MudCats CPM: Version 2.2.2 (Professional)
Src DUI: {9548AF3D-C74D-4C9F-AEEF-21EF560BC451} (c)
Doc DUI: {AB10F47E-4C5F-4650-91CB-A05A72E361C1} (o)

ATTACHMENT 2
Page 1 of 2

Customer

Custom Specification Report

Test No. 573794
Asset No. 160023

Oyo 3403 Unit, Suspension Telemetry,

Page 3 of 4

STEP NUM	FUNCTION TESTED	NOMINAL VALUE	AS FOUND	AS LEFT	Out of Tol	CALIBRATION TOLERANCE
	CH V Frequency Sine Wave	1000 Hz	998.9	Same		990 to 1010 Hz [EMU 0.005000]
	|	2000 Hz	2000	Same		1980 to 2020 Hz [EMU 0.010000]

Remarks:

MudCats CPM: Version 2.2.2 (Professional)
Src DUI: {9548AF3D-C74D-4C9F-AEEF-21EF560BC451} (c)
Doc DUI: {AB10F47E-4C5F-4650-91CB-A05A72E361C1} (o)

ATTACHMENT 2
Page 2 of 2

Customer

Pg 4 of 4
160023
573794

GEOVision geophysical services

SUSPENSION PS SEISMIC LOGGER/RECORDER CALIBRATION DATA FORM

INSTRUMENT DATA

System mfg.:	Oyo	Model no.:	3403
Serial no.:	160023	Calibration date:	7/17/2009
By:	Craig Branson	Due date:	7/17/2010
Counter mfg.:	Hewlett-Packard	Model no.:	5335A
Serial no.:	2626A09881	Calibration date:	1/29/2009
By:	SCE #S1-01252	Due date:	7/29/2009
Signal generator mfg.:	Hewlett-Packard	Model no.:	3325A
Serial no.:	2652A25647	Calibration date:	5/4/2009
By:	SCE #S1-01347	Due date:	11/4/2009

SYSTEM SETTINGS:

Gain:	8
Filter	10KHz
Range:	See sample period in table below
Delay:	0
Stack (1 std)	1
System date = correct date and time	7/17/2009 1019

PROCEDURE:

Set sine wave frequency to target frequency with amplitude of approximately 0.25 volt peak
Note actual frequency on data form.
Set sample period and record data file to disk. Note file name on data form.
Pick duration of 9 cycles using PSLOG.EXE program, note duration on data form, and save as .sps file. Calculate average frequency for each channel pair and note on data form.

Average frequency must be within +/- 1% of actual frequency at all data points.

Maximum error ((AVG-ACT)/ACT*100)% As found -0.11%. As left -0.11%.

Target Frequency (Hz)	Actual Frequency (Hz)	Sample Period (microS)	File Name	Time for 9 cycles Hn (msec)	Average Frequency Hn (Hz)	Time for 9 cycles Hr (msec)	Average Frequency Hr (Hz)	Time for 9 cycles V (msec)	Average Frequency V (Hz)
50.00	50.00	200	401	180.00	50.00	180.00	50.00	180.00	50.00
100.0	100.0	100	402	90.00	100.0	90.00	100.0	90.00	100.0
200.0	200.0	50	403	45.00	200.0	45.00	200.0	45.00	200.0
500.0	500.0	20	404	18.00	500.0	18.00	500.0	18.00	500.0
1000	1000	10	405	9.000	1000	9.000	1000	9.010	998.9
2000	2000	5	406	4.500	2000	4.500	2000	4.500	2000

Calibrated by:	Craig Branson	7/17/2009	Craig Branson
	Name	Date	Signature
Witnessed by:	Robert Steller	7/17/2009	
	Name	Date	Signature

Suspension PS Seismic Recorder/Logger Calibration Data Form Rev 2.0 July 21, 2008

MICRO PRECISION CALIBRATION, INC.
12686 HOOVER STREET
GARDEN GROVE CA. 92841-1823
714.901.5659

Certificate of Calibration

Date: 10/16/2009 **Lab #** AC-1274 **Certificate #: 749437**

Customer:
GEOVISION
1124 OLYMPIC DRIVE
CORONA, CA, 92881

Purchase Order:	9333-100601-001		
Work Order:	61143		
MPC Control #:	AM6767	Serial Number:	160023
Asset ID:	160023	Department:	N/A
Gage Type:	LOGGER	Performed By:	KYU HAN
Manufacturer:	OYO	Received Condition:	IN TOLERANCE
Model Number:	3403	Returned Condition:	IN TOLERANCE
Size:	N/A	Cal Date:	October 12, 2009
Temp./RH:	73 °F / 45 %	Cal. Interval:	12 MONTHS
		Cal. Due Date:	October 12, 2010

Found conditions meet or exceed manufacturer specifications.

***Calibration Notes:**

The UUT (unit under test) was calibrated using the customers procedures in our Garden Grove lab. The UUT was operated by the customers personnel and data collection was observed by MPC personnel. The UUT was found to be in tolerance to customer supplied specifications. The reference standards used are in complience with ISO/IEC 17025:2005, ISO9001:2000, ANSI/NCSL Z540-1-1994 and laboratory accreditiation for lab code 935.11. Frequency is accredited. Measurement uncertainity is 0.2 x E12 Hz. Please see attached data sheet.

Standards Used To Calibrate Equipment

I.D.	Description	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
AM4000	WAVEFORM GENERATOR	33250A	MY40000703	AGILENT	7/15/2010	662404
T1100	COUNTER	53131A	3546A09912	HEWLETT PACKARD	1/12/2010	646688

Calibrating Technician: KYU HAN

QC Approval: Tammy Webster

Unless Otherwise Noted, Uncertainty Estimated at >= 4 to 1. Uncertainties have been estimated at a 95 percent confidence level (k=2). Services rendered comply with ISO 17025:2005, ISO 9001:2000, ANSI/NCSL Z540-1, MPC Quality Manual, MPC CSD and with customer purchase order instructions.

Calibration cycles and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. The information on this report, pertains only to the instrument identified.

All standards are traceable to the National Institute of Standards and Technology (NIST). Services rendered include proper manufacture's service instructions and are warranted for no less than (30) days. This report may not be reproduced in part or in whole without the prior written approval of the issuing MPC lab.

Page 1 of 1

(CERT, Rev 0)

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GEOVision geophysical services

SUSPENSION PS SEISMIC LOGGER/RECORDER CALIBRATION DATA FORM

INSTRUMENT DATA

System mfg.:	Oyo	Model no.:	3403
Serial no.:	160023	Calibration date:	10/12/2009
By:	Charles Carter	Due date:	10/12/2010
Counter mfg.:	Hewlett-Packard	Model no.:	53131A
Serial no.:	3546a09912	Calibration date:	1/12/2009
By:	Microprecision	Due date:	1/12/2010
Signal generator mfg.:	Agilent	Model no.:	33250A
Serial no.:	MY40000703	Calibration date:	7/15/2009
By:	Microprecision	Due date:	7/15/2010

SYSTEM SETTINGS:

Gain:	2
Filter	10KHz
Range:	See sample period in table below
Delay:	0
Stack (1 std)	1
System date = correct date and time	10/12/2009

PROCEDURE:

Set sine wave frequency to target frequency with amplitude of approximately 0.25 volt peak
Note actual frequency on data form.
Set sample period and record data file to disk. Note file name on data form.
Pick duration of 9 cycles using PSLOG.EXE program, note duration on data form, and save as .sps file. Calculate average frequency for each channel pair and note on data form.

Average frequency must be within +/- 1% of actual frequency at all data points.

Maximum error ((AVG-ACT)/ACT*100)% As found + 0.20% As left + 0.20%

Target Frequency (Hz)	Actual Frequency (Hz)	Sample Period (microS)	File Name	Time for 9 cycles Hn (msec)	Average Frequency Hn (Hz)	Time for 9 cycles Hr (msec)	Average Frequency Hr (Hz)	Time for 9 cycles V (msec)	Average Frequency V (Hz)
50.00	50.00	200	2	180.2	49.94	179.8	50.06	180.2	49.94
100.0	100.0	100	3	90.00	100.0	90.10	99.9	90.00	100.0
200.0	200.0	50	4	44.95	200.2	44.95	200.2	44.95	200.2
500.0	500.0	20	5	18.00	500.0	18.00	500.0	18.00	500.0
1000	1000	10	6	9.000	1000	8.990	1001.1	9.000	1000.0
2000	2000	5	7	4.495	2002	4.505	1998	4.500	2000

Calibrated by:	Charles Carter	10/12/2009	Charles Carter
	Name	Date	Signature
Witnessed by:	Kyu Han	10/12/2009	
	Name	Date	Signature

Suspension PS Seismic Recorder/Logger Calibration Data Form Rev 2.0 July 21, 2008