725.1
L-211

POSITIONING OF
NORSKALD
WELL 34/10-3
FOR
STATOIL

Report No. 5698

March 1979

OD

Prepared by

A/S GEOTEAM
GAMLE DRAMMENSVEI 48
1320 STABEKK
NORWAY

Report No. 5698 Stabekk, 23 March 1979

Positioning of NORSKALD
Well 34/10-3
9 - 16 March 1979

Client: STATOIL

CONTENTS

APPENDICES

SYNOPSIS

For drilling Well 34/10-3 Norwegian Sector, the drill rig NORSKALD was positioned by A/S GEOTEAM 13 - 16 March 1979 utilizing a Magnavox MX-1502 Satellite Surveyor.

Well location at 1200 hrs 16 March 1979, referred to the European Datum 1950:

Latitude 61° 12' 49.48" N
Longitude 02° 11' 55.03" E

LOG SUMMARY

	GMT	
Mobilization, Tananger, Stavanger	2230	9 March 1979
Positioning system operational	1400	10 March 1979
Start of 3-D computations	2100	13 March 1979
End of 3-D computations	1200	16 March 1979
Arrival, Flesland, Bergen	1630	16 March 1979

SATELLITE POSITIONING

The final positioning was performed by a three-dimensional solution of data from several satellite passes. The observation of satellite passes started 2100 hrs 13 March 1979 and was completed 1200 hrs 16 March 1979.

Number of recorded satellite passes : 67
Number of passes accepted for 3-D computations : 57

The satellite antenna position determined by 57 passes, referred to the geodetic system WGS-72 is:

Latitude 61° 12' 48.47" N
Longitude 02° 11' 47.14" E

Antenna height: 64.4 metres (above the WGS-72 ellipsoide).

The distance from the satellite antenna to the anticipated well center and the perpendicular from the antenna to the rigs center line were measured by tape.

The rig heading read from the gyrocompass was 310 degrees. With these data the well center coordinates have been computed in WGS-72 as:

Latitude 61° 12' 47.49" N
Longitude 02° 11' 48.35" E

These coordinates were transformed to the European Datum 1950, International Spheroid, using formulae and transformation constants given by Naval Weapon Laboratories, U.S.A. The main transformation constants employed were: *(see note)

Δ X = 84 metres
Δ Y = 103 metres
Δ Z = 127 metres

(X, Y and Z constitute a righthand coordinate system fixed in the spheroid. X and Y lie in a plane parallel to the equator. X positive towards the Prime Meridian, and Y positive towards 90°E Longitude. Z is positive towards the North.)

The position for the well center, referred to the European Datum 1950 is:

	Geographic coordinates	UTM coordinates
Latitude	61° 12' 49.48" N	6787021 N
Longitude	02° 11' 55.03" E	456947 E

(The UTM coordinates refer to zone 31, with central meridian 3°E). This gives an offset of 21.7 m, 109° from the planned location fixed by Pulse 8 patterns 1-2 and 1-3.

Antenna height in European Datum was 35.4 metres. The altitude from sea level to the antenna was measured to 25.0 metres, thus the geoidal height is 10.4 metres.

NOTE.

It has recently become known that the positions obtained in the satellite system do not refer to the WGS-72, but the slightly different NWL-10D system. As suitable transformation procedures for this system has not yet been agreed, and to ensure consistence with earlier positioning in the area, the constants for WGS-72 have been applied.

ACCURACY OF SATELLITE POSITION

Based on the scatter of the positions derived from the different passes, a standard deviation of ± 3 metres on the latitude and ± 4 metres on the longitude are computed.

This way to determine the position accuracy does not include all error sources, and we believe the uncertainty of the satellite antenna to be ± 7 metres (RMS).

Correction from antenna position to well position may introduce an error of ± 1 metre due to uncertainty of rig heading.

Tests performed by A/S GEOTEAM at geodetic fix points in South Norway indicate inaccuracies of ± 5 metres in the transformation from the WGS-72 geodetic system to the European Datum 1950.

This gives a total RMS-error of ± 9 metres on the final position.

PULSE-8 POSITIONING

For comparison with the final satellite fixed position, Pulse-8 were recorded in the period 2200 hrs 13 March - 1100 hrs 15 March 1979.

As the station at Maloy was not in operation, the patterns 1-2 (Faroes) and 1-4 (Utsira) were used. For checking, the pattern 1-5 (Romoe) was also recorded.

For each pattern a total of 5000 readings were taken as ten times 500 readings. The resulting mean values are:

Pattern	Time difference	
1 - 2	11730.70	microseconds
1 - 4	34759.43	microseconds
1 - 5	48364.45	microseconds

Correction for the antenna offset was derived by the same procedure as described for the satellite antenna.

The position for the anticipated well center, fixed by pattern 1-2 and 1-4 is:

Geographic coordinates		UTM coordinates	
Latitude	61° 12' 49.72" N	6787028	N
Longitude	02° 11' 54.08" E	456933	E

(The UTM coordinates refer to zone 31, with central meridian 3°E).

This gives an offset of 16.0 metres 118 degrees from the satellite fixed position.

The pattern combination 1-2 and 1-5 give a position 5 metres from the one given above.

Corrections for fixed errors (c-o) were given by the Client. Those are listed below, compared with the values computed assuming that the satellite fixed position is true:
(Values in microseconds)

Pattern	Given by Client	Computed
1 - 2	0.00	+ 0.03
1 - 4	+ 0.16	+ 0.11
1 - 5	- 0.30	- 0.33

The positions are graphically presented in Appendix no. 5.

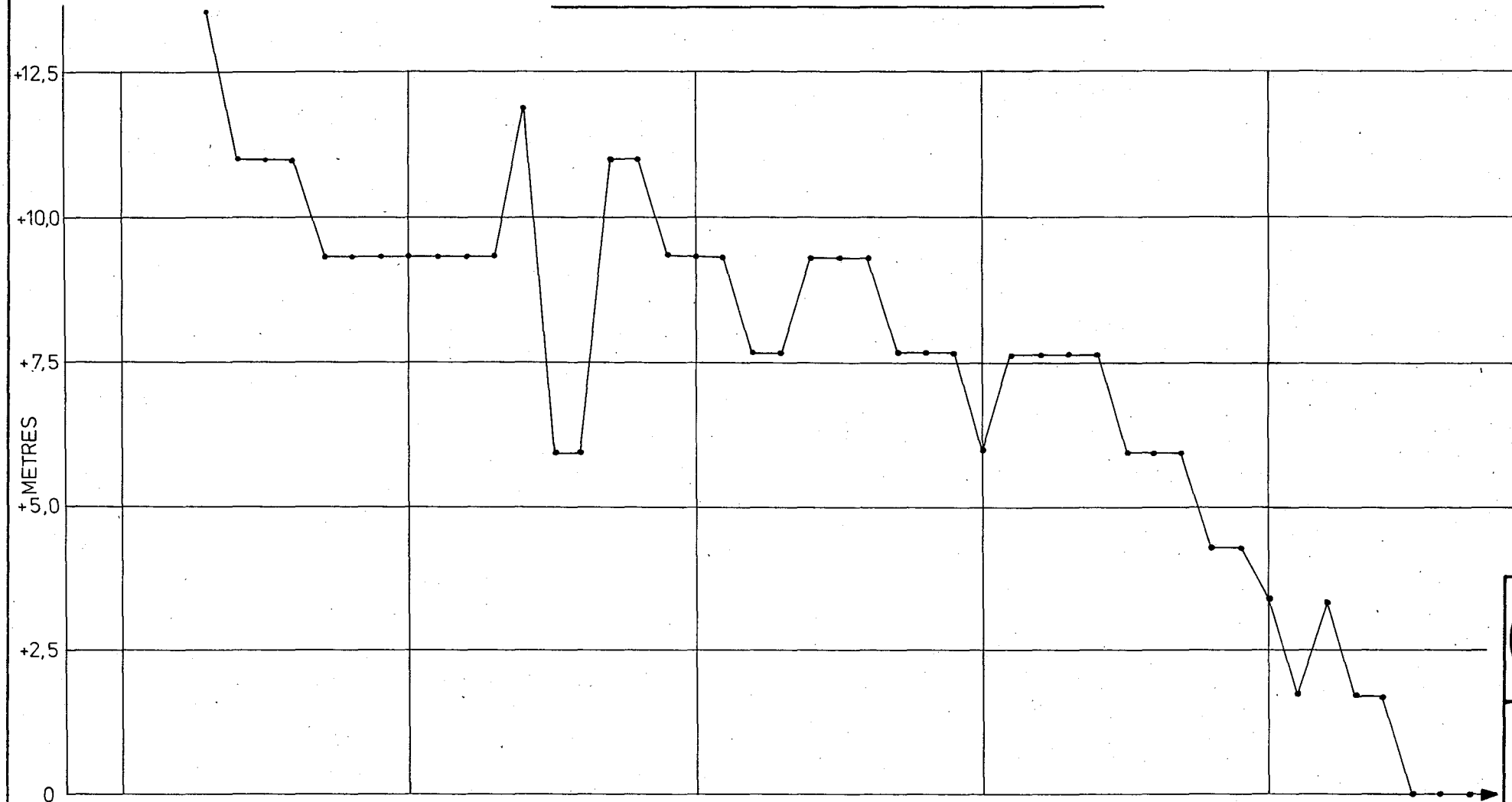
Stabekk, 23 March 1979

for A/S G E O T E A M

Jon Falkenberg

Leif Olav Horten

CONVERGENCE OF LATITUDE SOLUTION



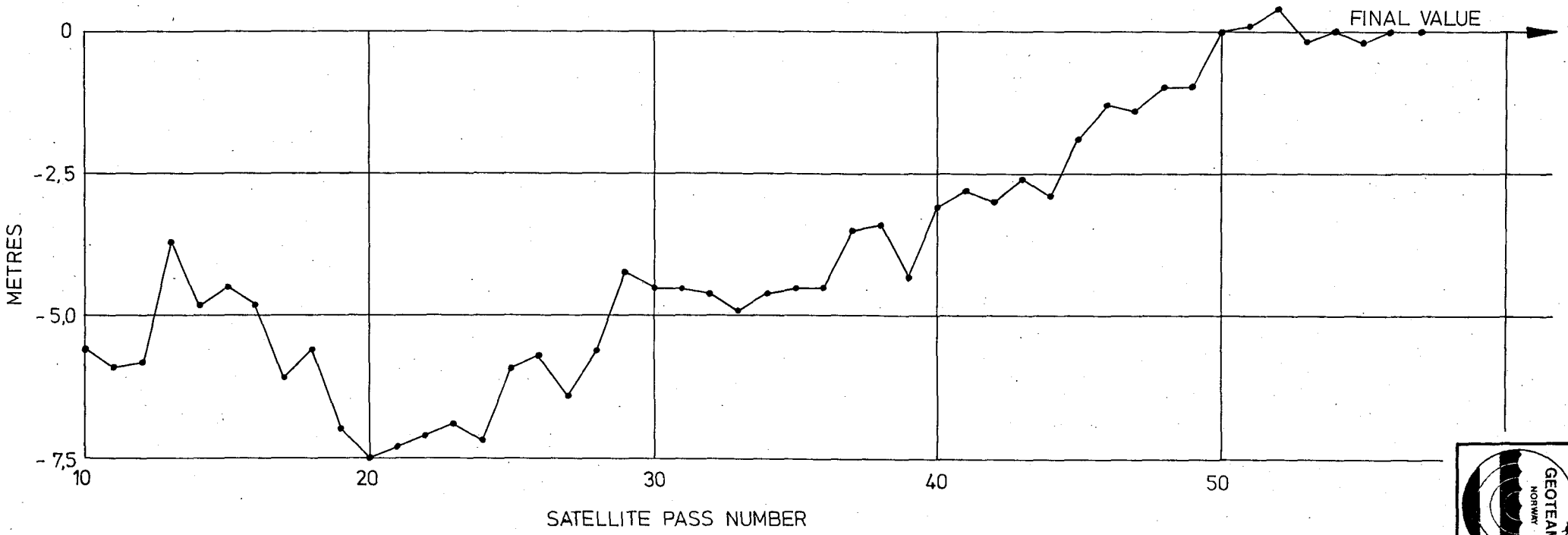
GEOTEAM NORWAY

Project no.: 5698

Appendix no.: 1


CONVERGENCE OF LONGTITUDE SOLUTION
+2,5
0
-2,5
-5,0
-7,5
-10,0
-12,5
METRES
FINAL VALUE
10
20
30
40
50
SATELLITE PASS NUMBER
GEOTEAM
NORWAY
Project no.: 5698
Appendix no.: 2

CONVERGENCE OF ANTENNA HEIGHT SOLUTION



GEOTEAM NORWAY

Project no.: 5698

Appendix no.: 3

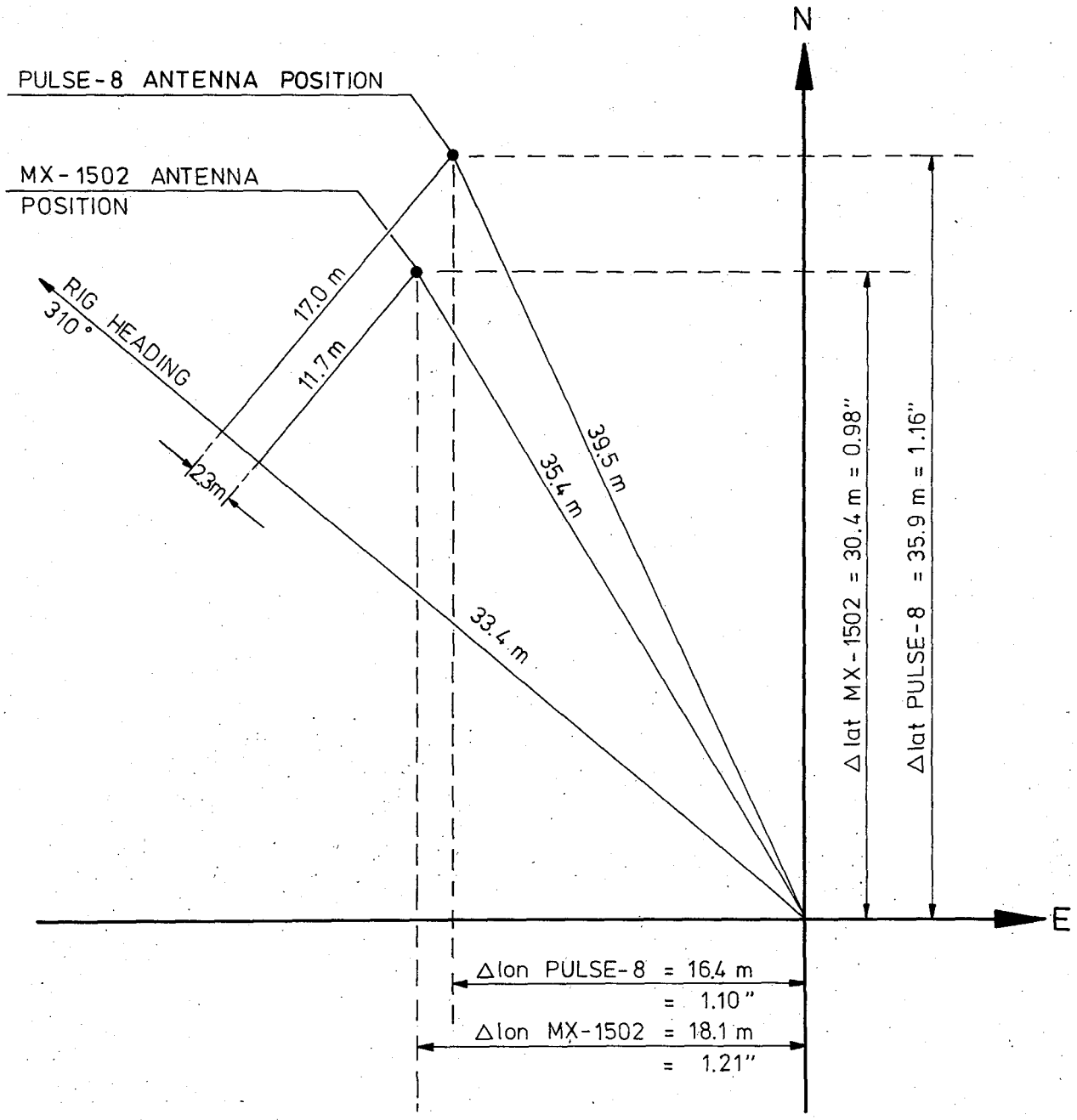
GEOTEAM NORWAY

Appendix no.: 4

Project no.: 5698

CONVERSION FROM THE ANTENNAE POSITIONS TO WELL CENTRE

SCALE 1:300



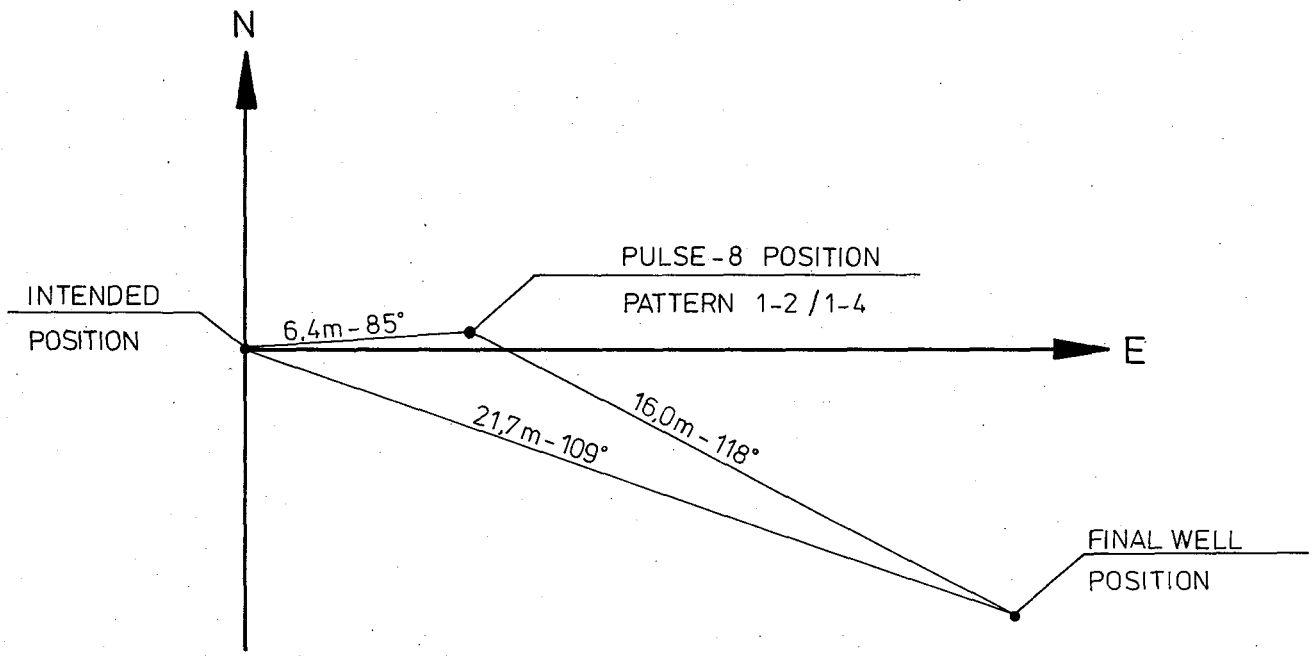
GEOTEAM NORWAY

Appendix no.: 5

Project no.: 5698

DEVIATIONS

INTENDED PULSE-8-FINAL WELL POSITIONS



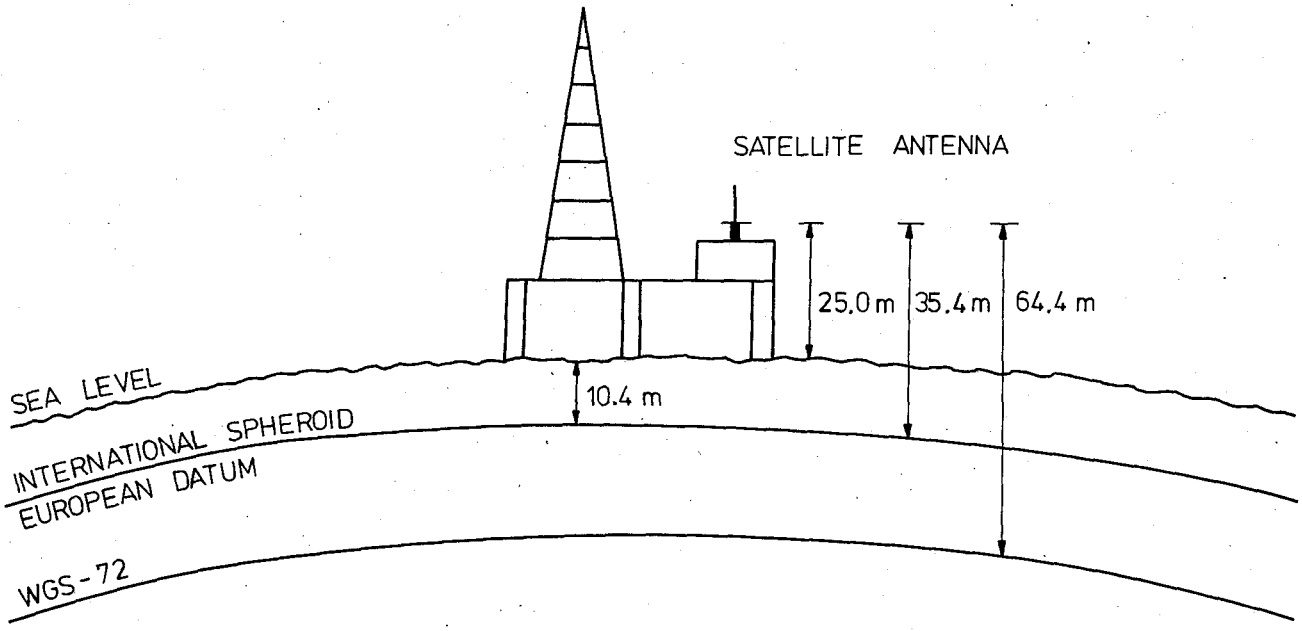
	LATITUDE / NORTHINGS	LONGITUDE / EASTINGS
INTENDED POSITION	61°12' 49", 70 N 6 787027,9	02° 11' 53", 65 E 456926,3
PULSE-8 POSITION PATTERN 1-2/1-4	61° 12' 49", 72 N 6 787 028,4	02° 11' 54", 08 E 456932,7
FINAL WELL POSITION	61° 12' 49", 48 N 6 787020,8	02° 11' 55", 03 N 456946,8

GEOTEAM NORWAY

Appendix no.: 6

Project no.: 5698

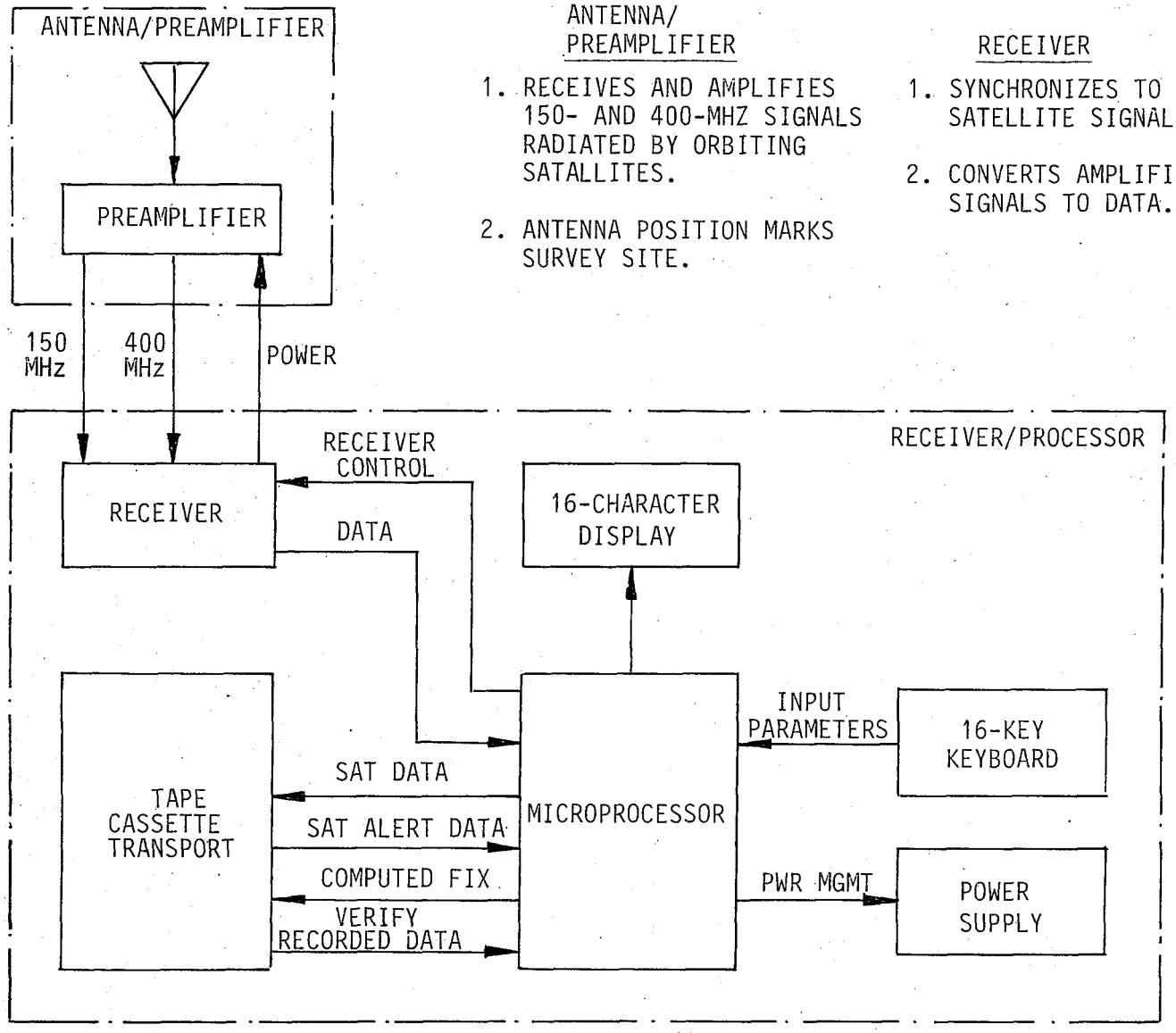
GEOIDAL HEIGHT



Appendix 7.

MS 2.11 MAGNAVOX MX 1502 POSITIONING SYSTEM

SIMPLIFIED FUNCTIONAL BLOCK DIAGRAM



ANTENNA/ PREAMPLIFIER

1. RECEIVES AND AMPLIFIES 150- AND 400-MHZ SIGNALS RADIATED BY ORBITING SATALLITES.
2. ANTENNA POSITION MARKS SURVEY SITE.

RECEIVER

1. SYNCHRONIZES TO SATELLITE SIGNAL
2. CONVERTS AMPLIFIED SIGNALS TO DATA.

MICROPROCESSOR

1. MANAGES POWER SUPPLIED TO ALL PARTS OF SYSTEM.
2. COLLECTS AND STORES POSITION DATA FROM SATELLITE.
3. COMPUTES POSITION.

TAPE CASSETTE

1. STORES SATELLITE PASS DATA.
2. STORES POSITION FIX COMPUTED BY MICROPROCESSOR.
3. LOADS SATELLITE ALERT DATA INTO MICROPORCESSOR.

KEYBOARD/DISPLAY

1. ENTER INPUT PARAMETERS.
2. DISPLAY INITIALIZATION PARAMETERS.
3. DISPLAY PARAMETERS REQUESTED BY USER.

Appendix 7.

MS 2.11 MAGNAVOX MX 1502 POSITIONING SYSTEM

SPECIFICATIONS

Antenna/Preamplifier:

Model No.	:	MX 1502 Dual frequency vertically polarized omnidirectional azimuth coverage.

Receiver/Processor/Tape Cassette Transport:

Type	:	Magnavox Geoceiver/Satellite Surveyor
Model No.	:	MX 1502

Power:

Internal		
Standard Battery	:	12 V DC, 2.5 Ampere/hour with charging circuit.
Optional Battery	:	12 V DC, 5.0 Ampere/hour with charging circuit.
External	:	12 V DC internally regulated.
Typical Power Consumption at 25°C:		
Average	:	12 Watts with a 25% satellite pass duty cycle.
Peak	:	48 Watts
Standby	:	5 Watts
Tracking Satellite (Display off)	:	33 Watts

Environmental:

Temperature		
Operating	:	-20°C to +55°C
Storage	:	-55°C to +100°C
Antenna	:	-40°C to +85°C

Appendix 7.

Humidity - operating and storage	:	Up to 100% from 0°C to +55°C
Altitude:		
Operating	:	Up to 4,600 meters
Transporting/storage	:	Up to 15,240 meters
Weather	:	Operates in wind-driven rain, sleet, snow and sand.
Shock:		
Operating	:	Capable of withstanding 15g peak, 11 ms half-sine pulse along three mutually perpendicular axes.
Transporting	:	Capable of withstanding a flat corner or edge drop from 0.6 meter.
Vibration:		
Operating	:	0.25 cm double-amplitude displacement from 5 to 20 Hz 2 g from 20 to 55 Hz.
Transporting	:	0.- cm double-amplitude displacement from 5 to 20 Hz 2 g from 20 to 2000 Hz.
Tape Cassette Transport:		
Recording Technique	:	Biphase Level (Fully ANSI/ECMA/ ISO compatible)
Read/Write Speed	:	25.4 cm/second
Rewind Speed	:	152.4 cm/second
Bit Density	:	315 bits/cm
Data Transfer Rate	:	8000 bits/second
Close Track	:	630 flux changes/cm
Power Consumption:		
Standby	:	3.25 Watts
Running	:	9.75 Watts

Appendix 7.

WORKING PRINCIPLE

The Magnavox Mx 1502 system is designed for accurate point positioning based on the transmissions from the TRANSIT satellites.

The Mx 1502 automatically tracks the 150 MHz and 400 MHz phase-modulated satellite signals, enabling the processor to correct for ionospheric refraction and read the satellite's true position. The droppler-shift is measured over 23 seconds signal periodes.

When a satellite passes above the horizon, data will be received during a periode of up to 16 minutes. Each 23 second periode defines a hyperboloid, and the intersection between two hyperboloids and the earth spheroid gives the position of the receiving antenna. Each satellite pass thus gives redundant data for position determination.

On a stationary point, the Magnavox 1502 Satellite Surveyer collects and process data from a number of satellite passes to provide a three-dimensional, 3-D, position (latitude, longitude and height). The least-squares solution automatically evaluate each droppler count according to its geometric effect on each component of the position. The number of available satellite passes, which are accepted for 3-D computations are varying from about 10 fixes per day around equator, to about 20 fixes at 60 degrees latitude.

Two-dimensional and three-dimensional positions are automatically calculated by the MX 1502 in World Geodetic System (WGS-72) co-ordinates.
The MX 1502 have built in programs for conversion to local datum, and for calculation of UTM coordinates.