

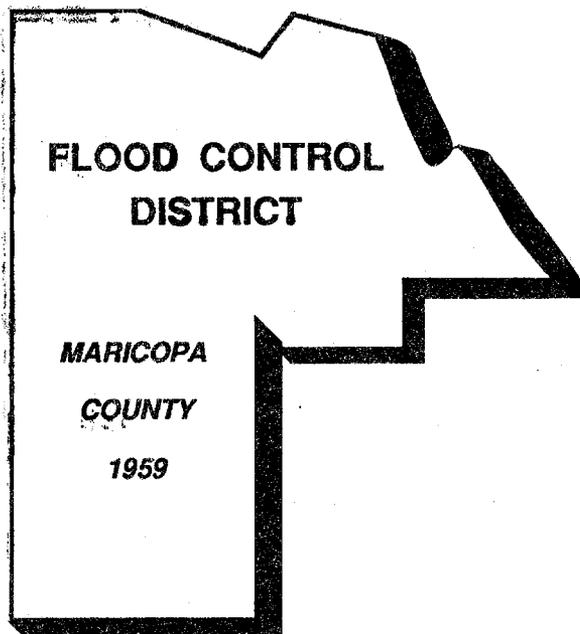
SALT - GILA RIVERS

Property of
Flood Control District of MC Libran
Please Return to
2801 W. Duta St
Phoenix, AZ 85009

GPS OBSERVATION WINDOWS

GPS CONTROL SURVEY

CONTRACT NO. 90-59



Baker

Michael Baker Jr., Inc

Greiner

**MARICOPA COUNTY SALT-GILA WATERCOURSE MASTER PLAN
PHASE 1 AERIAL MAPPING GPS CONTROL SURVEY NETWORK
PHOENIX, ARIZONA
GREINER, INC.
1991**

SUMMARY

The intent of this GPS Control Survey was to provide a photogrammetric horizontal control network for a 400 scale 4-foot contour aerial topographic map of the Salt-Gila Rivers in the general vicinity of Phoenix Arizona. Approximately 150 record monuments were targeted and occupied using Trimble 4000 ST single frequency receivers in accordance with the FGCC "Geometric Accuracy Standards and Specifications for using GPS Relative Positioning Techniques" in order to develop the photogrammetric horizontal control for this aerial mapping project. The photogrammetric vertical control for this aerial mapping project was developed by a Least Squares Adjustment of conventional leveling and is not a part of this report.

In accordance with the contract specifications, this GPS horizontal control network was tied into the Arizona State Plane Coordinate System by direct measurements to 3 NGS first order triangulation stations within the immediate vicinity of this mapping project. These first order NGS triangulation stations are: Broadway, Etta and Val Vista. Additionally, in consideration of the fact that the East-West scope of this aerial mapping project extended approximately 80 miles, several other NGS first order triangulation stations were occupied around the project perimeter. These additional first order triangulation stations were occupied in order to verify the existence of a uniform State Plane Coordinate Network and to identify any "Local Control" coordinate discrepancies which may exist and thereby have an impact on this project or future projects within the same general area. Although verification of the existing NGS triangulation network is beyond the scope of this 400 scale 4-foot contour aerial topographic mapping project, all baselines between the NGS triangulation stations listed below were measured at least twice in order to provide redundant measurements as defined in the FGCC specifications. Due to its historical significance, as the initial point of the Arizona public lands survey system, one NGS second order triangulation station "Initial Point" was occupied instead of the NGS first order triangulation station "Initial Monument" only a few feet away. The published NAD83 record coordinates of triangulation stations Etta, Broadway, Squaw Peak, Litchfield, and Initial Point (not Initial Monument) appear to be in general agreement due to the lack of significant differences between the record coordinate values and the (measured) coordinate values generated by the unconstrained GPS project adjustment. However, triangulation stations Val Vista, Powers Butte, and Wintersburg exhibit larger positional differences between the published record coordinate values and the (measured) coordinate values generated by the unconstrained GPS project adjustment. This positional discrepancy would appear to cast some doubt on the accuracy of the published record coordinates of these three triangulation stations in relation to the overall area network. Please see the attached table entitled "NAD83 Grid Coordinate Value Comparisons (International Foot)".

**MARICOPA COUNTY SALT-GILA WATERCOURSE MASTER PLAN
PHASE 1 AERIAL MAPPING GPS CONTROL SURVEY NETWORK
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1991**

Once again, it should be emphasized that the intent of this particular GPS control survey was to provide photogrammetric horizontal control for a 4-foot contour 400 scale aerial topographic map of the Salt-Gila Rivers, and an examination of the precision of the unconstrained adjustment proved to be well within the PPM requirements specified in the contract for this GPS control network. Under no circumstances should the resultant coordinate values of this GPS control survey be used for boundary analysis or land net control of a GIS digital mapping database.

THE FOLLOWING APPENDICES ARE INCLUDED AS PART OF THIS PROJECT REPORT:

An Appendix entitled GPS PROJECT COORDINATES which contains the following sections: NAD83 Arizona State Plane Ground Coordinates in International Feet, NAD83 Arizona State Plane Grid Coordinates in International Feet, NAD83 State Plane Grid Coordinates in Meters, and NAD27 Arizona State Plane Grid Coordinates in U.S. Survey Feet. Once again, it should be noted that the intent of this GPS control survey was to develop horizontal photogrammetric control for a 400 scale, 4-foot contour aerial topographic map of the Salt-Gila Rivers and under no circumstances should the resultant coordinate values be used for boundary analysis or land net control of a GIS digital mapping database.

An Appendix entitled GPS PROJECT ADJUSTMENTS which contains a GEOLAB least squares statistical adjustment with the title "Unscaled, #8 Constrained NAD83 Adjustment - Salt River GPS - 1991". This project adjustment was developed by the constrained NAD83 values of the following 8 NGS triangulation stations: Initial Point (not Initial Monument), Powers Butte, Wintersburg, Litchfield, Etta, Squaw Peak, Val Vista, and Broadway. It should be noted that due to the relatively large distance away from the immediate project, the record coordinate values of these 8 NGS control points were held "fixed" in the Geolab least squares adjustment but were not heavily weighted. Therefore, minor differences in the final coordinates of these points will be evident in the least squares adjustment report and the resultant coordinate listings due to a lack of agreement between the record coordinate values and the redundant GPS baseline vector measurements. The average ppm of the constrained project adjustment was 6 ppm, with a low value of 1 ppm and a high value of 35 ppm in a vector distance of 685 meters. This constrained adjustment was used to develop the NAD83 Coordinate values for this 400 scale 4-foot contour aerial topographic mapping project.

**MARICOPA COUNTY SALT-GILA WATERCOURSE MASTER PLAN
PHASE 1 AERIAL MAPPING GPS CONTROL SURVEY NETWORK
PHOENIX, ARIZONA
GREINER, INC.
1991**

An Appendix entitled GPS PROJECT ADJUSTMENTS which contains a GEOLAB least squares statistical adjustment with the title: "Unscaled, #8 Constrained NAD27 Adjustment - Salt River GPS - 1991". This project adjustment was developed from the constrained NAD27 values of the following 8 NGS triangulation stations: Initial Point (not Initial Monument), Powers Butte, Wintersburg, Litchfield, Etta, Squaw Peak, Val Vista, and Broadway. It should be noted that due to the relatively large distance away from the immediate project, the record coordinate values of these 8 NGS control points were held "fixed" in the Geolab least squares adjustment but were not heavily weighted. Therefore, minor differences in the final coordinates of these points will be evident in the least squares adjustment report and the resultant coordinate listings due to a lack of agreement between the record coordinate values and the redundant GPS baseline vector measurements. The average ppm of this constrained project adjustment was 6 ppm with a low value of 1 ppm and a high value of 31 ppm in a vector distance of 685 meters. This constrained adjustment was used to develop the NAD27 coordinate values for this 400 scale 4-foot contour aerial topographic mapping project.

An Appendix entitled GPS PROJECT ADJUSTMENTS which contains a GEOLAB least squares statistical adjustment with the title: "Scaled Unconstrained Project Adjustment - Salt River GPS - 1991". This project adjustment was developed by constraining the NAD83 value of a single NGS triangulation station (Etta), in order to provide a quality check of the internal consistency of the GPS measurements. This adjustment was scaled to better fit a bell curve graph and to pass the Chi-squared test. The average ppm of this scaled unconstrained project network was 3 ppm with a low value of 1 ppm, and a high value of 13 ppm, in a vector distance of 685 meters. This scaled unconstrained adjustment is well within contract specifications and was produced in order to examine the actual precision of the GPS measurements used for this 400 scale 4-foot contour aerial topographic mapping project.

An Appendix entitled GPS PROJECT PROCESSING which contains the Trimble (Rev E) automatic baseline processing software parameters for the GPS observations of the NGS triangulation station network verification along with the resulting baseline summary reports and a Trimble "TMAP" plot of the baselines observed. In consideration of the relatively long baselines measured in the NGS triangulation station verification, the GPS observation data was first processed using the Trimble preset "automatic" processing parameters and then reprocessed using "manually" modified processing parameters in order to provide a comparison of the resultant vector differences. For all intents and purposes, the resultant raw GPS baseline vectors developed from the program preset "automatic" processing parameters were nearly identical to the resultant raw GPS baseline vectors developed from the "manually" modified processing. Therefore, the "automatic" GPS vectors were considered to be adequate for the NGS triangulation station verification of this 400 scale, 4 foot contour aerial mapping project. Please see the attached comparison tables entitled "Trimble 4000 ST Single Frequency Field Calibration and Comparisons".

**MARICOPA COUNTY SALT-GILA WATERCOURSE MASTER PLAN
PHASE 1 AERIAL MAPPING GPS CONTROL SURVEY NETWORK
PHOENIX, ARIZONA
GREINER, INC.
1991**

An Appendix entitled GPS PROJECT PROCESSING which contains the Trimble (Rev E) manually modified baseline processing software parameters for the GPS observations of the NGS triangulation station verification along with the resulting baseline summary reports and a Trimble "TMAP" plot of the baselines observed. In consideration of the relatively long baseline measurements included in the NGS triangulation station verification, the Trimble processing parameters were manually modified in order to provide a comparison to the preset automatic processing sequence. Although the positional dilution of precision (PDOP) improved noticeably, the resultant raw GPS "Manual" baseline vectors were only slightly different than the processed preset "Automatic" baselines. Therefore, the program processed and adjusted "Automatic" baselines were considered to be adequate for the NGS triangulation station verification of this 400 scale, 4 foot contour aerial mapping project. Please see the attached comparison tables entitled "Trimble 4000 ST Single Frequency Field Calibration and Comparisons".

An Appendix entitled GPS PROJECT CLOSURES which contains the Trimble (Rev E) "Tclose" traverse closure reports for the NGS triangulation station verification and the 20 project loops. In accordance with the FGCC standards and specifications, all 20 project network loops were 10 sides or less. The average ppm closure for the loops in the project network was 2 ppm with a low value of 1 ppm and a high value of 5 ppm. The average value of 2 ppm for all the loops in this project network was considerably less than the specified allowable average of 16 ppm, and the maximum project loop closure of 4.53 ppm for Loop #8 was also considerably less than the allowable maximum of 25 ppm as specified in the FGCC standards.

An Appendix entitled GPS OBSERVATION REPORTS which contains the daily work reports recorded by the GPS field crew for each GPS observation day. These daily work reports are a general summary of the hours worked and points observed by each member of the GPS field crew. In order to satisfy contract requirements, daily work reports were recorded in addition to the GPS observation sheets which provide a detailed summary of each observation session.

An Appendix entitled GPS OBSERVATION SHEETS which contains the GPS observation sheets for all the points of this project as recorded by each member of the GPS field crew. These observation sheets show relevant information concerning each GPS occupation including: the name of the field operator, the model and serial number of the GPS receiver, the location and description of the point occupied, information regarding the satellite constellation for each individual observation session, and the antenna height entered into the receiver along with the three independent measurement checks required by the FGCC specifications.

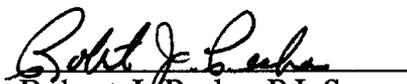
MARICOPA COUNTY SALT-GILA WATERCOURSE MASTER PLAN
PHASE 1 AERIAL MAPPING GPS CONTROL SURVEY NETWORK
PHOENIX, ARIZONA
GREINER, INC.
1991

An Appendix entitled GPS OBSERVATION WINDOWS which contains the satellite windows available for this project as well as the Trimble satellite "SKYLOT" configurations for the individual observation sessions. All observations sessions were designed according to the "FGCC Geometric Accuracy Standards and Specifications for using GPS Relative Positioning Techniques".

An Appendix entitled GPS OBSERVATION POINTS which contains the recon sheet "Visibility", "To Reach", and "Point Identification" descriptions for all the GPS observation points of this project. This binder also includes the published record coordinates and "To Reach" descriptions for the occupied NGS triangulation stations surrounding the general vicinity of this 400 scale 4-foot contour aerial topographic mapping project.



David Paul Johnson
Project Surveyor, G.P.S.



Robert J. Pecha, P.L.S.
Project Manager



MARICOPA COUNTY SALT-GILA WATERCOURSE AERIAL MAPPING

RAW GPS "AUTOMATIC" BASELINE MEASUREMENT COMPARISONS (DIRECTORY VCTR1)

TRIMBLE 4000 ST SINGLE FREQUENCY RECEIVER FIELD CALIBRATION AND COMPARISONS

<u>STATION FROM</u>	<u>RECEIVER FROM</u>	<u>STATION TO</u>	<u>RECEIVER TO</u>	<u>GPS DAY</u>	<u>VECTOR DISTANCE (m)</u>
0001	WHITE	0013	BLUE	330-1	22,356.121 *
0001	WHITE	0013	BLUE	330-2	22,356.297
0001	RED	0013	WHITE	337-1	22,356.248
0001	RED	0013	WHITE	337-2	22,356.214
0001	GREEN	0013	RED	339-1	22,356.396
0001	GREEN	0013	RED	339-4	22,356.352

#2934A00381 = RED

#2934A00379 = WHITE

#2934A00382 = BLUE

#2934A00373 = GREEN

* NOTE: As noted per the attached letter, Trimble GPS receivers are calibrated before they leave the factory, and also undergo a self calibration routine each time they are turned on. However, in an effort to provide an actual project field comparison, a common network baseline was measured repeatedly using three different receiver combinations with the resultant raw GPS vector distances shown above. Except for the first raw GPS vector distance which would appear to contain operator error, the maximum difference between any pair of measured "automatic" vectors is 182mm in 22,356m, or 8ppm. Of further note is the fact that the maximum difference realized between any raw GPS vector developed from preset "Automatic" processing and the corresponding raw GPS vector developed from "Manual" processing (set to process each measurement observation) was only 91mm in 22,356 meters, or 4ppm (please refer to the following page).

MARICOPA COUNTY SALT-GILA WATERCOURSE AERIAL MAPPING

RAW GPS "MANUAL" BASELINE MEASUREMENT COMPARISONS (DIRECTORY VCTR1M)

TRIMBLE 4000 ST SINGLE FREQUENCY RECEIVER FIELD CALIBRATION AND COMPARISONS

<u>STATION FROM</u>	<u>RECEIVER FROM</u>	<u>STATION TO</u>	<u>RECEIVER TO</u>	<u>GPS DAY</u>	<u>VECTOR DISTANCE (m)</u>
0001	WHITE	0013	BLUE	330-1	22,356.139 *
0001	WHITE	0013	BLUE	330-2	22,356.273
0001	RED	0013	WHITE	337-1	22,356.291
0001	RED	0013	WHITE	337-2	22,356.281
0001	GREEN	0013	RED	339-1	22,356.305
0001	GREEN	0013	RED	339-4	22,356.288

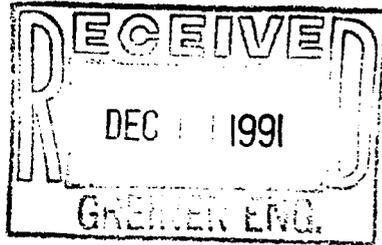
#2934A00381 = RED

#2934A00379 = WHITE

#2934A00382 = BLUE

#2934A00373 = GREEN

* NOTE: As noted per the attached letter, Trimble GPS receivers are calibrated before they leave the factory, and also undergo a self calibration routine each time they are turned on. However, in an effort to provide an actual project field comparison, a common network baseline was measured repeatedly using three different receiver combinations with the resultant raw GPS vector distances shown above. Except for the first raw GPS vector distance which would appear to contain operator error, the maximum difference between any pair of measured "manual" vectors is 32mm in 22,356m, or 1ppm. Of further note is the fact that the maximum difference realized between any raw GPS vector developed from preset "Automatic" processing and the corresponding raw GPS vector developed from "Manual" processing (set to process each measurement observation) was only 91mm in 22,356 meters, or 4ppm (please refer to the previous page).



TrimbleNavigation

1 November 1991

Dave Johnson
GREINER, INC.
1261 East Dyer Road
Santa Ana, CA 92705-5605

Dear Mr. Johnson:

As per your request for information regarding the calibration of GPS Carrier Phase Tracking receivers. All receivers are calibrated before leaving Trimble Navigation Ltd by our Q.A. group. This calibration includes measuring a baseline of known coordinates to determine any abnormalities in the antenna phase center or the receivers tracking loop. The receivers also do a self calibration between all the channels every time a survey is started. The results of this calibration are available for the user to analyze, and are located in the double difference output file.

Should you have any further questions or if I can be of service to you, please call me at 1-800-874-6253 extension 2019.

Regards,

TRIMBLE NAVIGATION LTD.

A handwritten signature in cursive script that reads "Ken Mooyman".

Ken Mooyman
Survey Sales
Western Region

645 North Mary Avenue
Post Office Box 3642
Sunnyvale, CA 94088-3642

(408) 730-2900
FAX (408) 730-2997
Telex 6713973

All-In-View PDOP for MARICOPA-GPS

Date : 1 Dec 1991
 Time : 4:15 -> 16:15
 Cut-off Elevation : 15

Latitude : 33 00' 00" N
 Longitude : 112 00' 00" W
 Zone : - 7:00

Satellite Constellation	Time Rise	Time Set	dT	PDOP Rise	PDOP Set
2 6 12 13 24	4:15	4:15	0:00	3.8	3.8
12 13 20 24	4:55	5:12	0:17	13.2	14.6
12 13 16 20 24	5:12	6:22	1:10	2.1	3.0
12 16 20 24	6:22	6:32	0:10	12.9	9.0
3 12 16 20 24	6:32	7:02	0:30	3.5	2.5
3 16 20 24	7:02	7:12	0:10	4.9	6.1
3 16 17 20 24	7:12	8:12	1:00	2.7	3.0
3 15 17 20	8:12	8:37	0:25	15.7	19.6
3 16 17 20 23	8:37	9:37	1:00	4.5	3.4
3 16 17 23	9:37	9:50	0:13	3.5	3.4
3 17 21 23	10:20	12:12	1:52	4.5	25.1
3 11 17 21 23	12:12	12:17	0:05	2.5	2.5
11 17 21 23	12:17	12:32	0:15	4.0	4.1
11 12 17 21 23	12:32	13:52	1:20	3.4	4.0
11 12 21 23	13:52	14:07	0:15	5.9	4.8
11 12 15 21 23	14:07	14:37	0:30	3.7	3.1
11 15 21 23	14:37	15:10	0:33	3.5	3.8

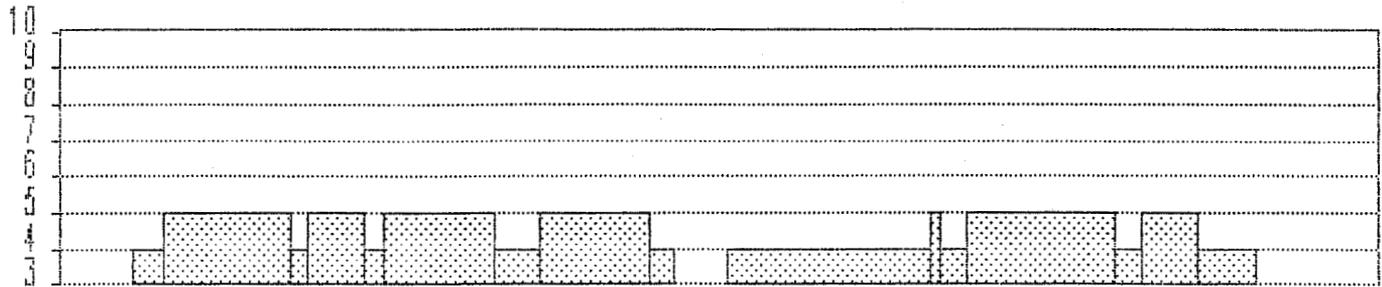
All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude :33 00'00"N Longitude :112 00'00"W

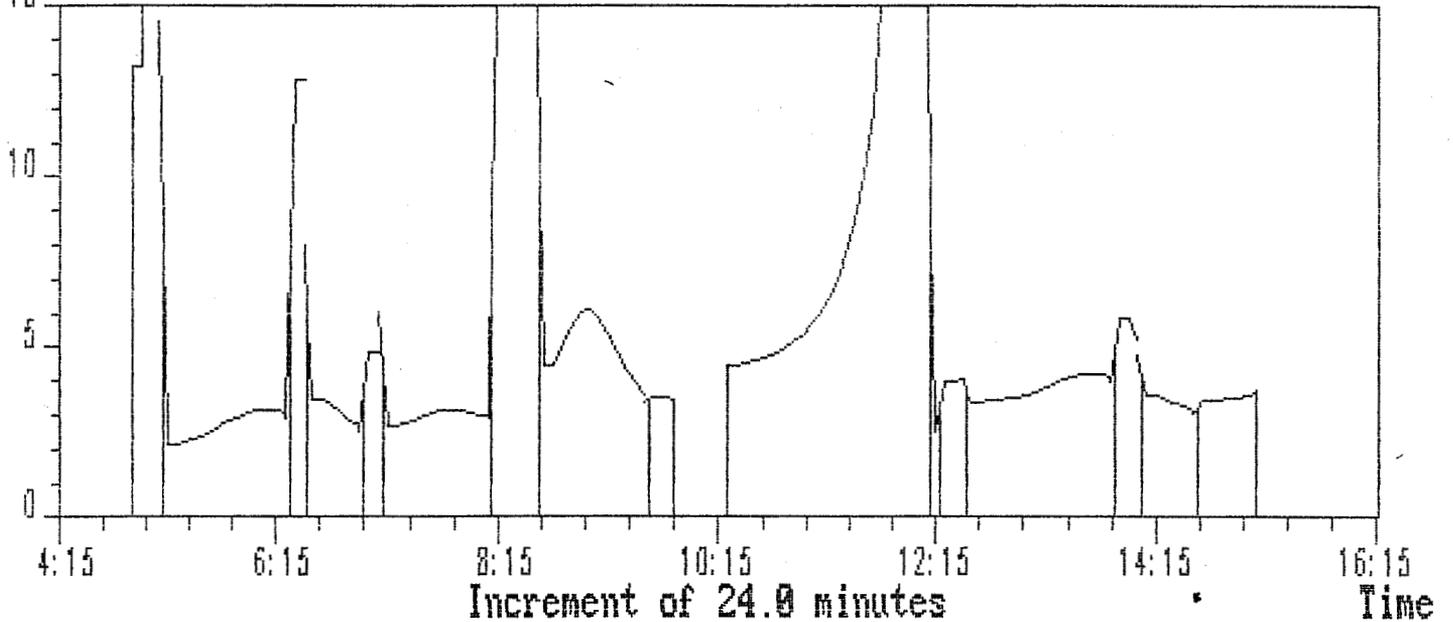
Date : 1 Dec 1991 Zone :- 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver



PDOP

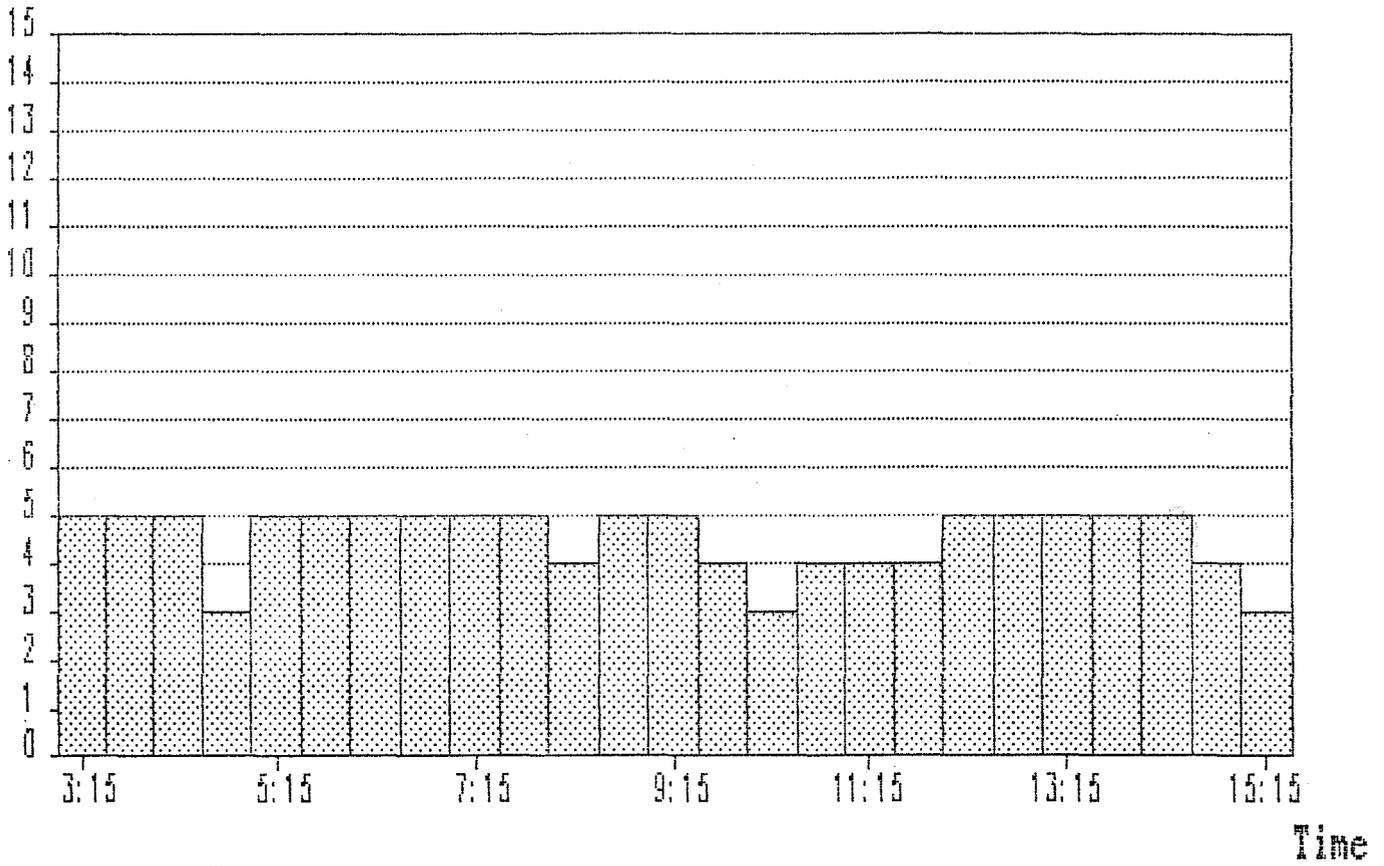


Number of Visible Satellites vs Time

Station : MARICOPA-GPS Latitude :33 00'00"N Longitude :112 00'00"W

Date : 1 Dec 1991 Zone :- 7:00 Cut-off Elevation : 15

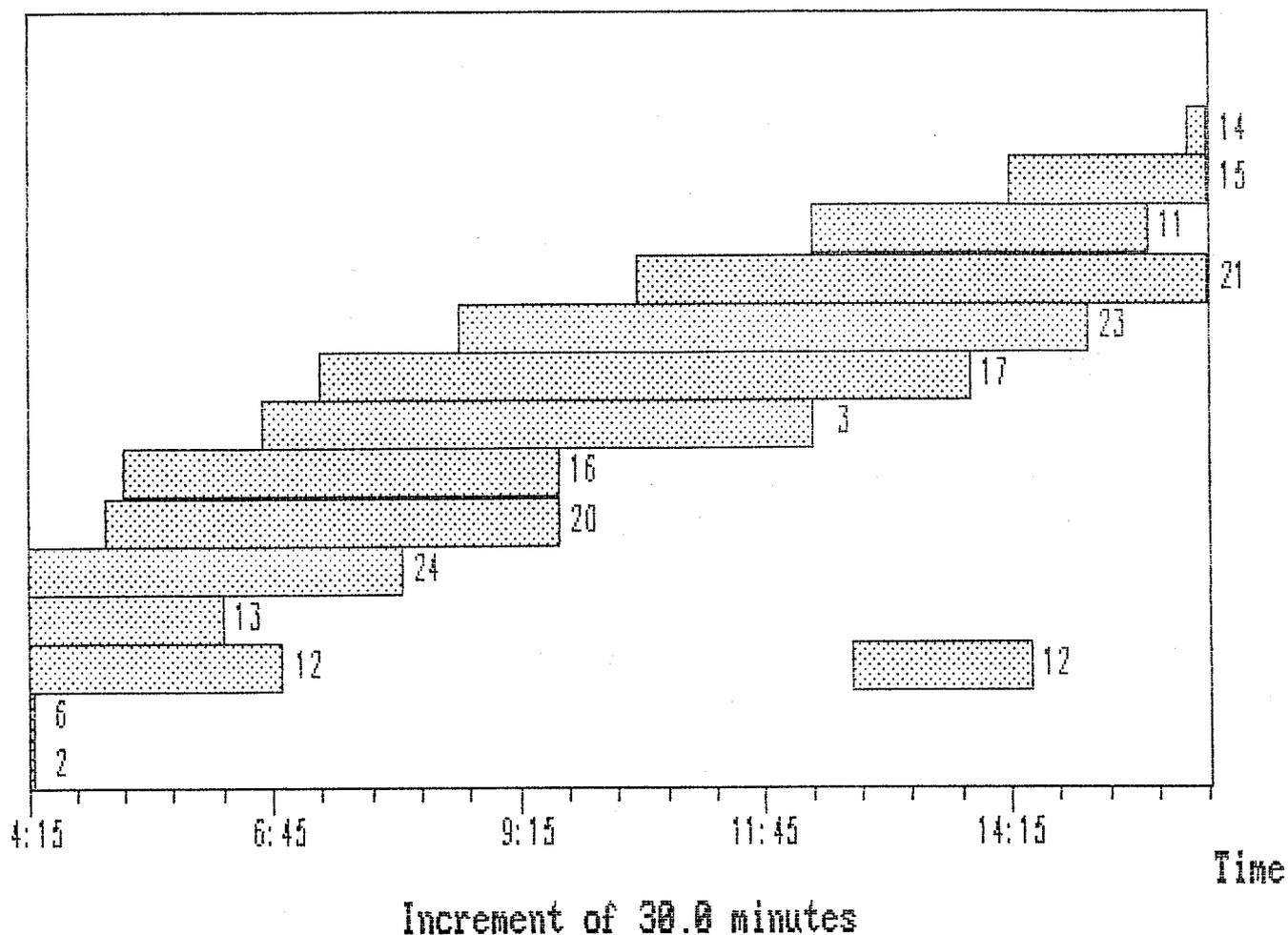
Number of Satellites



Increment of 30.0 minutes

Visible Satellites vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00"N Longitude : 112 00' 00"W
Date : 1 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15



Skyplot : Azimuth vs Elevation

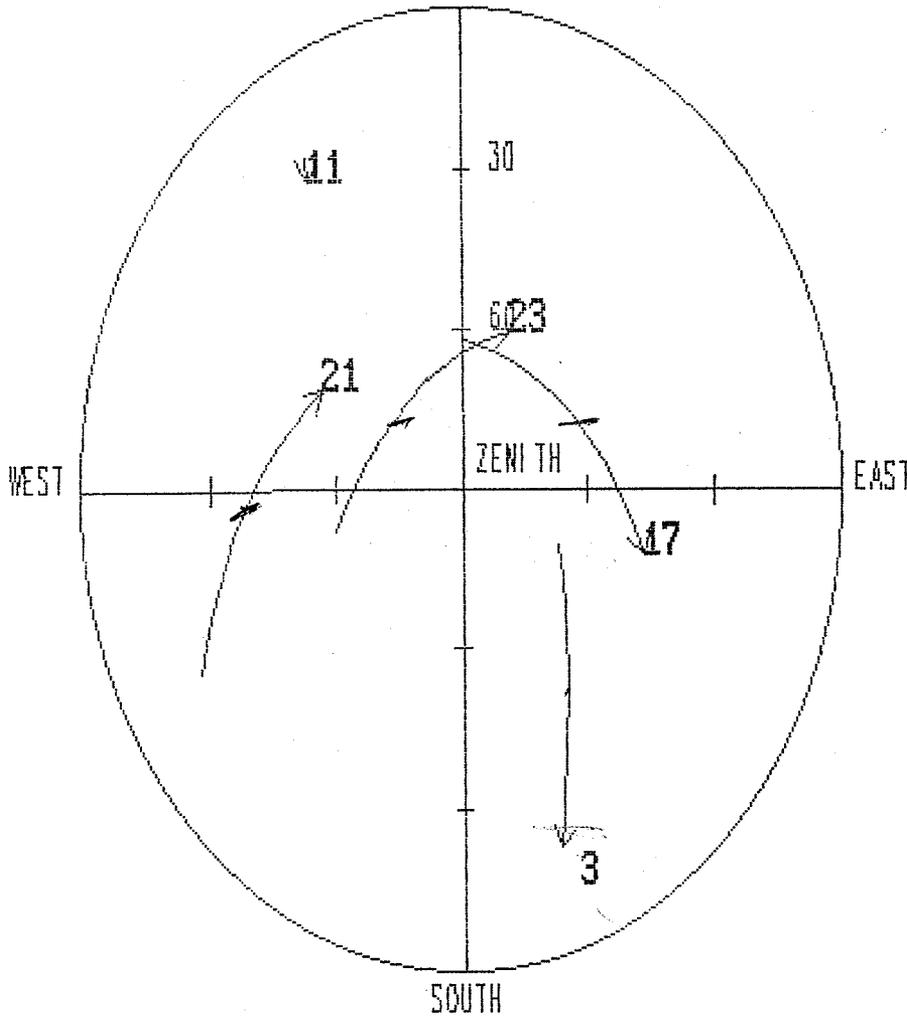
Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 1 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

NORTH HORIZON

Time : 10:30
to
12:30

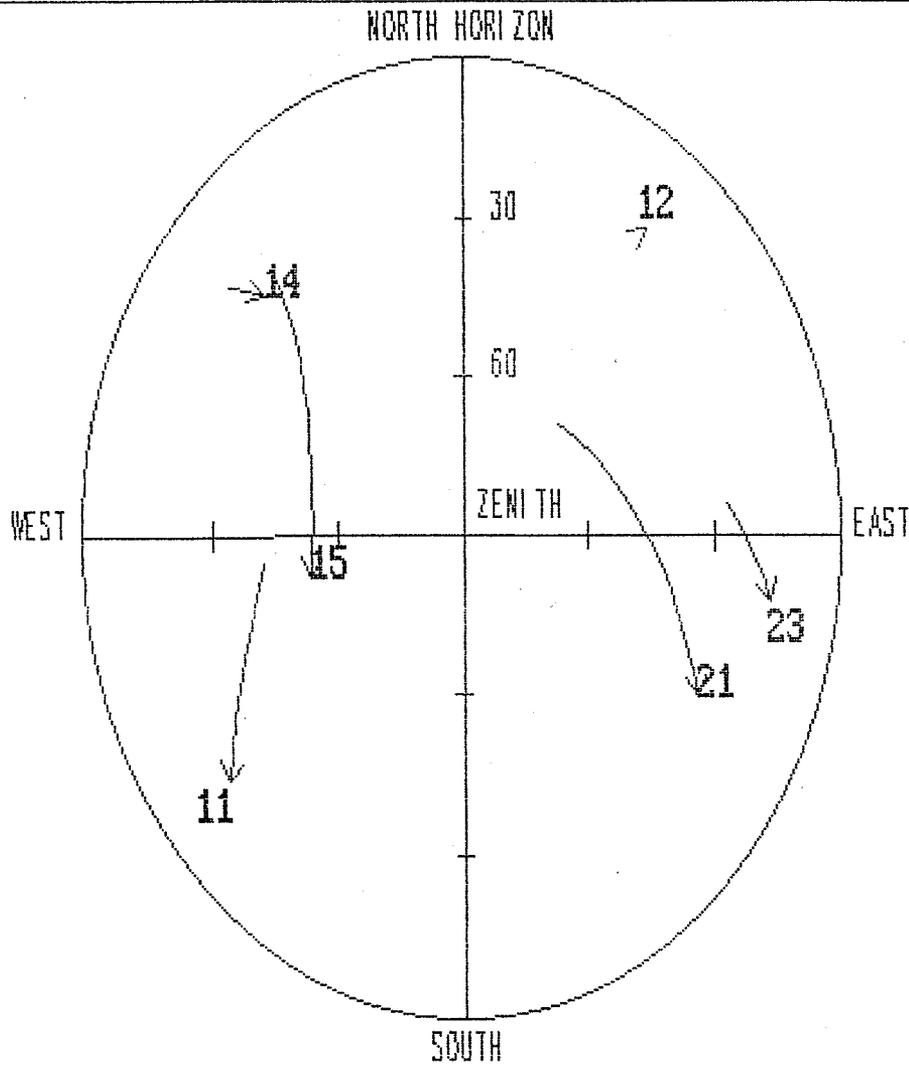
 Curtain



Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 1 Dec 1991 Zone :- 7:00 Cut-off Elevation : 15



Time : 14:30
to
16:30

 Curtain

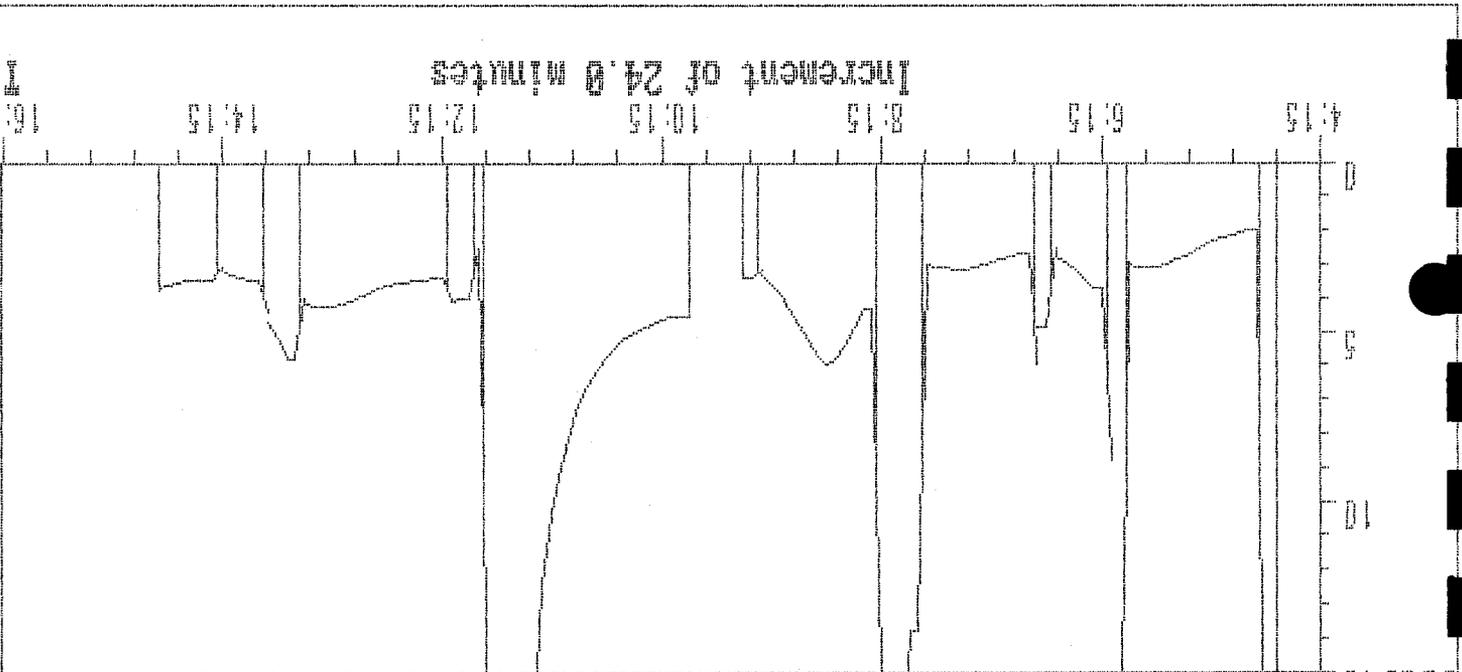
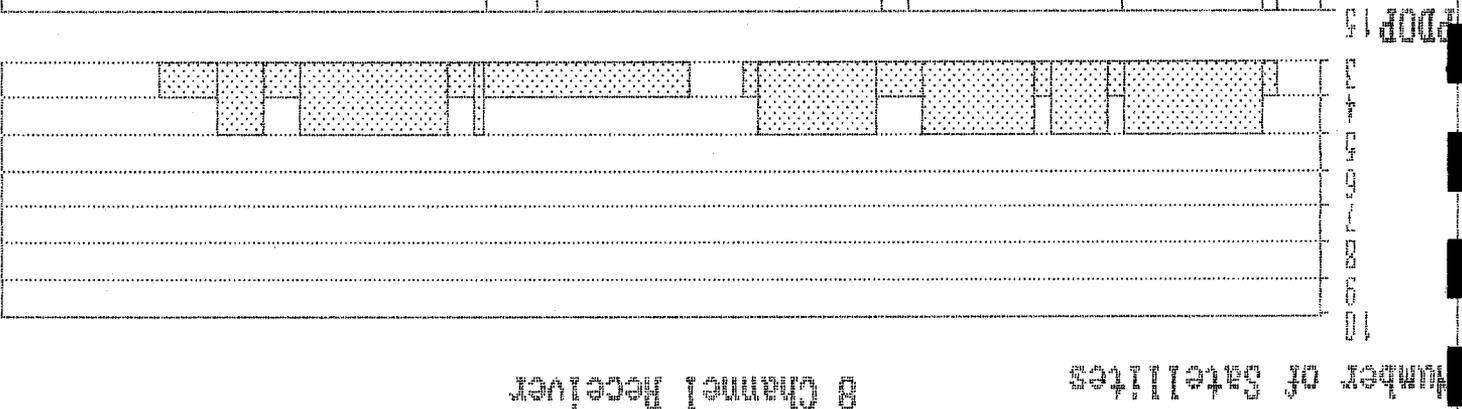
All-In-View PDOP for MARICOPA-GPS

Date : 6 Dec 1991
 Time : 4:15 -> 16:15
 Cut-off Elevation : 15

Latitude : 33 00' 00" N
 Longitude : 112 00' 00" W
 Zone : - 7:00

Satellite Constellation	Time Rise	Time Set	dT	PDOP Rise	PDOP Set
12 13 20 24	4:40	4:47	0:07	31.5	57.8
12 13 16 20 24	4:47	6:02	1:15	2.0	2.9
12 16 20 24	6:02	6:12	0:10	15.4	8.8
3 12 16 20 24	6:12	6:42	0:30	3.7	2.6
3 16 20 24	6:42	6:52	0:10	4.9	6.0
3 16 17 20 24	6:52	7:52	1:00	2.7	3.0
3 16 17 20	7:52	8:17	0:25	13.8	17.4
3 16 17 20 23	8:17	9:22	1:05	4.4	3.1
3 16 17 23	9:22	9:30	0:08	3.4	3.4
3 17 21 23	10:00	11:52	1:52	4.5	23.9
3 11 17 21 23	11:52	11:57	0:05	2.5	2.5
11 17 21 23	11:57	12:12	0:15	4.1	4.1
11 12 17 21 23	12:12	13:32	1:20	3.4	4.0
11 12 21 23	13:32	13:52	0:20	5.8	4.4
11 12 15 21 23	13:52	14:17	0:25	3.5	3.1
11 15 21 23	14:17	14:50	0:33	3.4	3.8

R11-In-View PDOP vs Time
 Station : MRHICPPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
 Date : 6 Dec 1991 Zone : - 7:00
 Out-of Elevation : 15



B Channel Receiver
 Number of Satellites

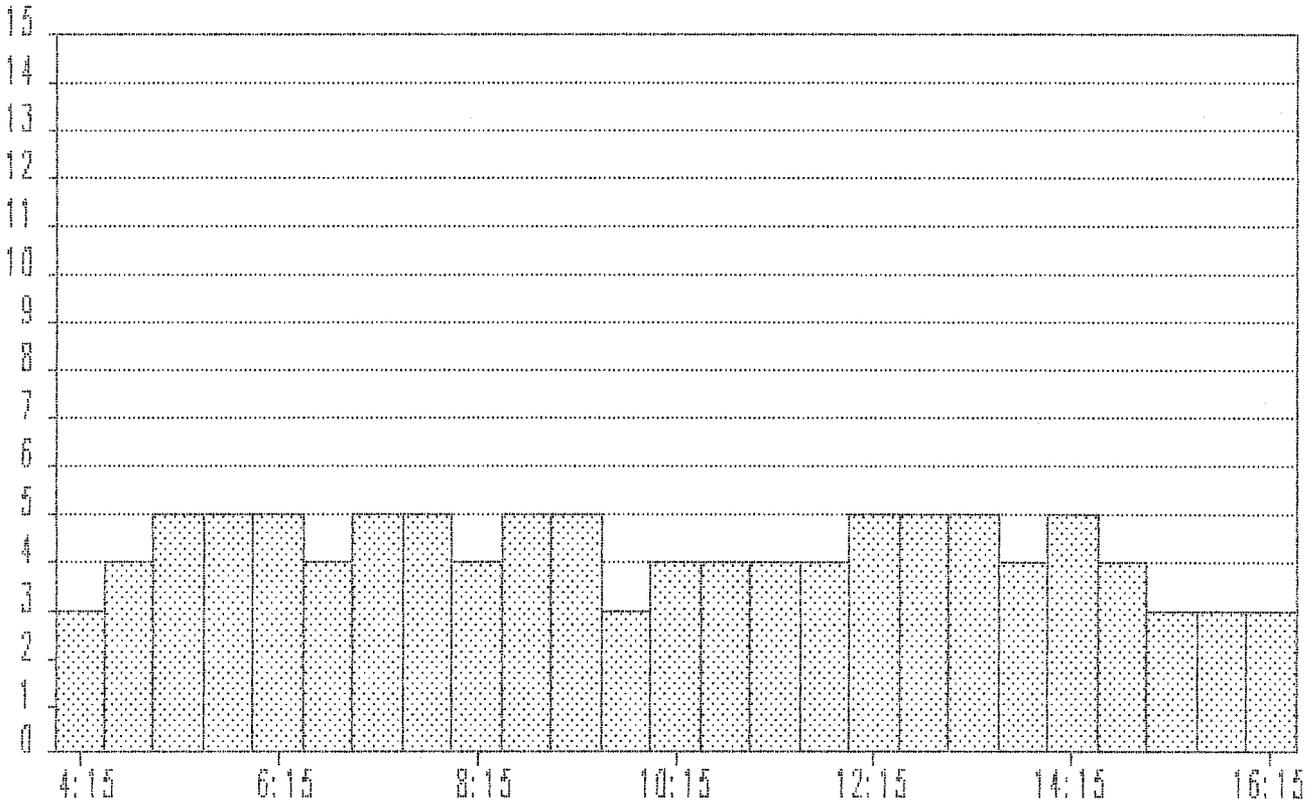
Increment of 24.0 minutes

Time

Number of Visible Satellites vs Time

Station : MARICOPA-GPS Latitude : 33 00'00"N Longitude : 112 00'00"W
Date : 6 Dec 1991 Zone :- 7:00 Cut-off Elevation : 15

Number of Satellites

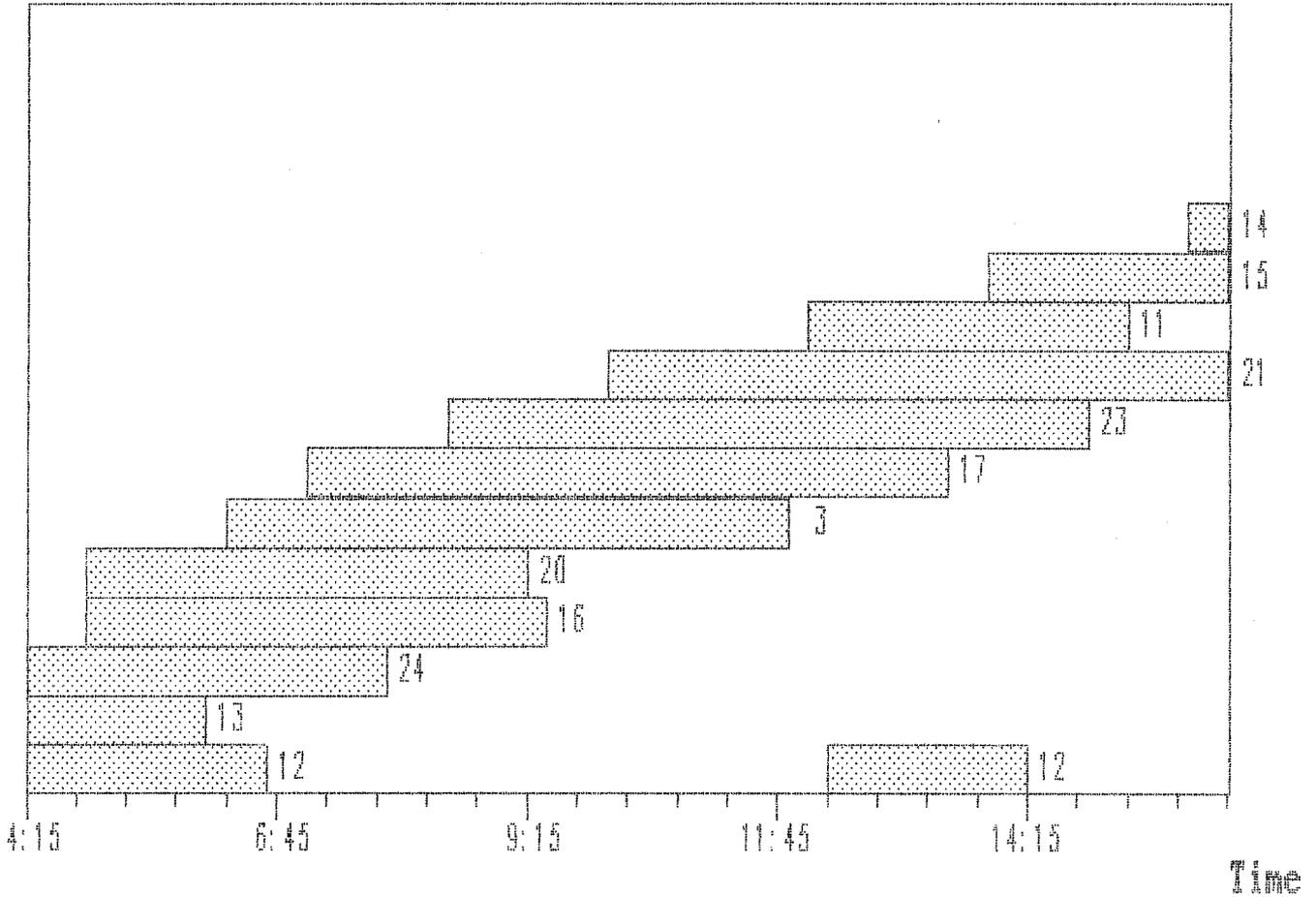


Time

Increment of 30.0 minutes

Visible Satellites vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 6 Dec 1991 Zone :- 7:00 Out-off Elevation : 15



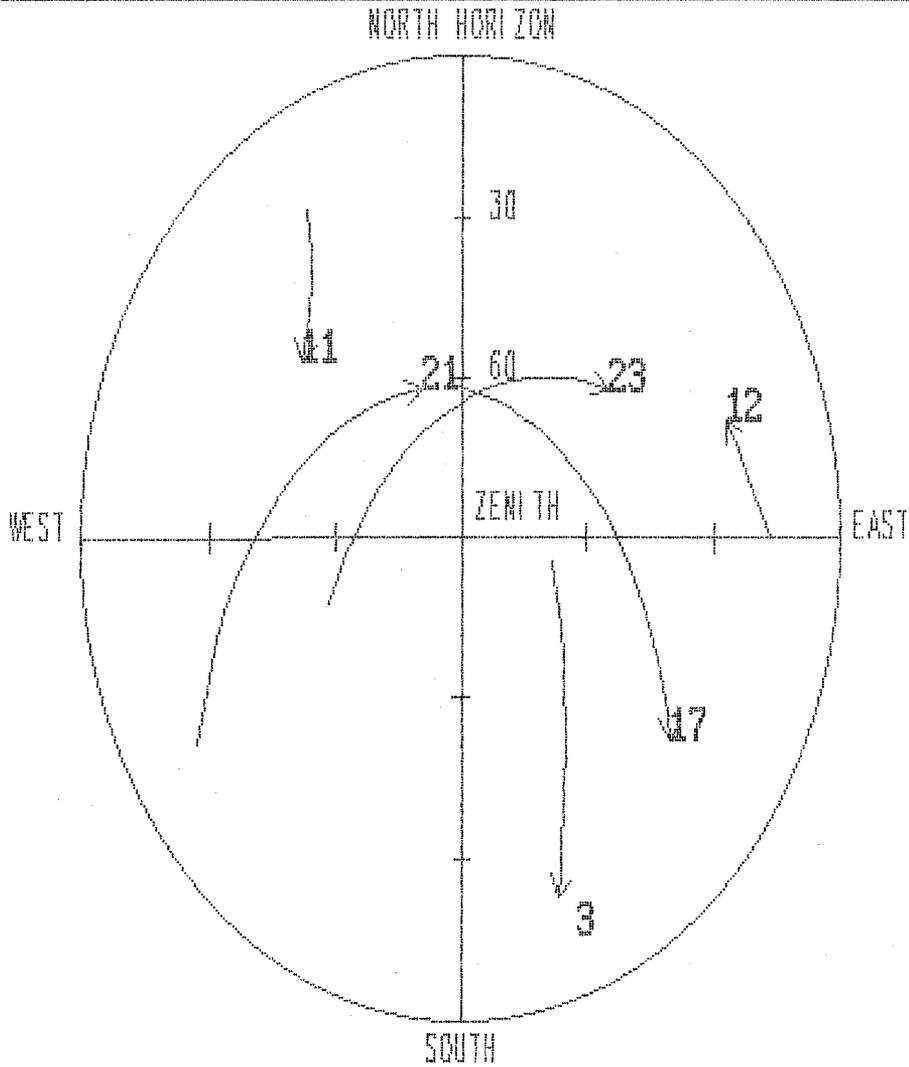
Increment of 30.0 minutes

Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 6 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

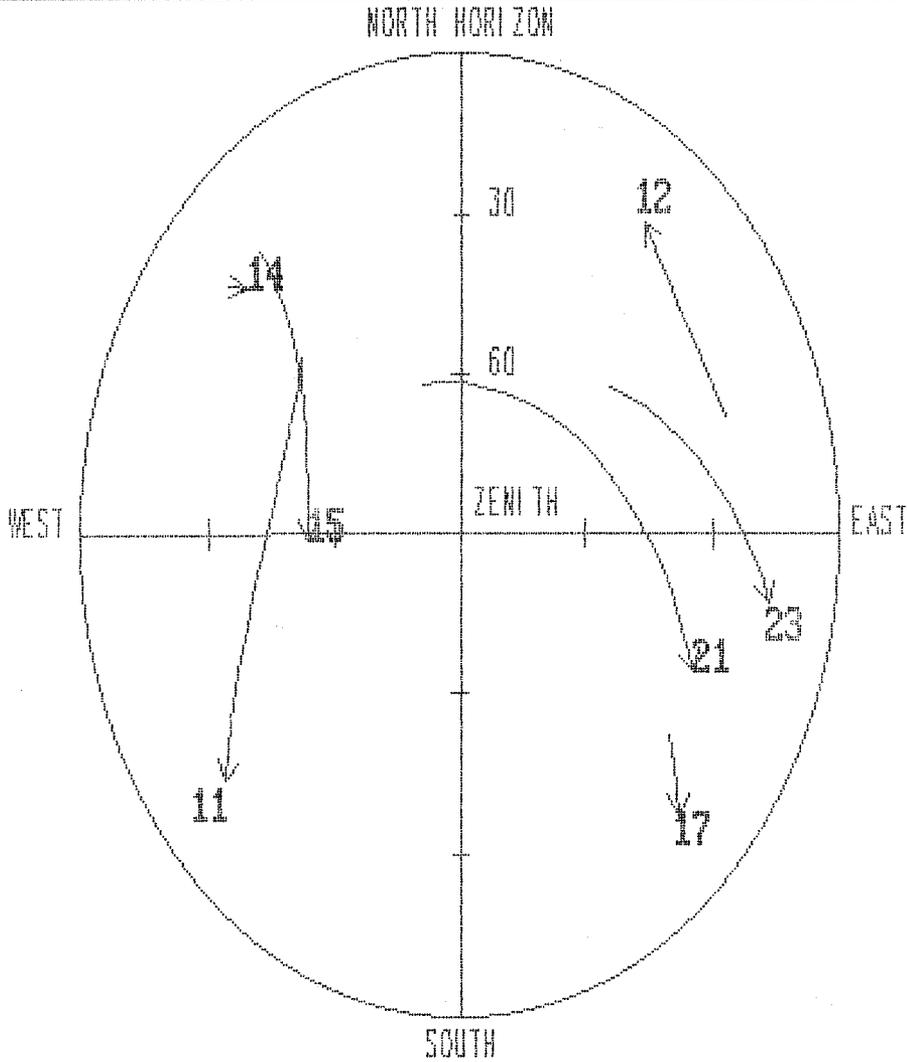
Time : 10:00
to
13:00



Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00'00"N Longitude : 112 00'00"W
Date : 6 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Time : 13:00
to
16:00



All-In-View PDOP for MARICOPA-GPS

Date : 11 Dec 1991
 Time : 5:10 -> 13:10
 Cut-off Elevation : 15

Latitude : 33 00' 00" N
 Longitude : 112 00' 00" W
 Zone : - 7:00

Satellite Constellation	Time Rise	Time Set	dY	PDOP Rise	PDOP Set
12 13 16 20 24	5:10	5:43	0:33	2.9	2.9
12 16 20 24	5:43	5:53	0:10	17.6	7.5
3 12 16 20 24	5:53	6:21	0:28	3.7	2.6
3 16 20 24	6:21	6:31	0:10	4.5	6.1
3 16 17 20 24	6:31	7:33	1:02	2.7	3.0
3 16 17 20	7:33	7:57	0:24	13.2	16.5
3 16 17 20 23	7:57	9:03	1:06	4.2	3.1
3 16 17 23	9:03	9:08	0:05	3.4	3.4
3 17 21 23	9:34	11:31	1:57	4.5	22.5
3 11 17 21 23	11:31	11:39	0:08	2.5	2.6
11 17 21 23	11:39	11:51	0:12	4.1	4.1
11 12 17 21 23	11:51	13:10	1:19	3.4	4.0



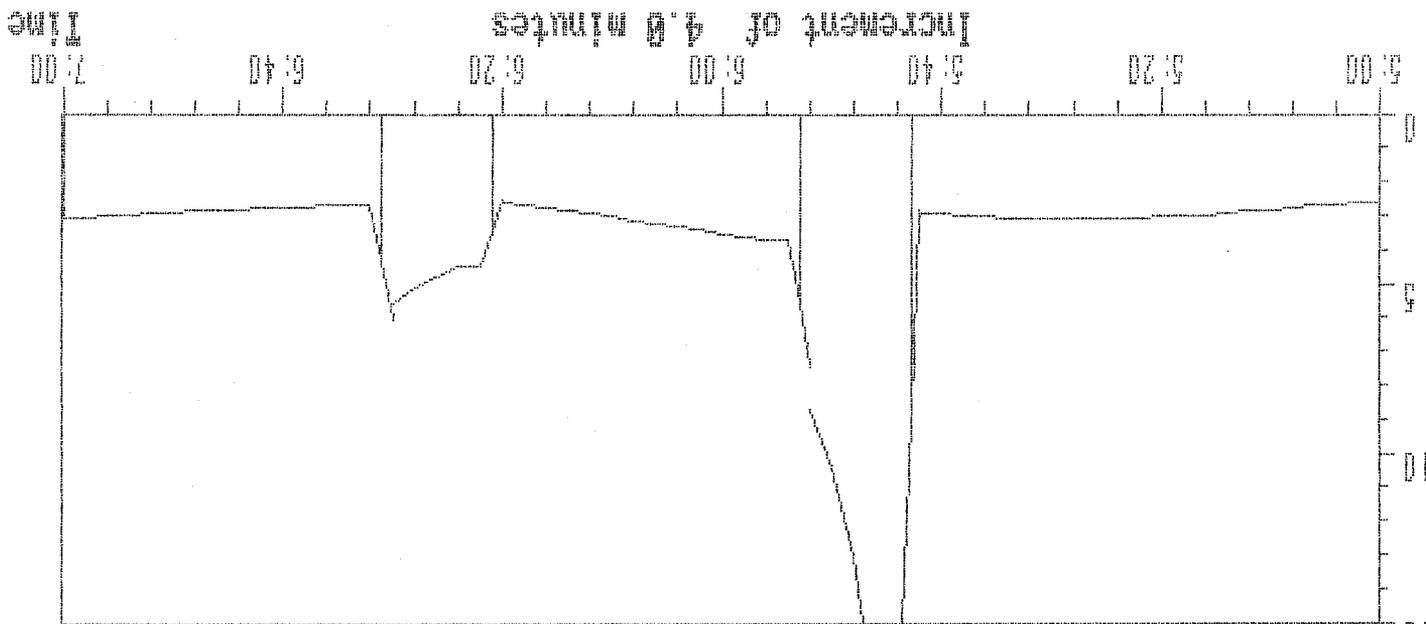
R11-In-View PDOP vs Time

Station : MARIOPR-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 11 Dec 1991 Zone : - 7:00
Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver

PDOP 15
14
13
12
11
10



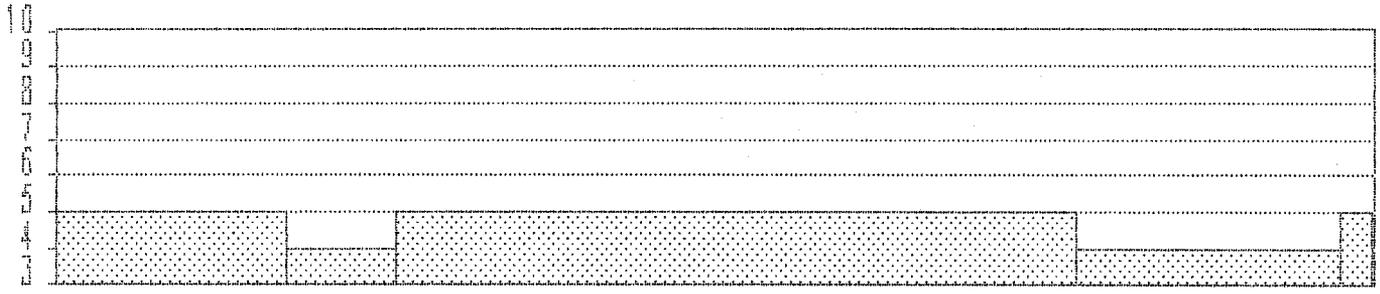
All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

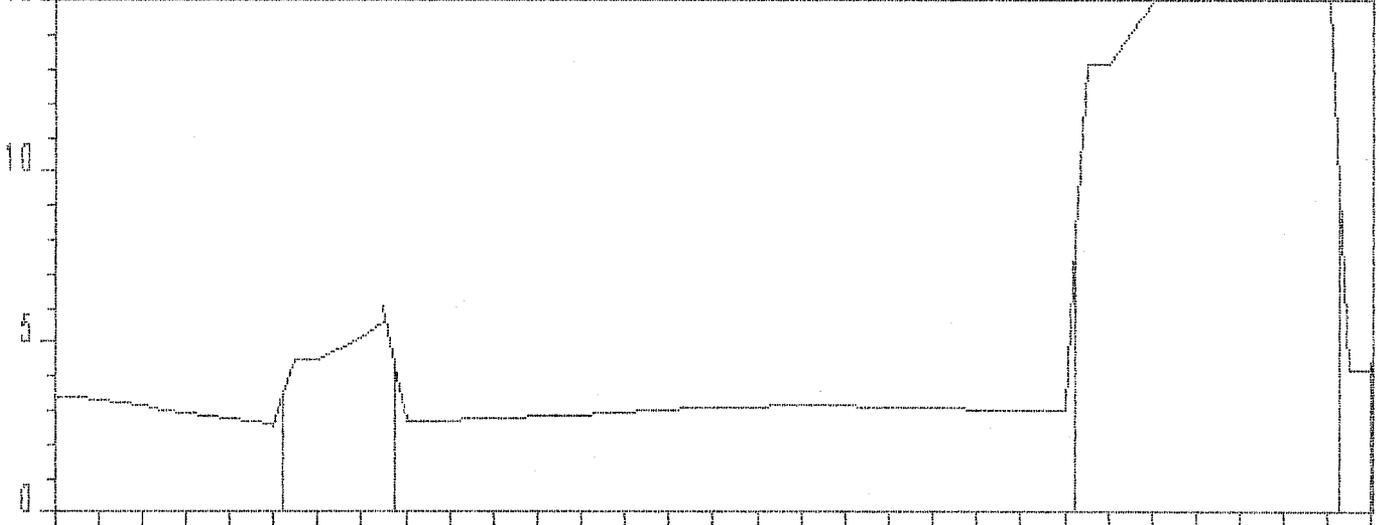
Date : 11 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver



PDOP



Increment of 4.0 minutes

Time

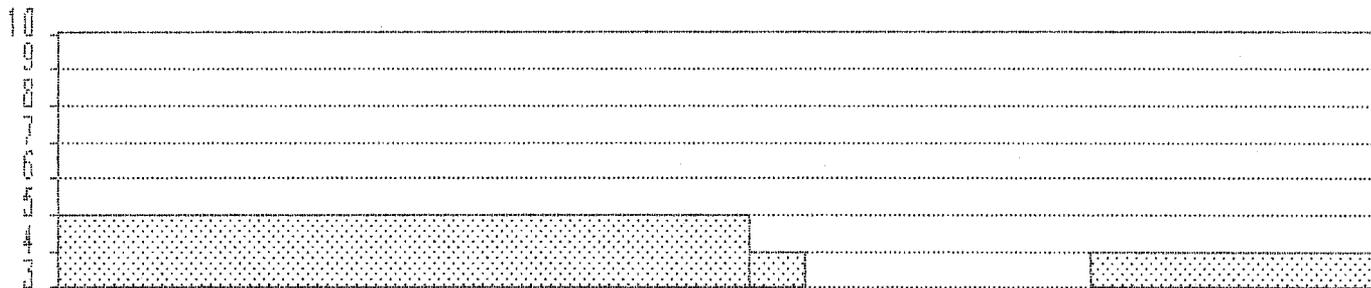
All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

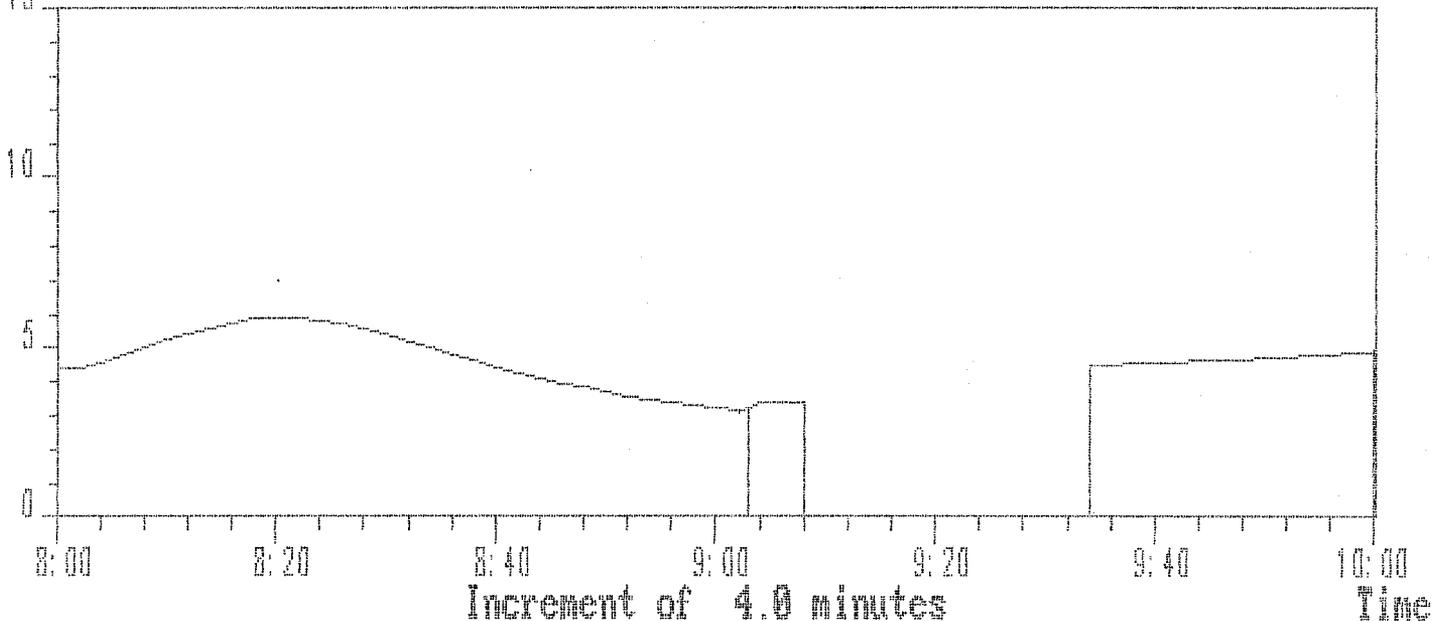
Date : 11 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver

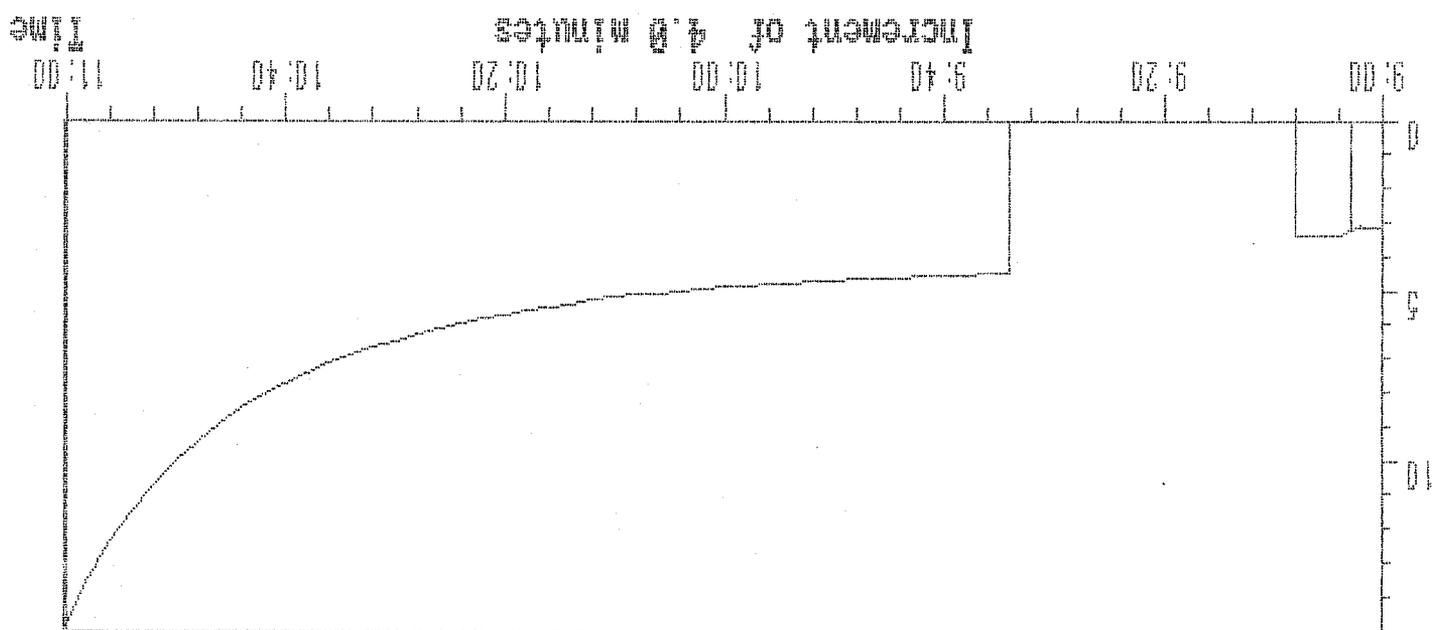
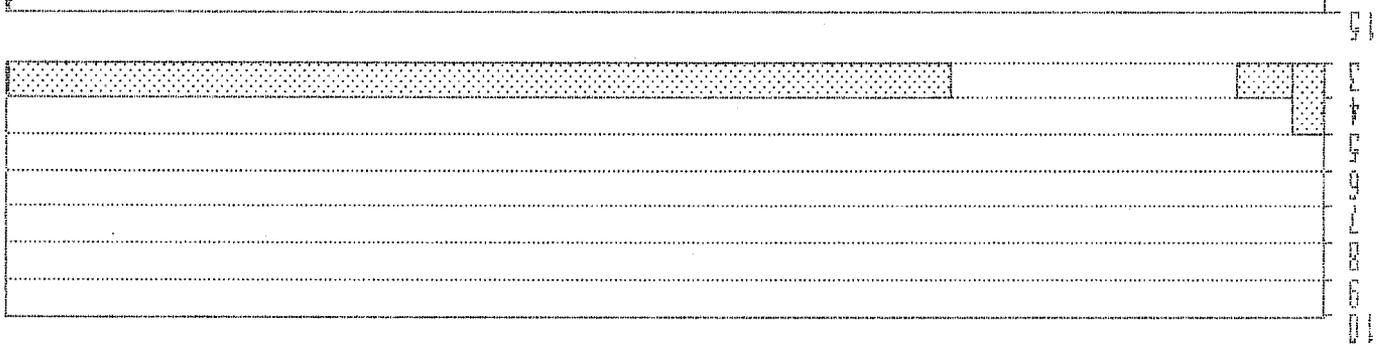


PDOP



All-In-View PDOP vs Time
 Station : MRRICOPR-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
 Date : 11 Dec 1991 Zone : -7:00
 Cut-off Elevation : 15

8 Channel Receiver
 Number of Satellites



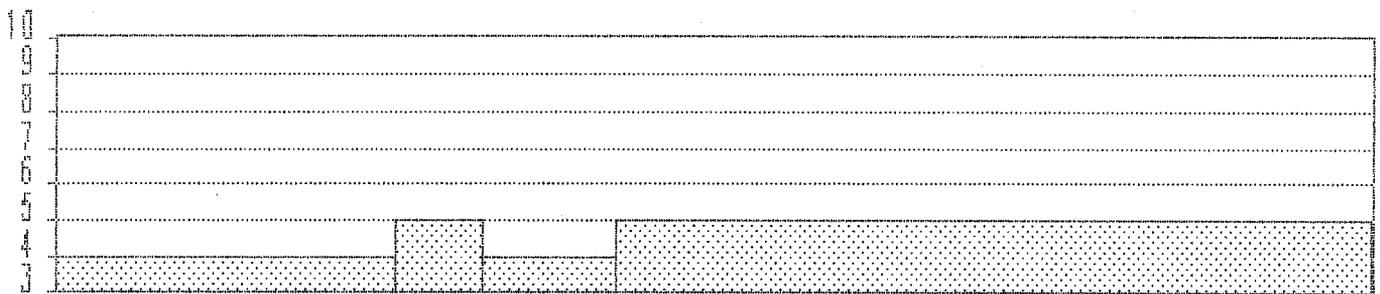
Increment of 4.0 minutes
 Time

All-In-View PDOP vs Time

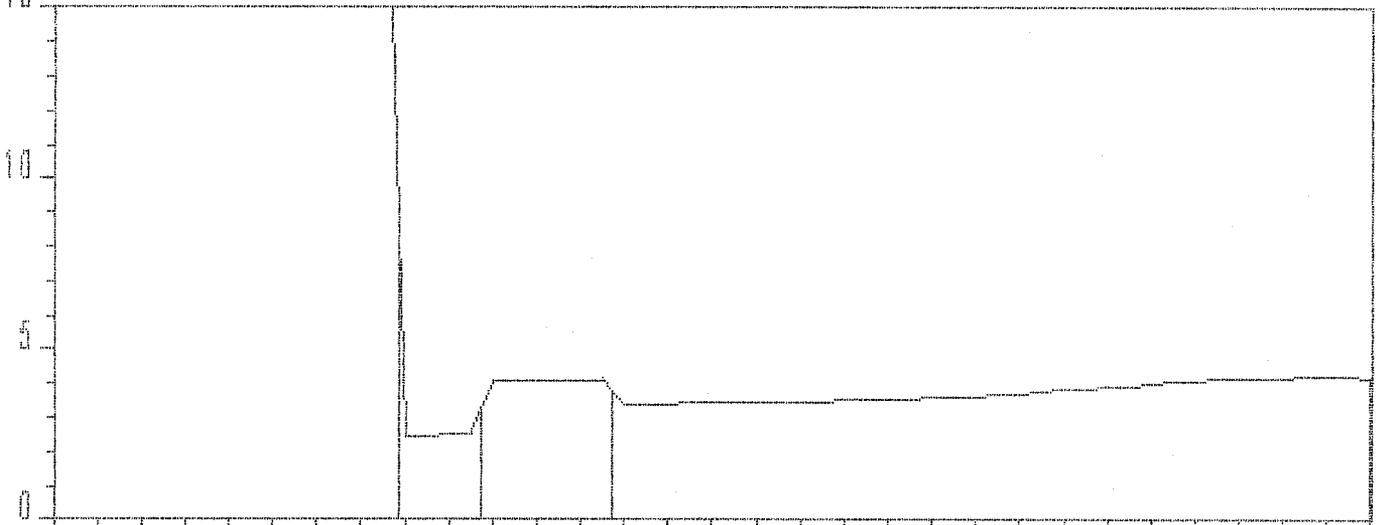
Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 11 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver



PDOP



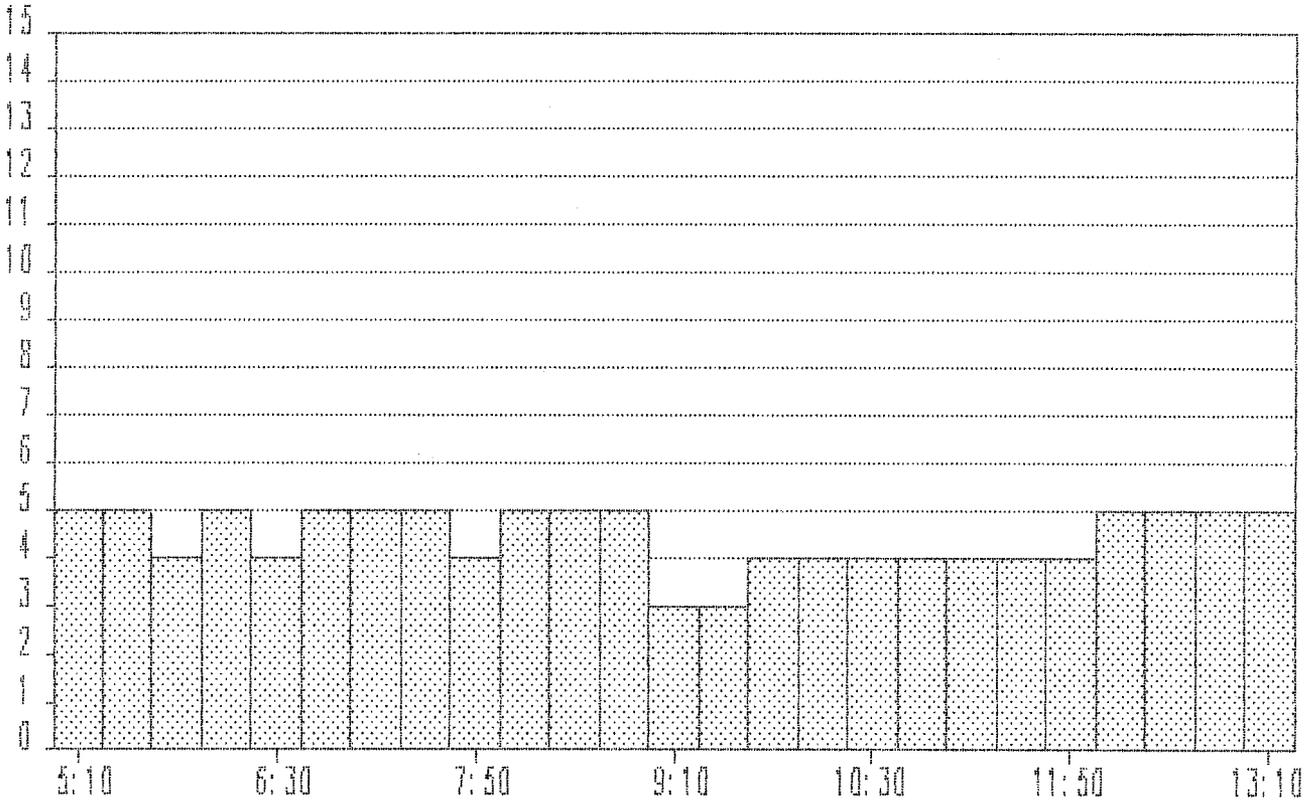
Increment of 4.0 minutes

Time

Number of Visible Satellites vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 11 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

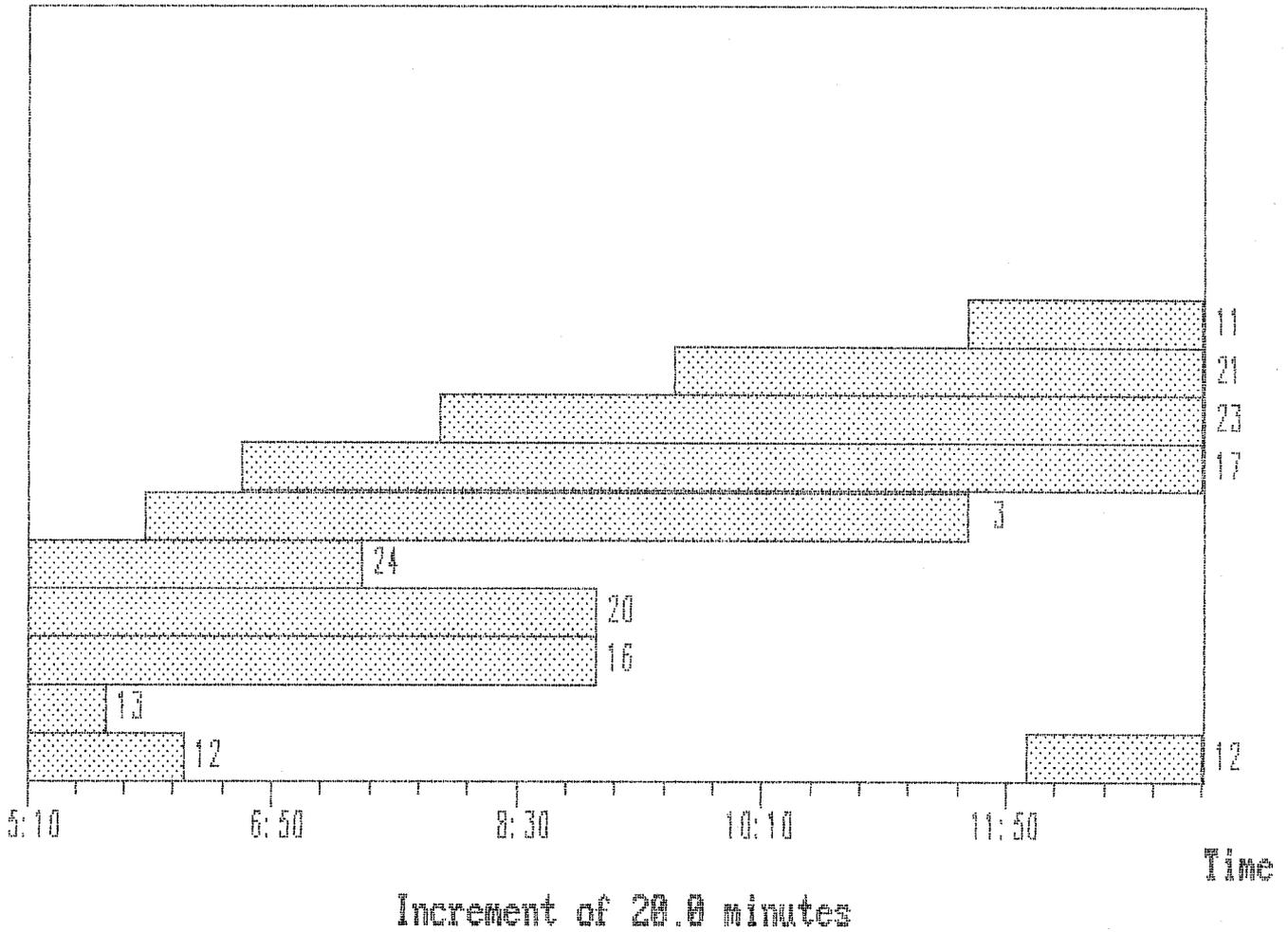


Time

Increment of 20.0 minutes

Visible Satellites vs Time

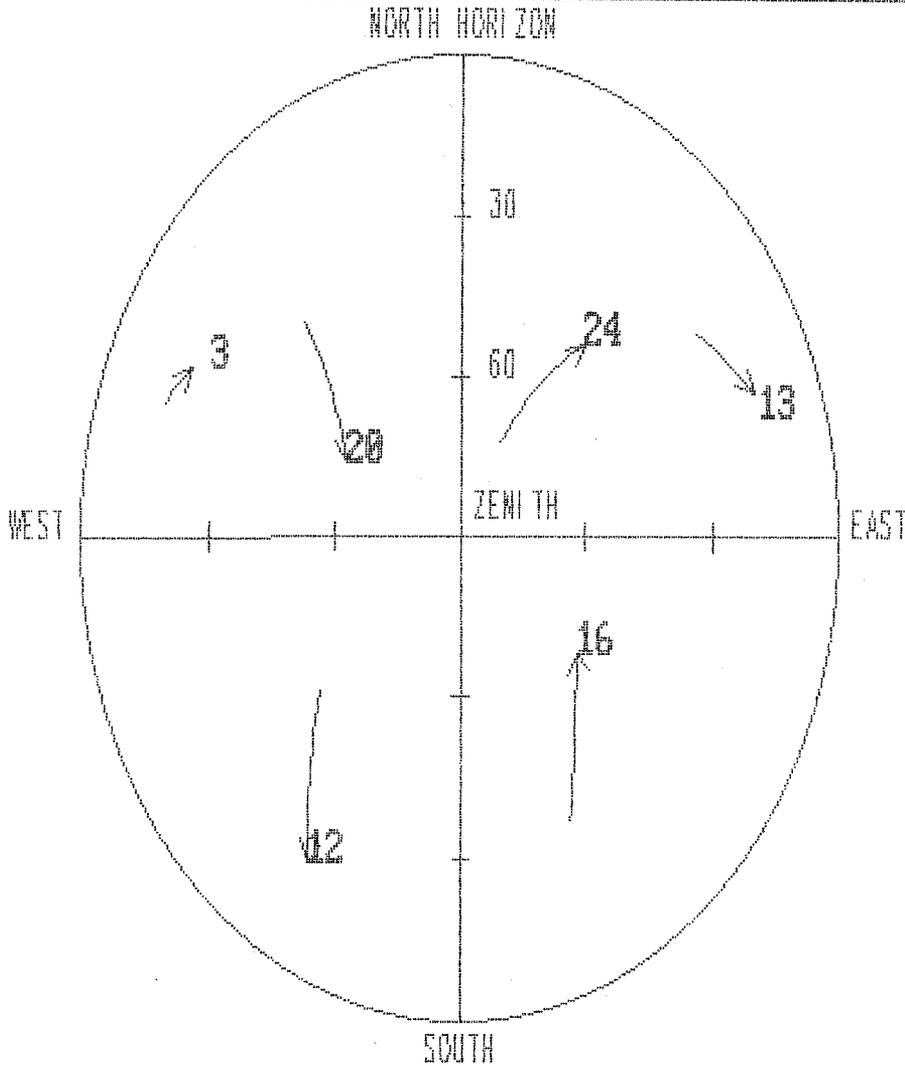
Station : MARICOPA-GPS Latitude :33 00'00"N Longitude :112 00'00"W
Date : 11 Dec 1991 Zone :- 7:00 Out-off Elevation : 15



Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 11 Dec 1991 Zone : - 7:00 Out-off Elevation : 15

Time : 5:10
to
6:10



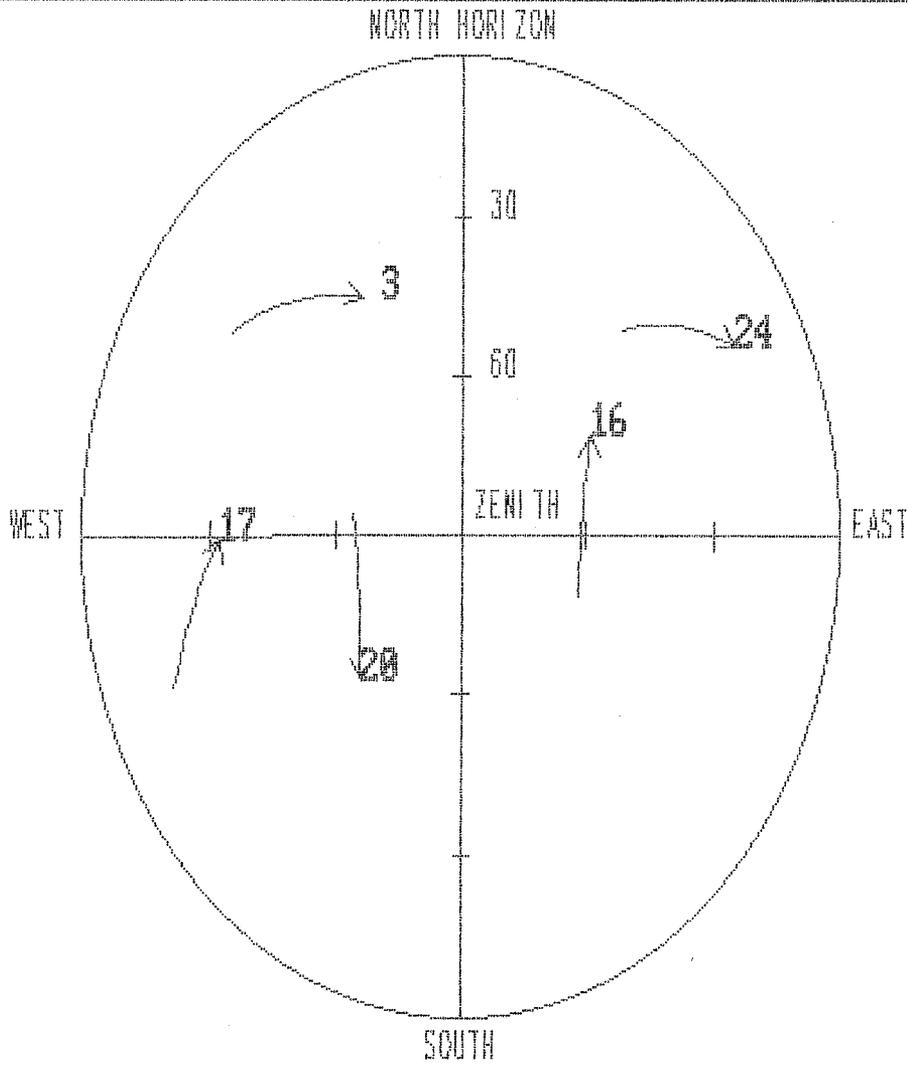


Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 11 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Time : 6:30
to
7:30

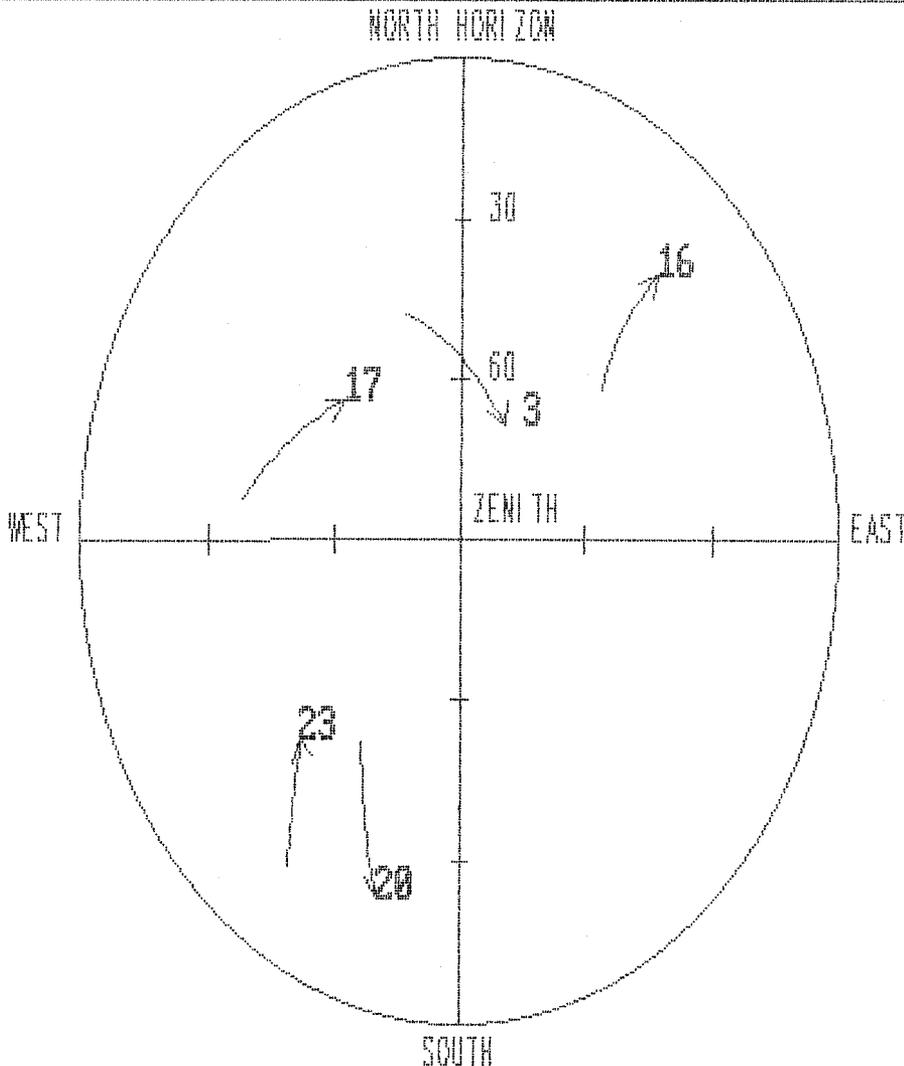


Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 11 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

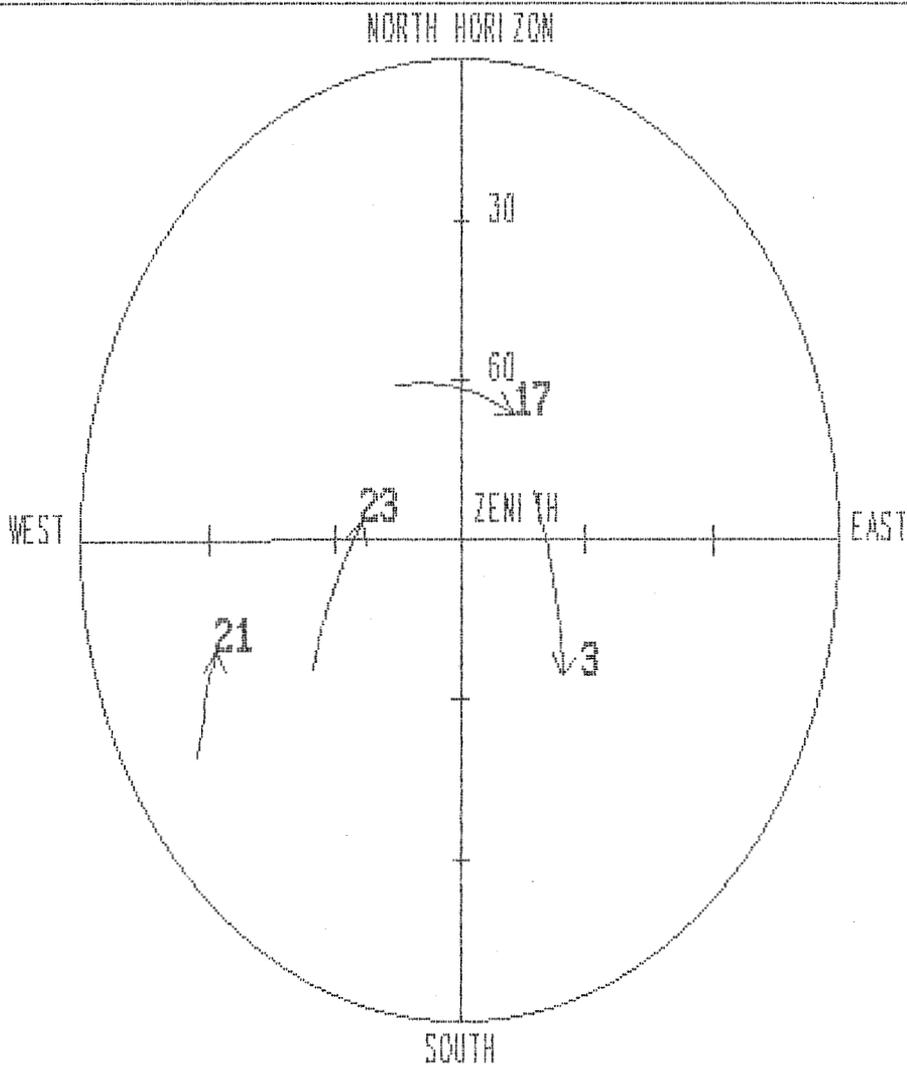
Time : 7:50
to
8:50



Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00'00"N Longitude : 112 00'00"W
Date : 11 Dec 1991 Zone :- 7:00 Cut-off Elevation : 15

Time : 9:15
to
10:15



Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS

Latitude : 33 00' 00" N

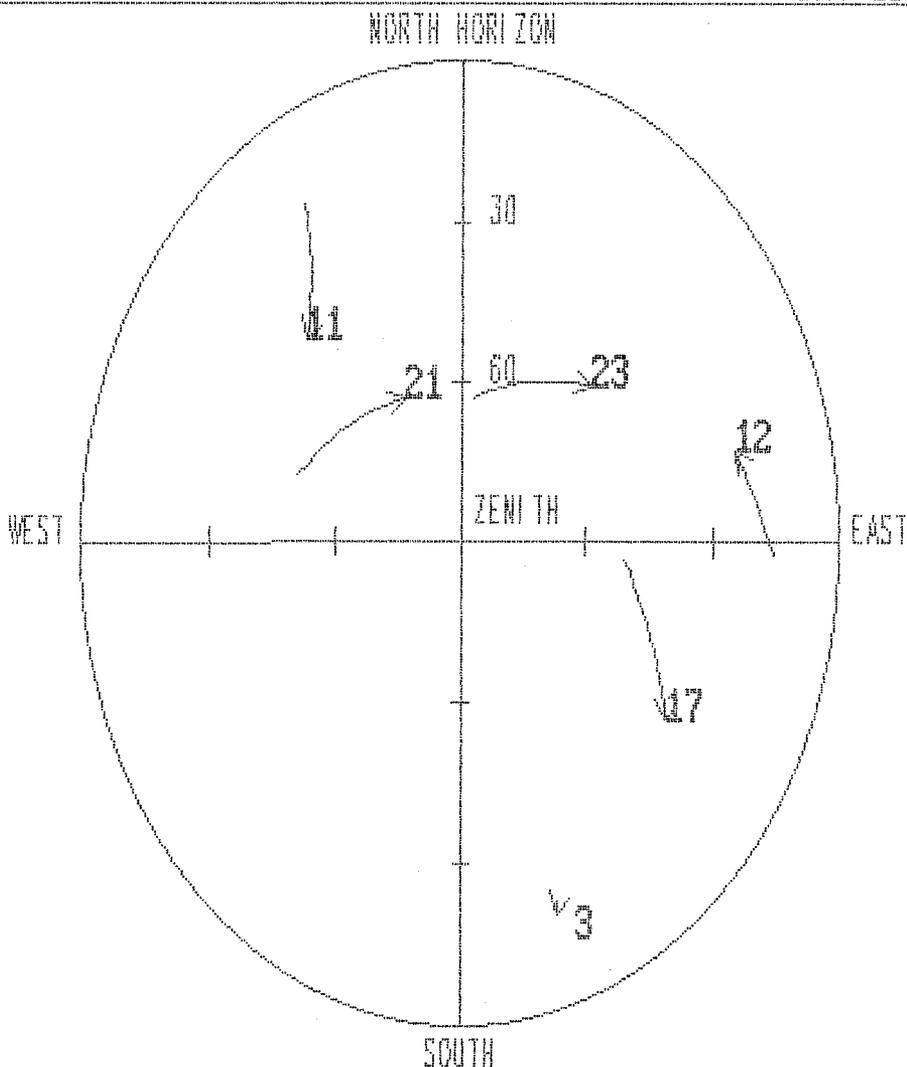
Longitude : 112 00' 00" W

Date : 11 Dec 1991

Zone : - 7:00

Cut-off Elevation : 15

Time : 11:30
to
12:30



All-In-View PDOP for MARICOPA-GPS

Date : 25 Dec 1991
 Time : 0:30 -> 0:30
 Off Elevation : 15

Latitude : 33 00' 00" N
 Longitude : 112 00' 00" W
 Zone : - 7:00

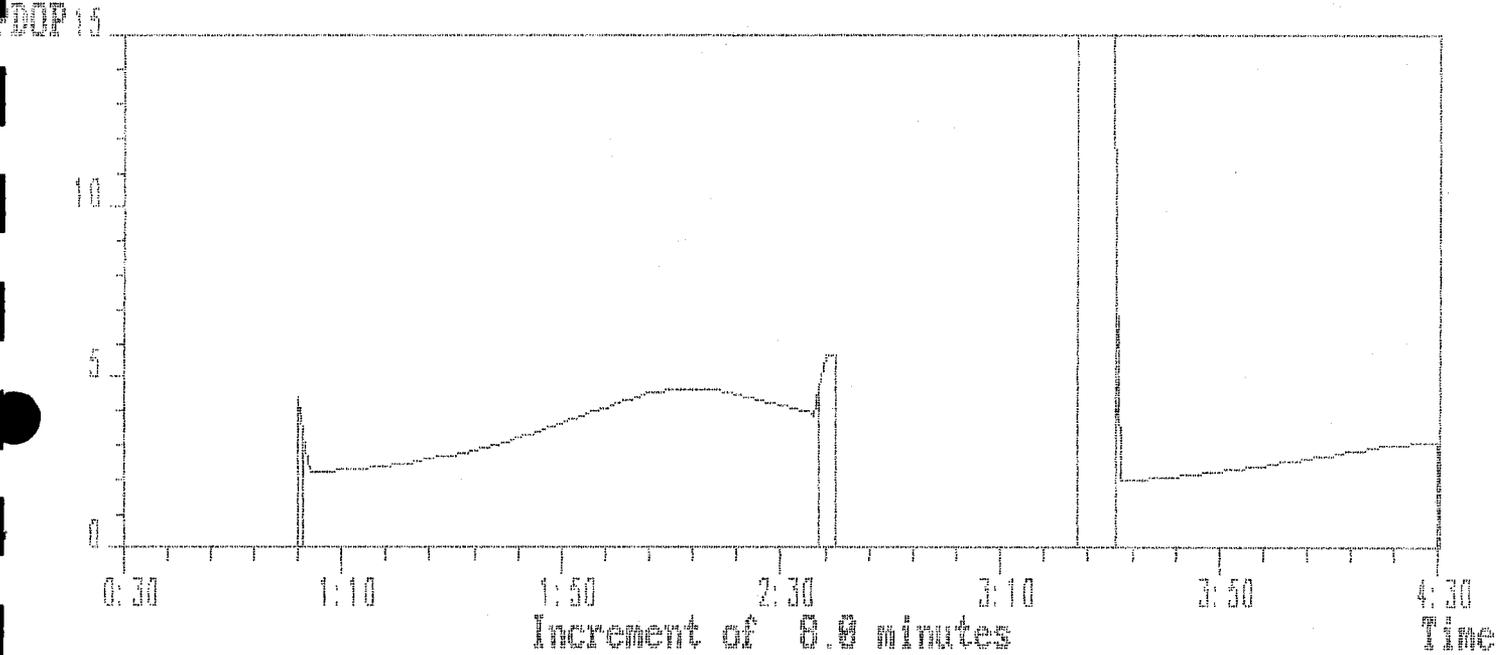
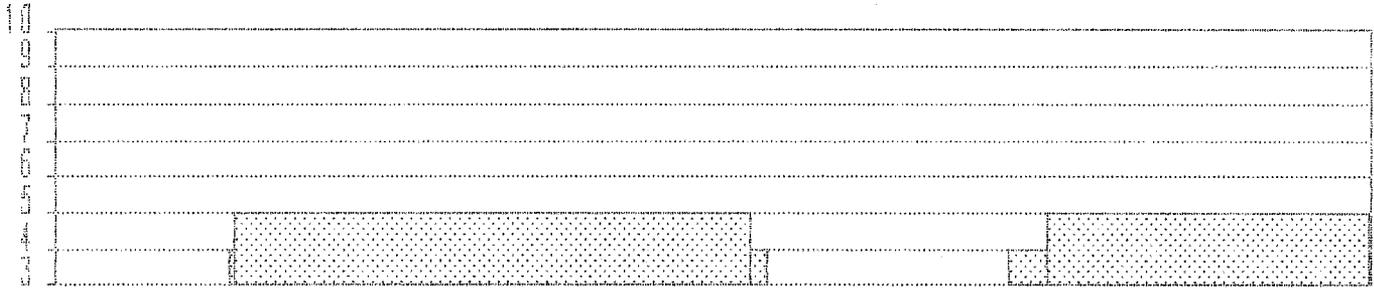
Satellite Constellation	Time Rise	Time Set	dT	PDOP Rise	PDOP Set
2 6 12 13 24	1:05	2:37	1:32	2.2	3.9
2 12 13 24	2:37	2:40	0:03	5.6	5.6
12 13 20 24	3:25	3:32	0:07	85.8	26.6
12 13 16 20 24	3:32	4:47	1:15	2.0	2.8
12 16 20 24	4:47	4:57	0:10	12.3	7.7
3 12 16 20 24	4:57	5:22	0:25	3.6	2.7
3 16 20 24	5:22	5:32	0:10	4.6	5.4
3 16 17 20 24	5:32	6:37	1:05	2.7	3.0
3 16 17 20	6:37	6:57	0:20	13.6	16.3
3 16 17 20 23	6:57	8:07	1:10	4.2	3.1
3 16 17 23	8:07	8:10	0:03	3.4	3.4
3 17 21 23	8:35	10:32	1:57	4.6	25.4
3 11 17 21 23	10:32	10:42	0:10	2.5	2.6
11 17 21 23	10:42	10:52	0:10	4.1	4.1
11 12 17 21 23	10:52	12:17	1:25	3.4	3.8
11 12 21 23	12:17	12:32	0:15	5.5	4.6
11 12 15 21 23	12:32	12:57	0:25	3.6	3.2
11 15 21 23	12:57	13:30	0:33	3.5	3.7
11 14 18 19	19:25	19:25	0:00	4.3	4.3
2 11 18 19	19:50	20:42	0:52	3.5	3.8
2 6 11 18 19	20:42	22:12	1:30	3.0	2.7
6 6 11 15 18 19	22:12	22:22	0:10	2.5	2.4
6 6 11 15 19	22:22	22:37	0:15	5.3	9.9
2 6 15 19	22:37	22:52	0:15	23.6	99.9
2 6 13 15 19	22:52	0:02	1:10	3.4	3.6
2 6 13 15	0:02	0:10	0:08	11.1	11.0

All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00"N Longitude : 112 00' 00"W
Date : 25 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver

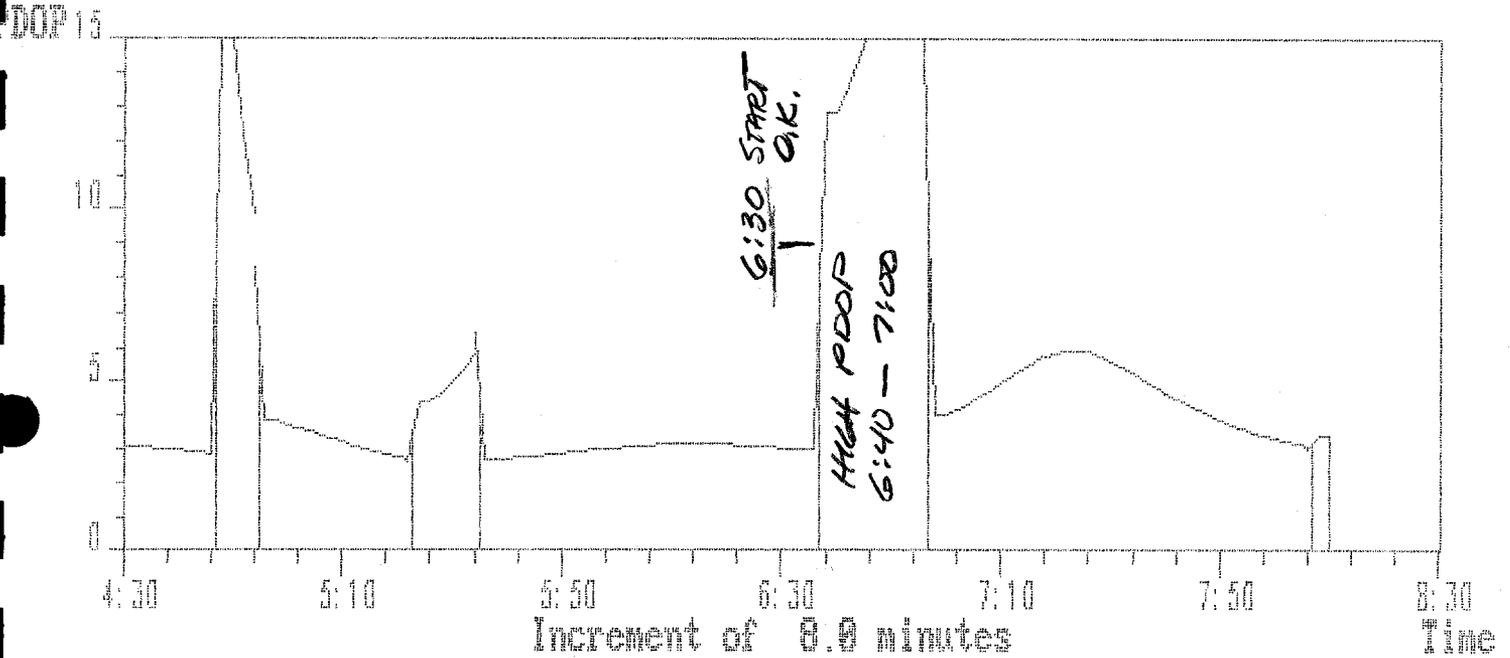
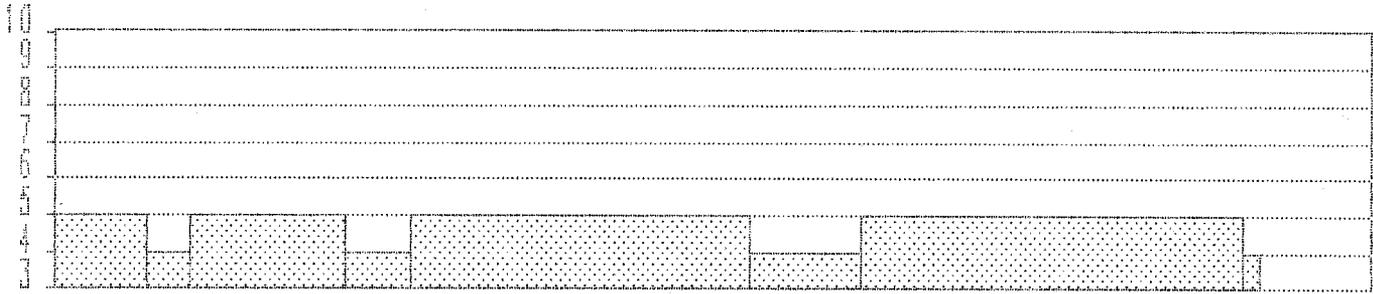


All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 25 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver

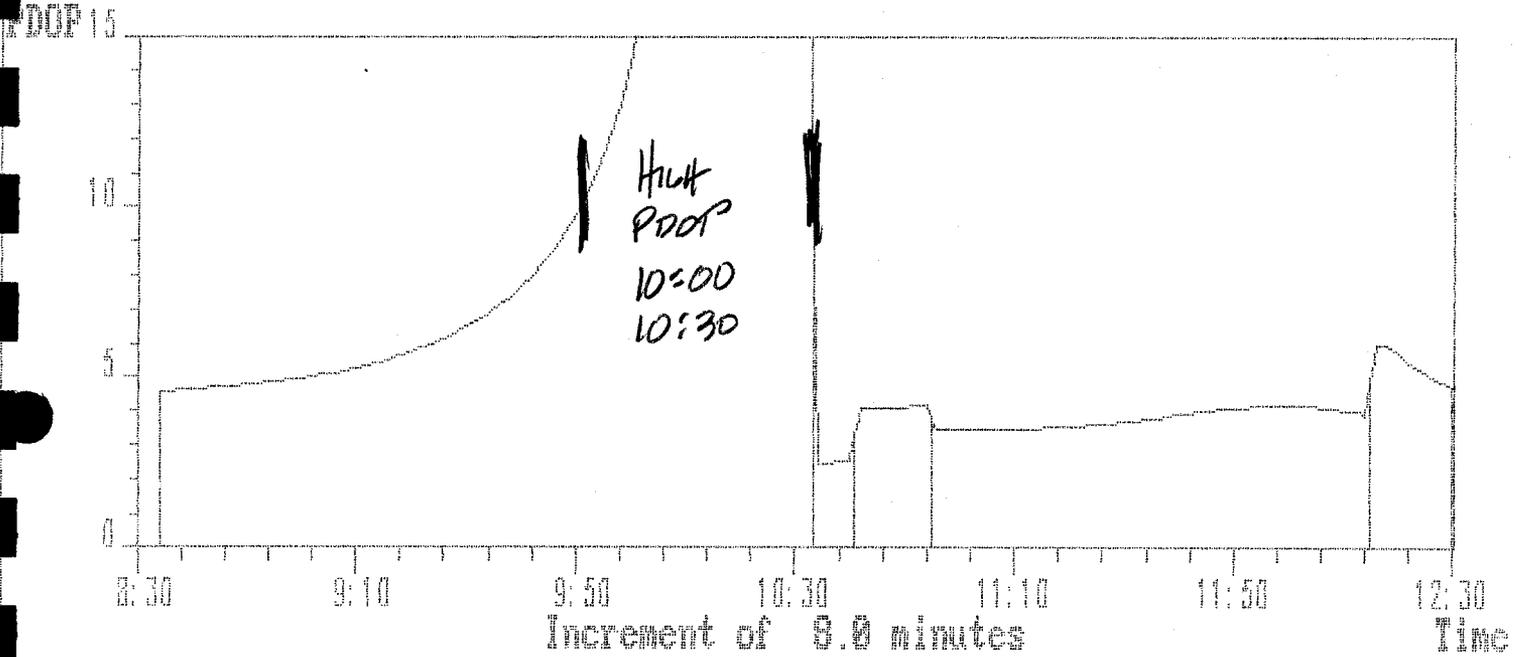
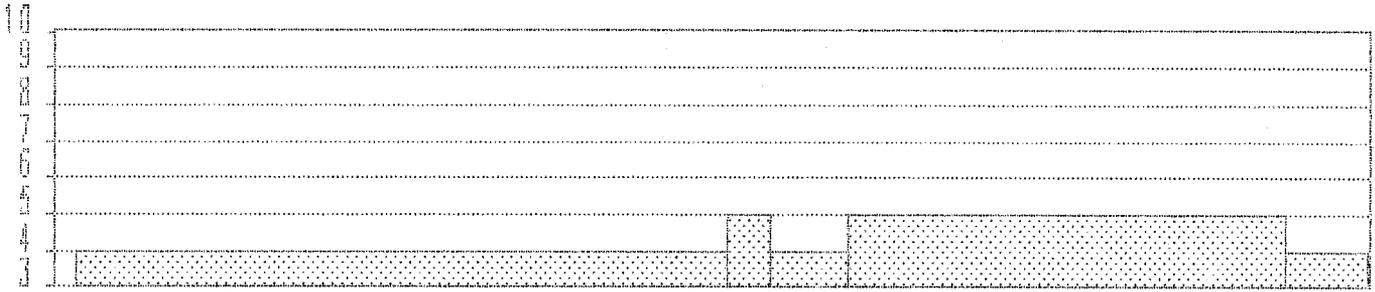


All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00"N Longitude : 112 00' 00"W
Date : 25 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Number of Satellites

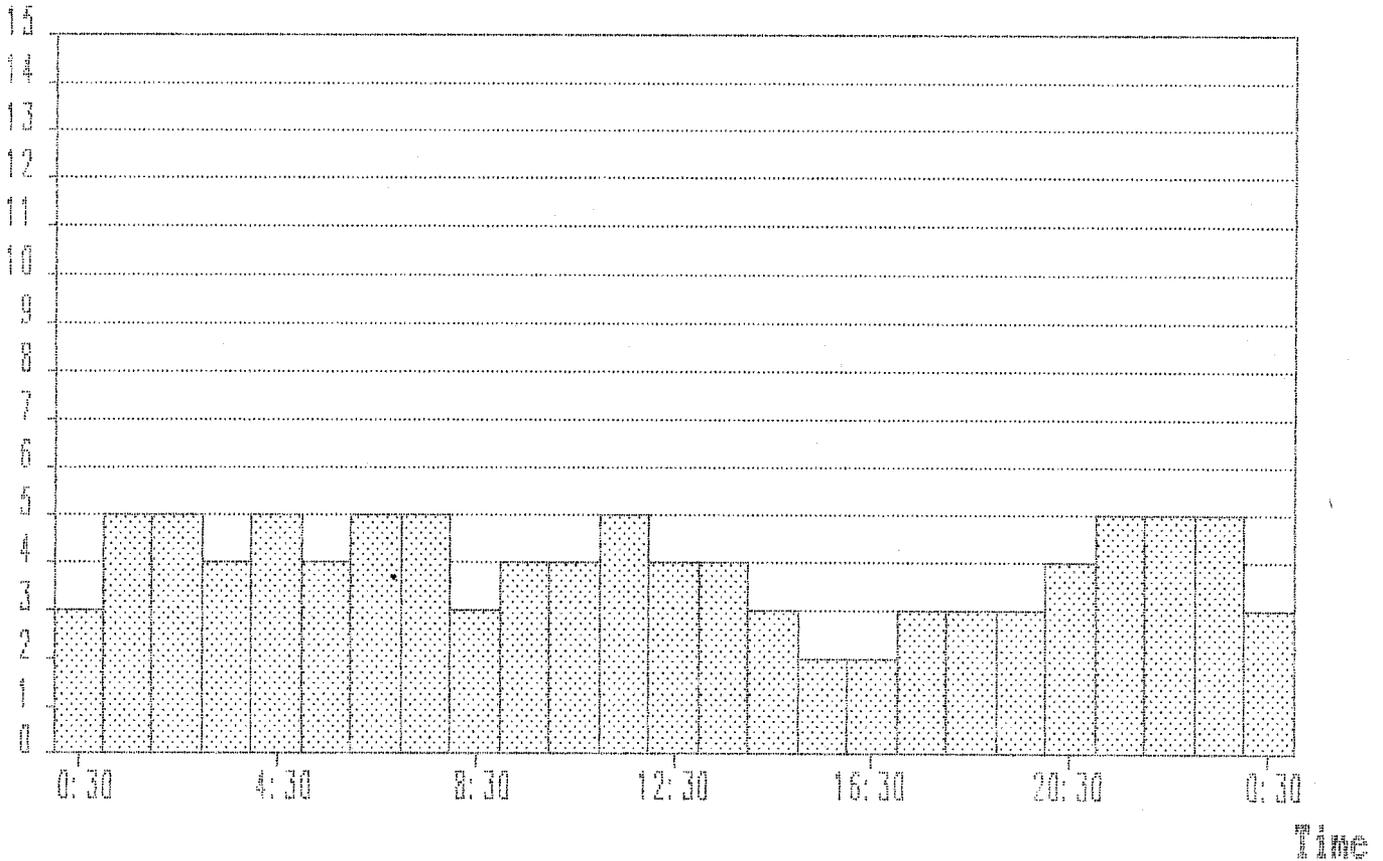
8 Channel Receiver



Number of Visible Satellites vs Time

Station : MARIKOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 25 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

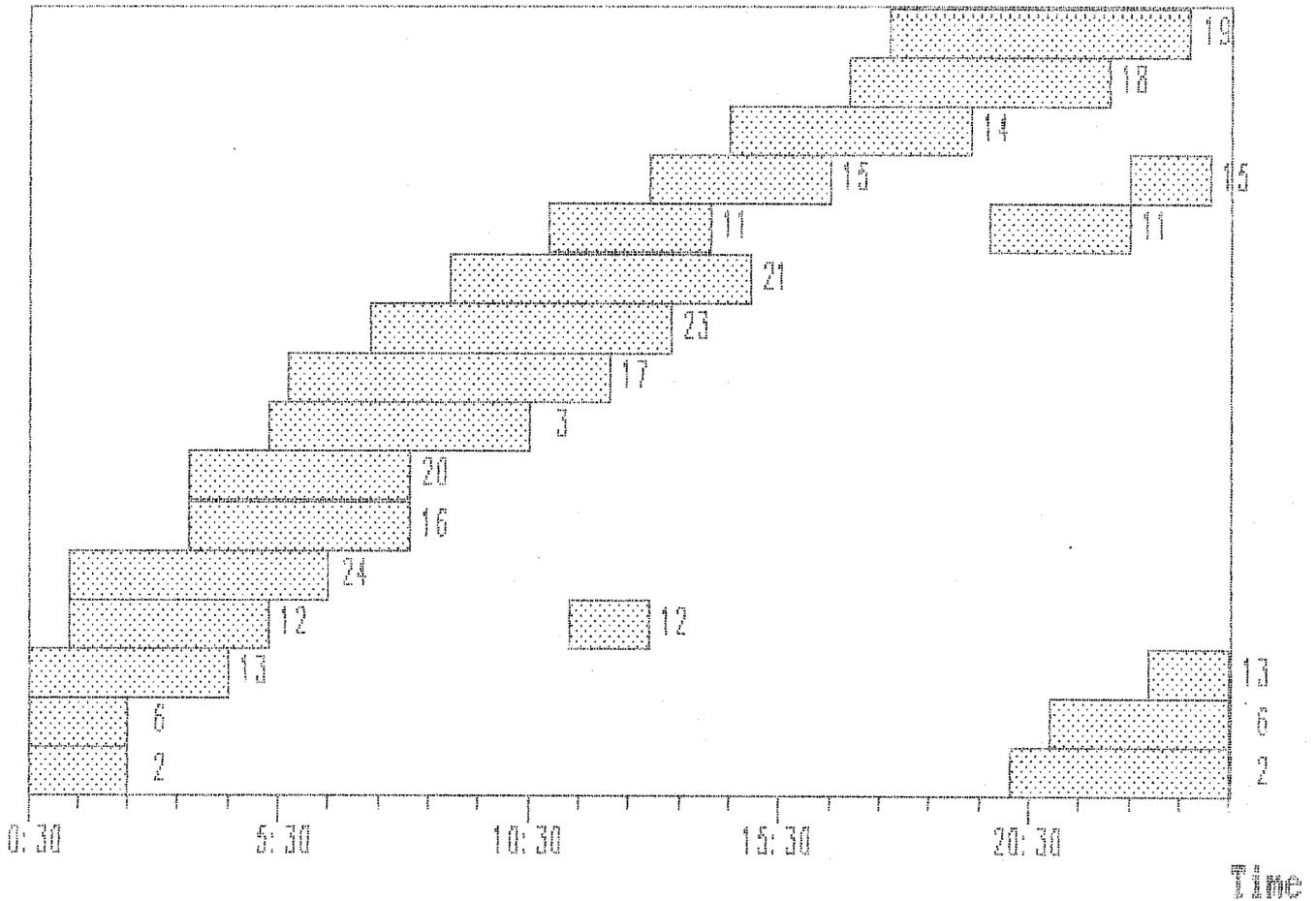
Number of Satellites



Increment of 60.0 minutes

Visible Satellites vs Time

Station : MARICOPA-GPS Latitude : 33 00' 00"N Longitude : 112 00' 00"W
Date : 25 Dec 1991 Zone : - 7:00 Out-off Elevation : 15



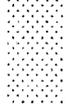
Increment of 60.0 minutes

Skyplot : Azimuth vs Elevation

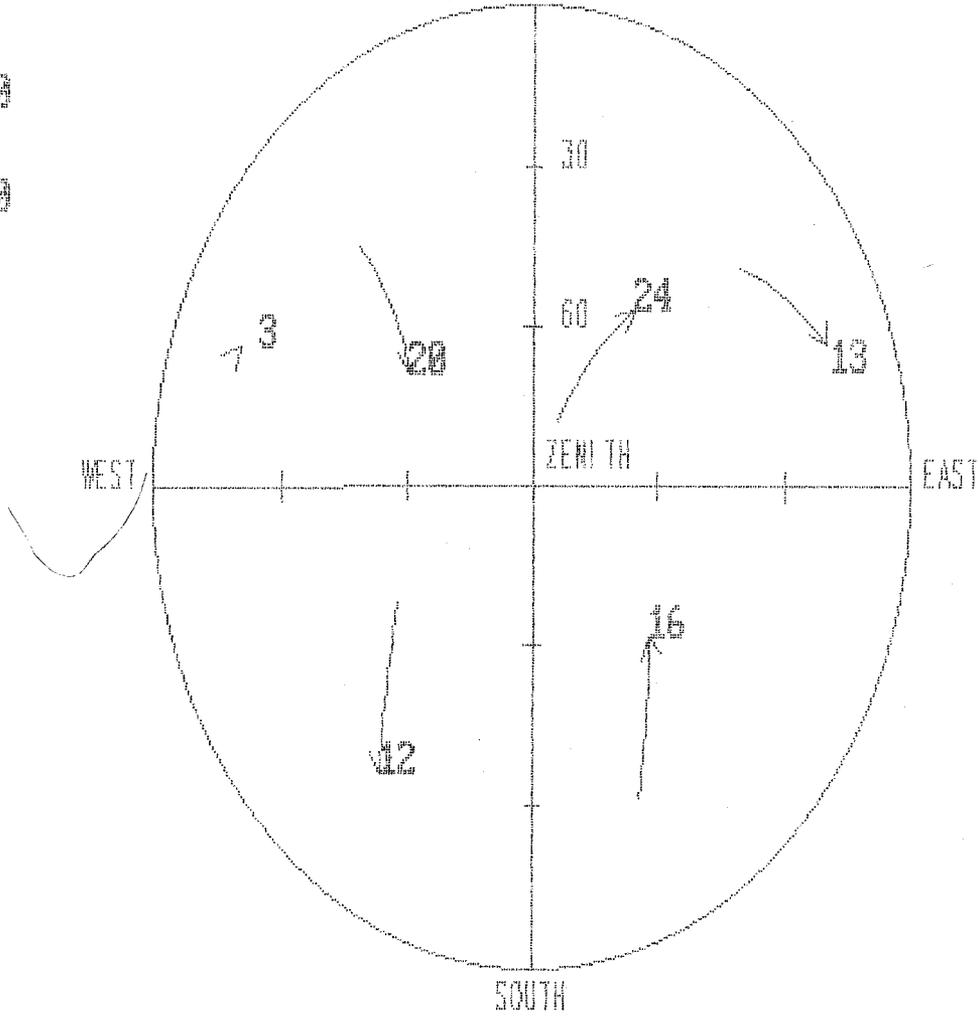
Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 25 Dec 1991 Zone :- 7:00 Out-off Elevation : 15

NORTH HORIZON

Time : 4:00
to
5:00



Curtain



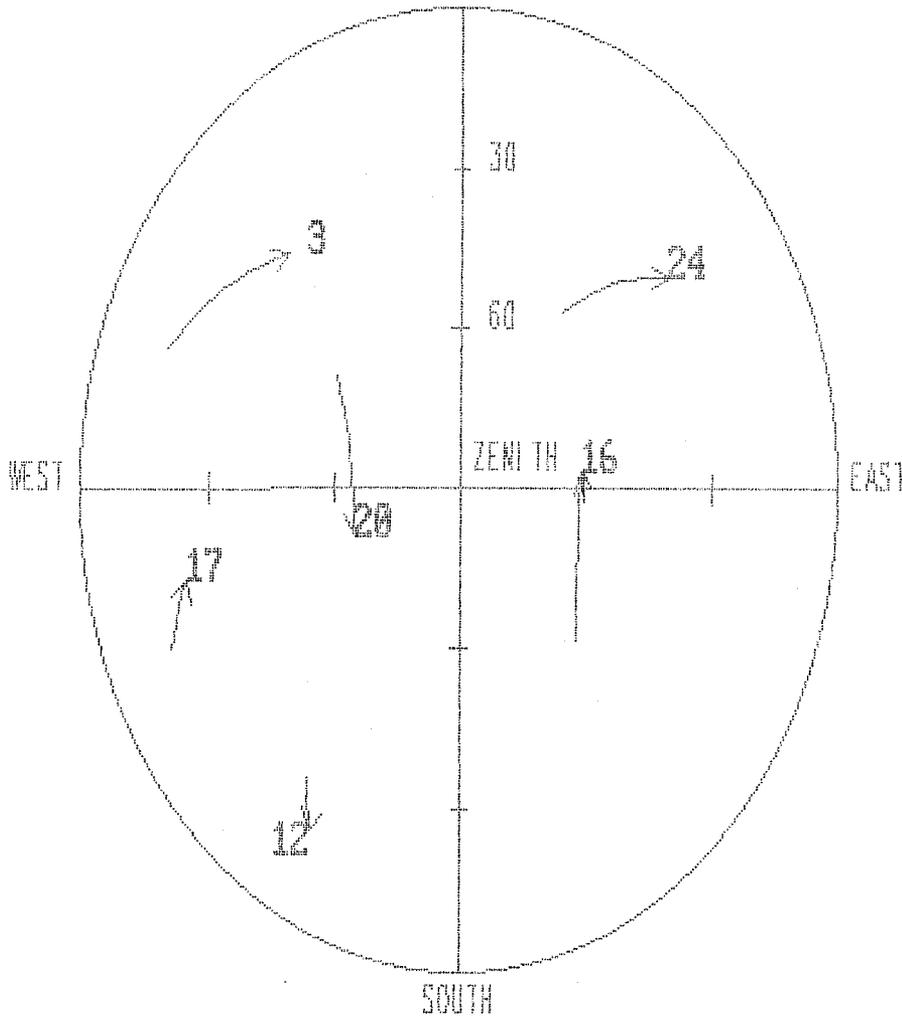
Skyplot : Azimuth vs Elevation

Station : NARIKOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 25 Dec 1991 Zone : - 7:00 Out-off Elevation : 15

NORTH HORIZON

Time : 5:00
to
6:00

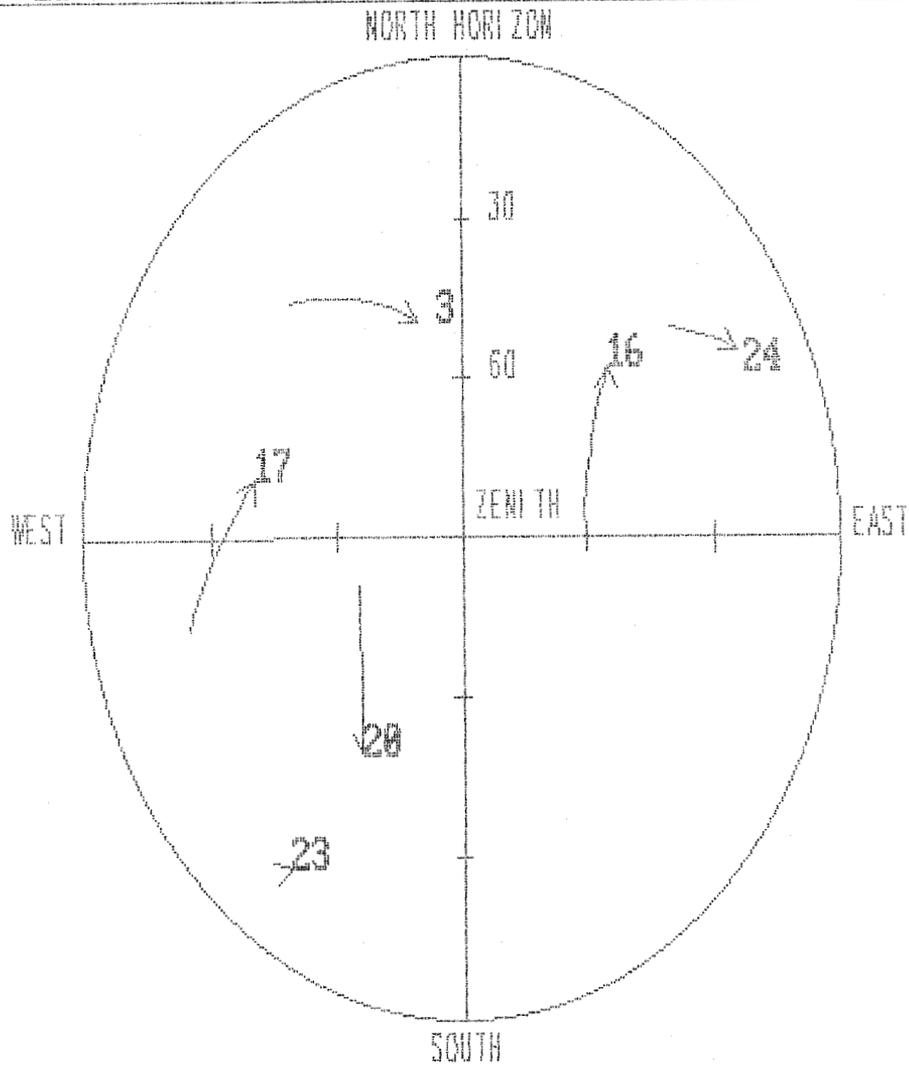


Curtain

Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00'00"N Longitude : 112 00'00"W
Date : 25 Dec 1991 Zone :- 7:00 Cut-off Elevation : 15

Time : 6:00
to
7:00



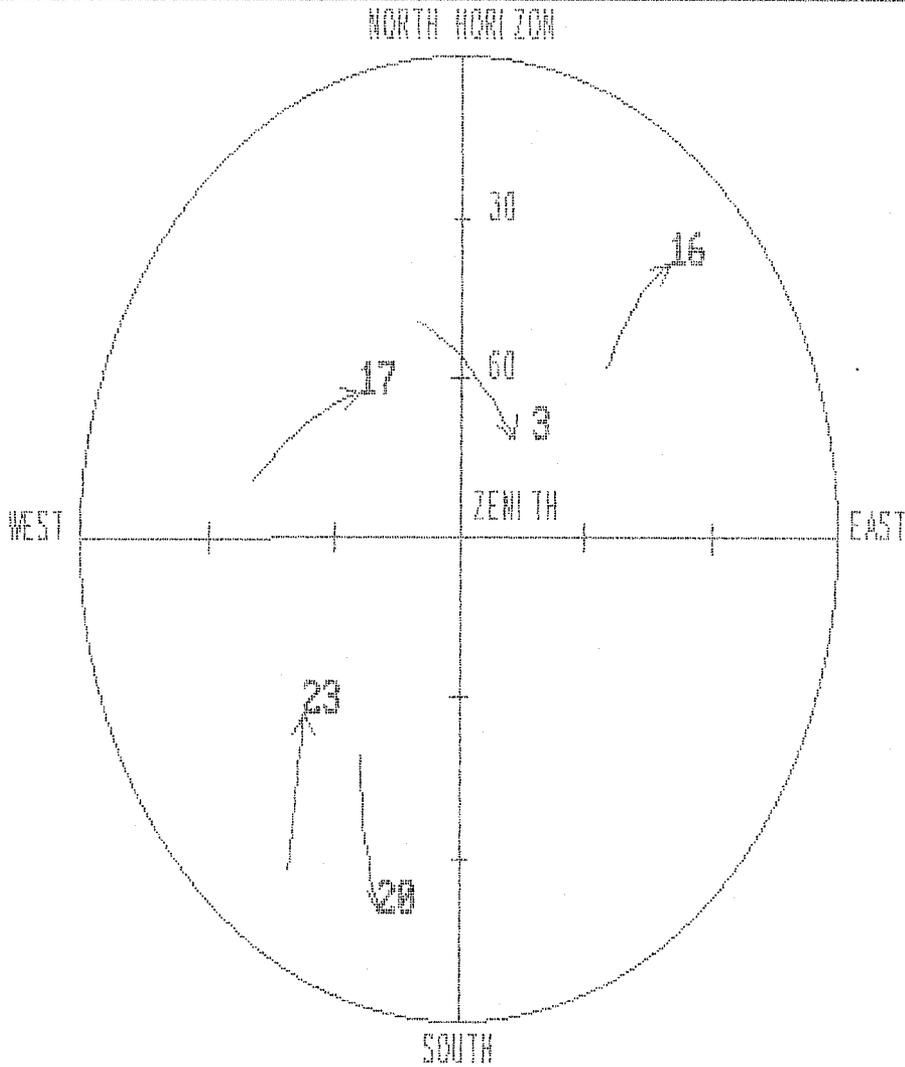
 Curtain

Skyplot : Azimuth vs Elevation

Station : MARIQUA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 25 Dec 1991 Zone :- 7:00 Out-off Elevation : 15

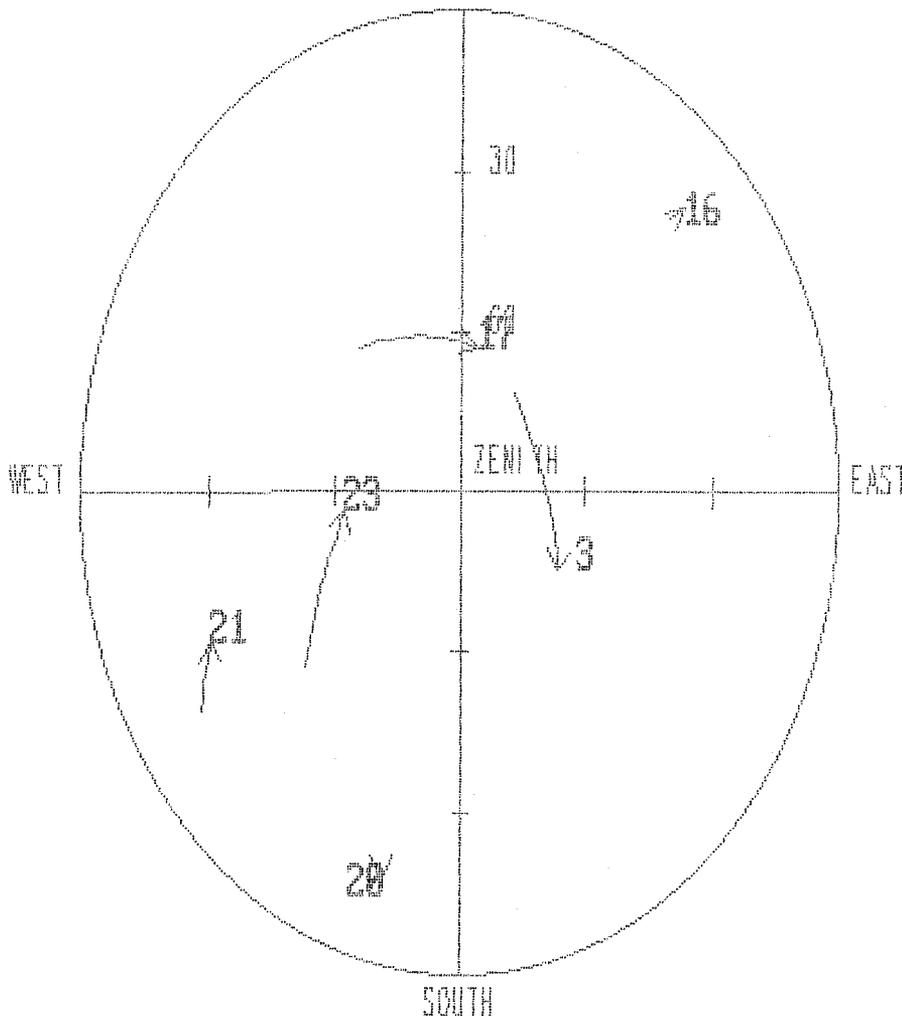
Time : 7:00
to
8:00



Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W
Date : 25 Dec 1991 Zone : - 7:00 Out-off Elevation : 15

NORTH HORIZON



Skyplot : Azimuth vs Elevation

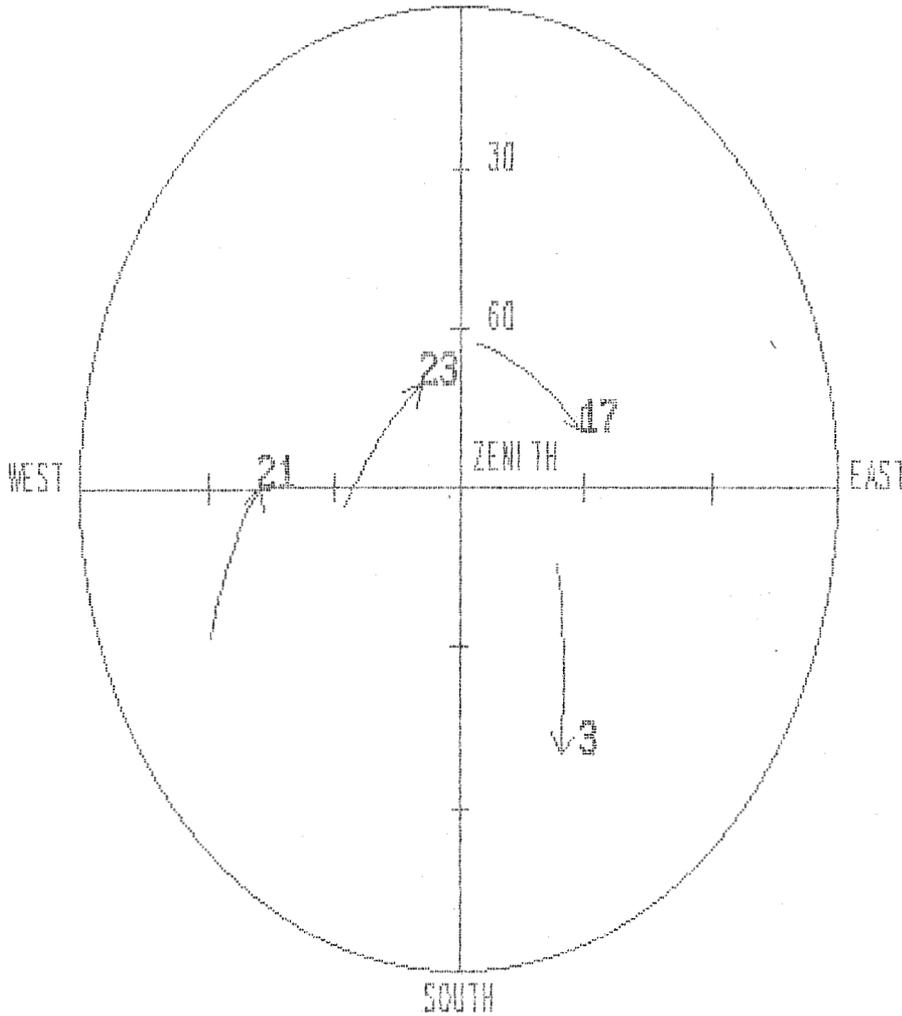
Station : MARICOPA-GPS Latitude : 33 00'00"N Longitude : 112 00'00"W

Date : 25 Dec 1991 Zone : - 7:00 Out-off Elevation : 15

NORTH HORIZON

Time : 9:00
to
10:00

 Curtain

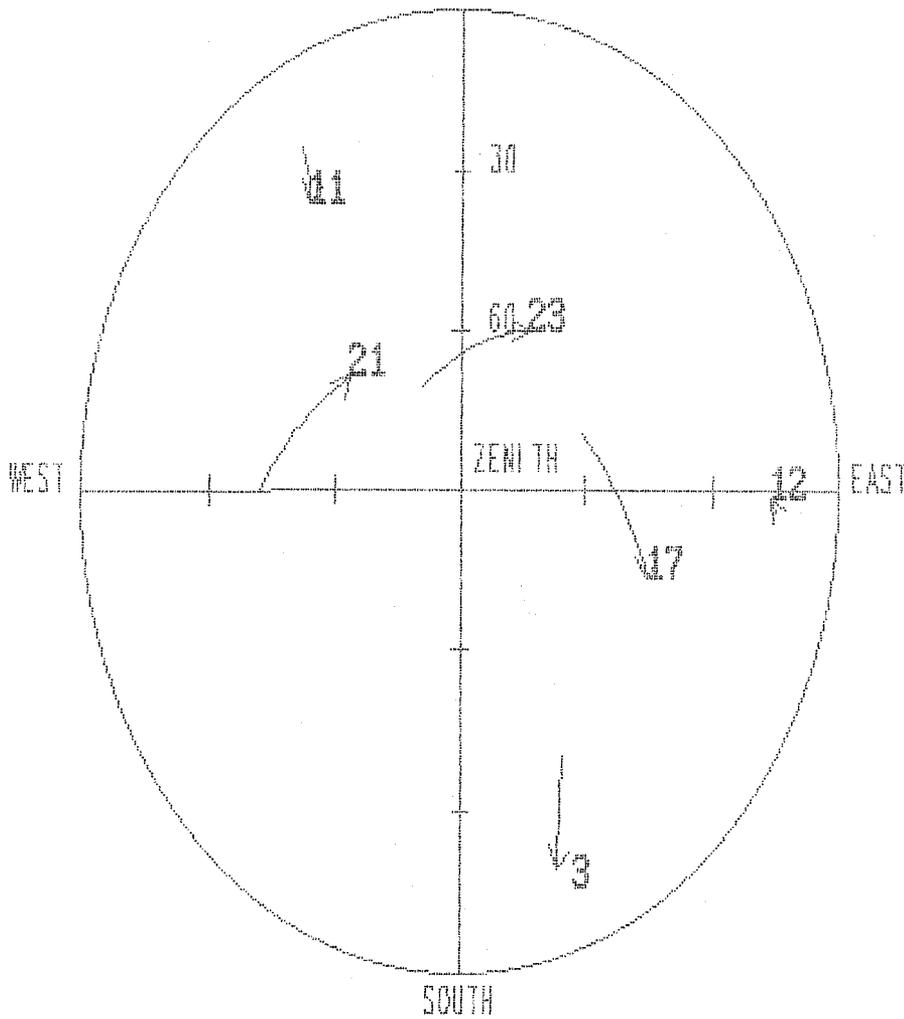


Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 25 Dec 1991 Zone : - 7:00 Out-off Elevation : 15

NORTH HORIZON



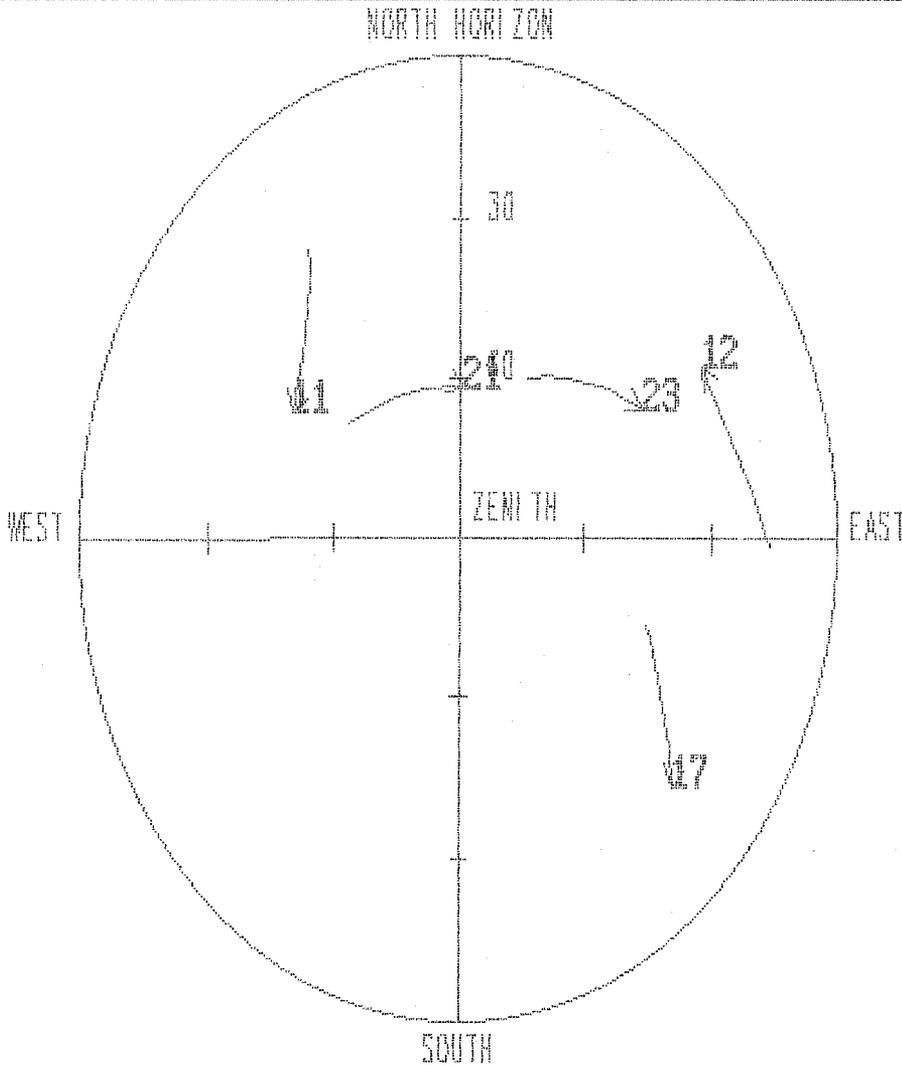
Time : 10:00
to
11:00

Skyplot : Azimuth vs Elevation

Station : MARICOPA-GPS Latitude : 33 00' 00" N Longitude : 112 00' 00" W

Date : 25 Dec 1991 Zone : - 7:00 Cut-off Elevation : 15

Time : 11:00
to
12:00



Curtain

All-In-View PDOP for MARICOPA-GPS

Date : 15 Jan 1992
 Time : 3:30 -> 11:30
 Cut-off Elevation : 15

Latitude : 33 00' 00" N
 Longitude : 112 00' 00" W
 Zone : - 7:00

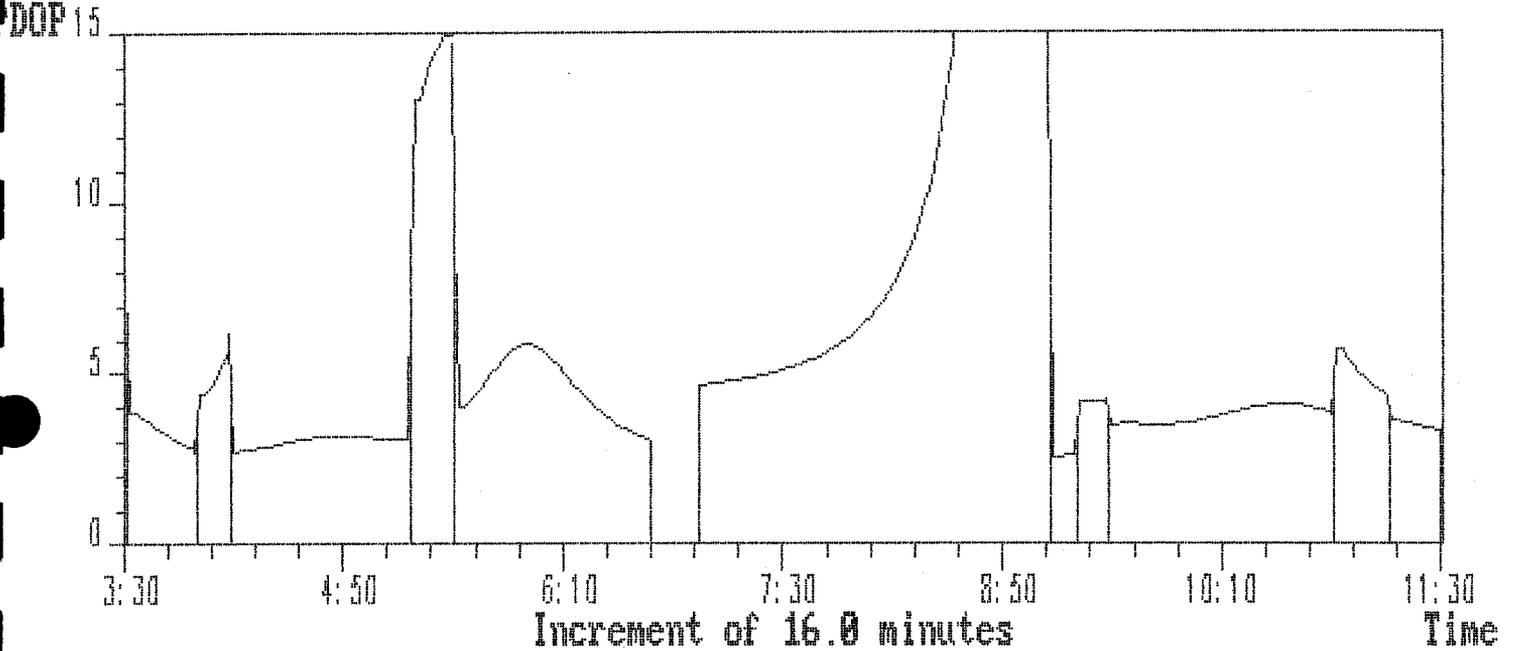
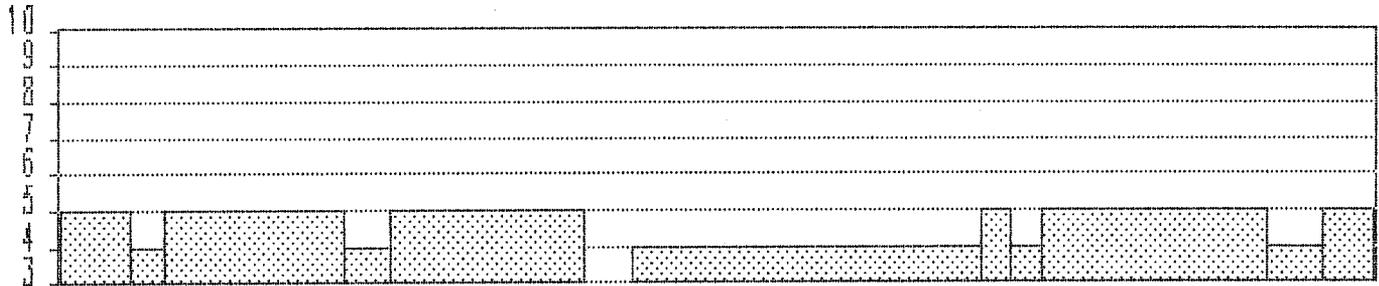
Satellite Constellation	Time Rise	Time Set	dT	PDOP Rise	PDOP Set
12 16 20 24	3:30	3:31	0:01	7.9	7.9
3 12 16 20 24	3:31	3:57	0:26	3.9	2.7
3 16 20 24	3:57	4:09	0:12	4.4	6.2
3 16 17 20 24	4:09	5:15	1:06	2.7	3.1
3 16 17 20	5:15	5:31	0:16	13.1	14.7
3 16 17 20 23	5:31	6:42	1:11	4.0	3.0
3 17 21 23	7:00	9:07	2:07	4.7	19.2
3 11 17 21 23	9:07	9:17	0:10	2.5	2.7
11 17 21 23	9:17	9:29	0:12	4.2	4.2
11 12 17 21 23	9:29	10:51	1:22	3.5	3.8
11 12 21 23	10:51	11:11	0:20	5.7	4.2
11 12 15 21 23	11:11	11:30	0:19	3.6	3.3

All-In-View PDOP vs Time

Station : MARICOPA-GPS Latitude :33 00'00"N Longitude :112 00'00"W
Date : 15 Jan 1992 Zone :- 7:00 Cut-off Elevation : 15

Number of Satellites

8 Channel Receiver



Increment of 16.0 minutes

Time