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PHILCO CORPORATION — Western Development Laboratories

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22 April 1963

SUBJECT: Contract AF04(695)-278
Submittal of WDL-TR1943, Volume IV, as a deliverable item

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(b) Exhibit "B" W/S to AF04(695)-278, Paragraph 8.0
(c) AFBM Exhibit 58-1, Paragraph 4.2.2

In accordance with the requirements of references (a), (b), and (c), we are forwarding ten (10) copies of the following document:

Title	Number and Date
Special Parameter Tracking Simulation Study, Low Altitude Satellite	WDL-TR1943 Volume IV 22 April 1963

PHILCO CORPORATION
Western Development Laboratories

R. W. Boyd

R. W. Boyd
Manager, Contracts Management

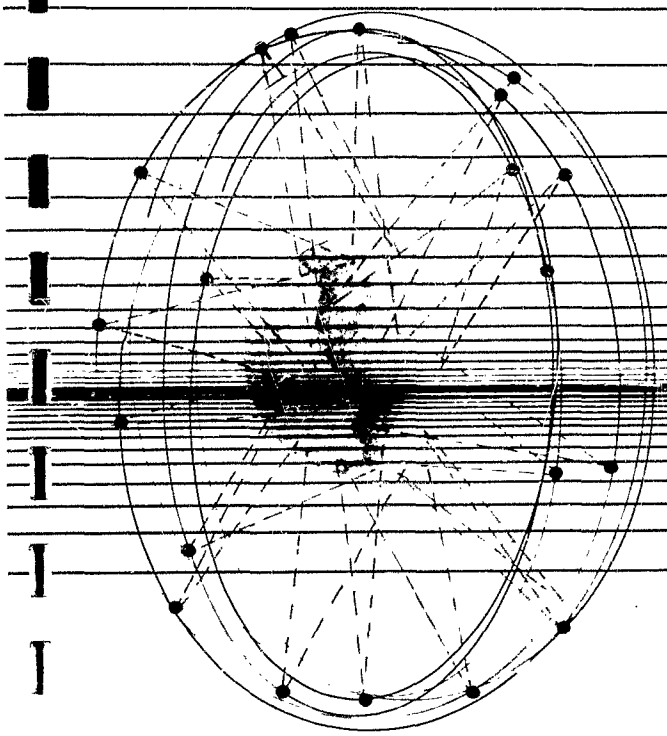
8/11.00

WDL-TRI943

VOLUME IV

TECHNICAL DOCUMENTARY REPORT

22 APRIL 1963



SPECIAL PARAMETER TRACKING SIMULATION STUDY LOW ALTITUDE SATELLITE VOLUME IV

PREPARED FOR:

AIR FORCE SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
INGLEWOOD, CALIFORNIA

CONTRACT NO. AF04(695) -113

PHILCO
A SUBSIDIARY OF Ford Motor Company

WESTERN DEVELOPMENT LABORATORIES
PALO ALTO, CALIFORNIA

(11) Rept. no.
WDL-TR1943, vol. 4
Volume ~~IV~~
(9) 22 April ~~1~~ 1963

(7)
TECHNICAL DOCUMENTARY REPORT

(6)
SPECIAL PARAMETER TRACKING SIMULATION STUDY LOW ALTITUDE SATELLITE VOLUME IV

Prepared by

(5) 697 900

PHILCO CORPORATION
Western Development Laboratories
Palo Alto, California

(8) NA

(10) 1v. incl. illus. tables

(12) Contract AF04(695)-278

(13) NA
(14) Unclassified
(15) NA

Prepared for

SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Inglewood, California

SUMMARY

This report presents results in satellite position and velocity accuracy as a function of tracking data, number of passes, station latitude separation, and other pertinent variables in graphical form. The information in this report, which is to be used as a design tradeoff handbook for error propagation in orbit determination, was obtained by using the Co-Variance (Fixed Bias) Simulator Program and a detailed list of AFSSD-supplied tradeoff parameters.

Volume IV is an extension of Volume I (125 nmi orbit, overhead pass) with tracked passes made through 120°, 90°, and 60° of azimuth.

Paragraph 1 contains general introductory material to the report.

Paragraph 2 discusses the parameter cases which were used for this study.

Paragraph 3 describes the information and notations presented on the graphs.

Paragraph 4 comments on the assumptions of the Co-Variance (Fixed-Bias) Program.

Tabular information concerning sensor errors appears preceding the Appendix Section I graphs and Appendix Section II graphs.

ABSTRACT

PHILCO WDL-TR1943 UNCLASSIFIED
SPECIAL PARAMETER
TRACKING SIMULATION STUDY
LOW ALTITUDE SATELLITE-VOLUME IV 140 pages
22 April 1963 Contract AF04(695)-113

This report presents results in satellite position and velocity accuracy as a function of tracking data, number of passes, station latitude separation, and other pertinent variables in graphical form. The information was obtained by using the Co-Variance (Fixed-Bias) Simulator Program and a detailed list of AFSSD-supplied tradeoff parameters. The report is to be used as a design tradeoff handbook for error propagation in orbit determination. Volume IV is an extension of Volume I, with tracked passes made through 120°, 90°, and 60° of azimuth.

THIS UNCLASSIFIED ABSTRACT IS DESIGNED FOR RETENTION IN A STANDARD 3-BY-5 CARD-SIZE FILE, IF DESIRED. WHERE THE ABSTRACT COVERS MORE THAN ONE SIDE OF THE CARD, THE ENTIRE RECTANGLE MAY BE CUT OUT AND FOLDED AT THE DOTTED CENTER LINE. (IF THE ABSTRACT IS CLASSIFIED, HOWEVER, IT MUST NOT BE REMOVED FROM THE DOCUMENT IN WHICH IT IS INCLUDED.)

FOREWORD

This Technical Documentary Report has been prepared in accordance with Exhibit "D" to Letter Contract AF04(695)-278 and Paragraph 4.2.2 of AFBM Exhibit 58-1, "Contractor Reports Exhibit", dated 1 October 1959, as revised and amended.

This report was prepared by Philco Western Development Laboratories in fulfilling the requirements of Paragraph 8.0 of Exhibit "B", Work Statement to Contract AF04(695)-278.

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SPECIAL PARAMETER TRACKING SIMULATION STUDY LOW ALTITUDE SATELLITE

1. GENERAL

This report was prepared by the Mathematical Analysis Department of Philco WDL by using the Co-Variance, Fixed-Bias Simulator Program. It is to be used as a design tradeoff handbook for error propagation in orbit determination. This report presents, in graphical form, the results and trends in satellite position accuracy as a function of tracking data error magnitudes, different combinations of tracking data, number of passes, station separation, and other pertinent variables.

Volume IV contains additional results for the 125 nmi circular polar orbit. The passes, however, are not overhead and the effects of both fixed and random errors are included.

2. PARAMETER CASES

In the set of parameter cases considered in this report, the tracking configurations and sensor accuracies listed in Table I were used. The following combinations were run:

a. Sensors "a" and "b" in all cases (i.e., A-1 through C-3 for Sections I and II, with all combinations of sensor accuracies except a range error of 1000 feet and an azimuth and elevation error of 0.25 milliradian).

b. One sample per 4 seconds was assumed in all orbits.

c. All data within 5° of the horizon was used. The passes were through 120°, 90°, or 60° of azimuth.

d. For fixed error only, the 1000-foot error in range and 0.25-milliradian error in angles was used separately in sensor case "a" and with 0.1 foot per second error in range rate in sensor case "b".

TABLE I. CONFIGURATIONS AND SENSOR ACCURACIES

CONFIGURATION	
A: Passes through 120° of azimuth (17.2° maximum elevation angle)	
1: one station	one pass (69 data points)
2: two stations with 45° latitude separation	one pass each station (138 data points)
3: two stations with 90° latitude separation	one pass each station (138 data points)
B: Passes through 90° of azimuth (10.5° maximum elevation angle)	
1: one station	one pass (57 data points)
2: two stations with 45° latitude separation	one pass each station (114 data points)
3: two stations with 90° latitude separation	one pass each station (114 data points)
C: Passes through 60° of azimuth (7.1° maximum elevation angle)	
1: one station	one pass (42 data points)
2: two stations with 45° latitude separation	one pass each station (84 data points)
3: two stations with 90° latitude separation	one pass each station (84 data points)
Orbit Case I: Fixed Error Orbit Case II: Random Error	

SENSOR ACCURACIES	
Sensor Case "a"	R, θ, Φ
Sensor Case "b"	$R, \dot{R}, \theta, \Phi$
Angle accuracies	0.25, 1 milliradian
Range accuracies	50, 300, 1000 feet
Range-rate accuracies	0.1, 1 foot/second

Outputs of the above simulations are plots of in-track, altitude, and cross-track position and velocity errors versus time through one revolution from the last sighting. The plots have the last sighting on a common axis for ready cross-comparison.

3. DESCRIPTION OF GRAPHS

For fixed bias, each graph consists of the errors in the orbit's Frenet trihedron coordinates plotted against time. For covariance, each graph consists of the standard deviations of the orbit's Frenet trihedron coordinates (X,Y,Z) plotted against time. The Frenet trihedron coordinates (X,Y,Z) are the set of local coordinates in the orbital plane and normal to it with the origin in the satellite's position and with the following directions:

X is in the direction of the velocity vector,

Y is orthogonal to the left (directed counterclockwise through 1/2 in the orbital plane, and

Z is perpendicular to (X,Y) by the righthand rule.

Then, for a circular orbit:

σ_x or Δ_x is the in-track error,

σ_x or Δ_y is the altitude error, and

σ_z or Δ_z is the cross-track error.

Further, $\sigma_{\dot{x}}$ or $\Delta_{\dot{x}}$, $\sigma_{\dot{y}}$ or $\Delta_{\dot{y}}$, and $\sigma_{\dot{z}}$ or $\Delta_{\dot{z}}$ are the errors in $\dot{X}$, $\dot{Y}$, and $\dot{Z}$ respectively. If σ's are used, random errors are being discussed; if Δ's are used, fixed-bias errors are being discussed. Sensor error tables for fixed-bias error cases and covariance error cases are given at the beginning of Appendix Sections I and II.

4. CO-VARIANCE, FIXED-BIAS PROGRAM ASSUMPTIONS

The graphs in Appendix Sections I and II were obtained from the Co-Variance, Fixed-Bias Program. The method assumes that the error propagation is linear.

APPENDIX SECTION I

FIXED BIAS ERROR

SECTION I

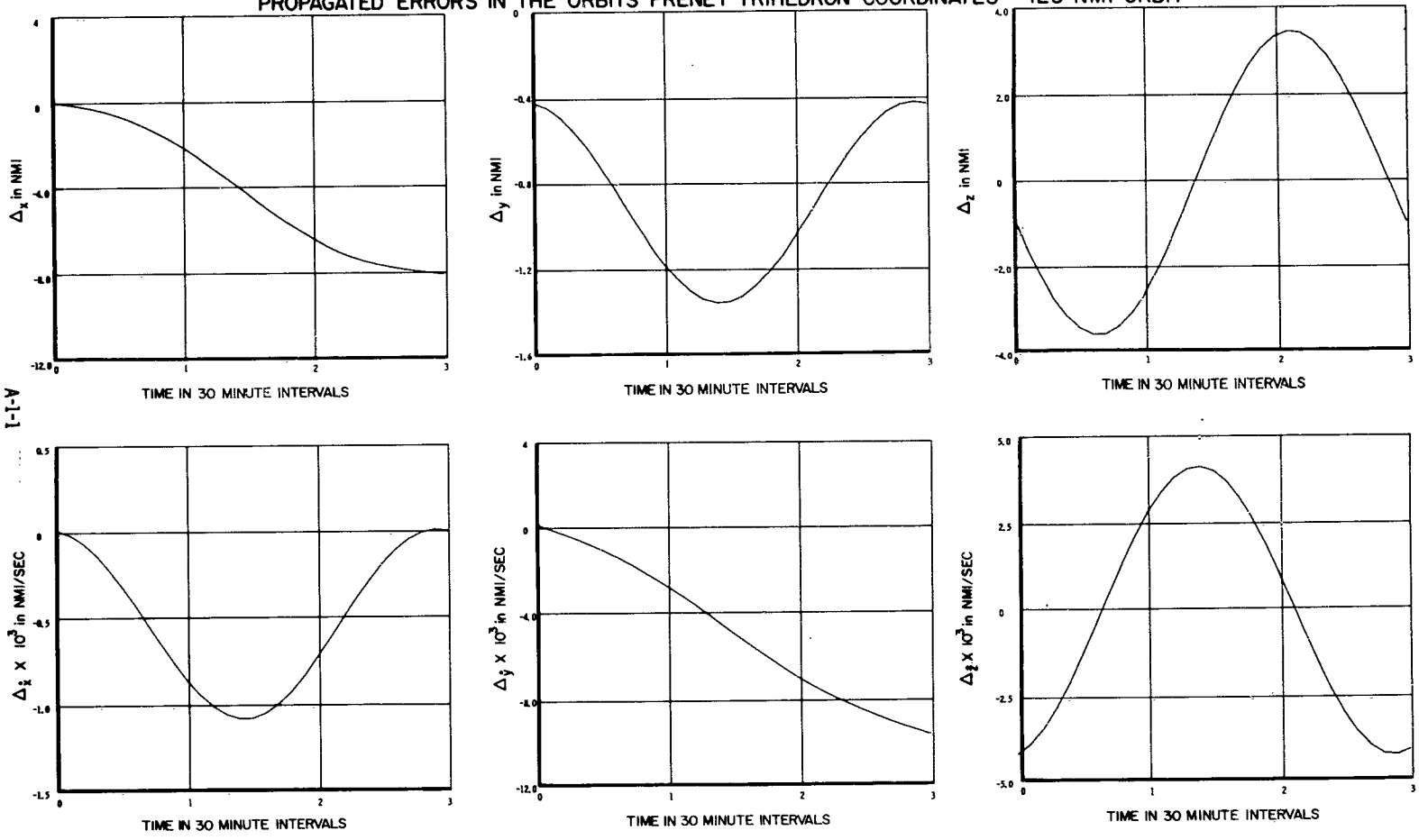
FIXED BIAS ERROR

TABLE II. SENSOR ERRORS FOR FIXED BIAS ERROR

CASE NUMBER	RANGE AND ANGLE SENSORS	
	RANGE (ft.)	AZ AND EL. (mr)
1	50	1
2	300	1
	1000	0.25

CASE NUMBER	RANGE, RANGE-RATE, AND ANGLE SENSORS		
	RANGE (ft.)	RANGE-RATE (ft./sec.)	ANGLE (mr)
4	50	0.1	1.0
5	50	1	1.0
6	300	0.1	1.0
7	300	1	1.0
8	1000	0.1	0.25

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

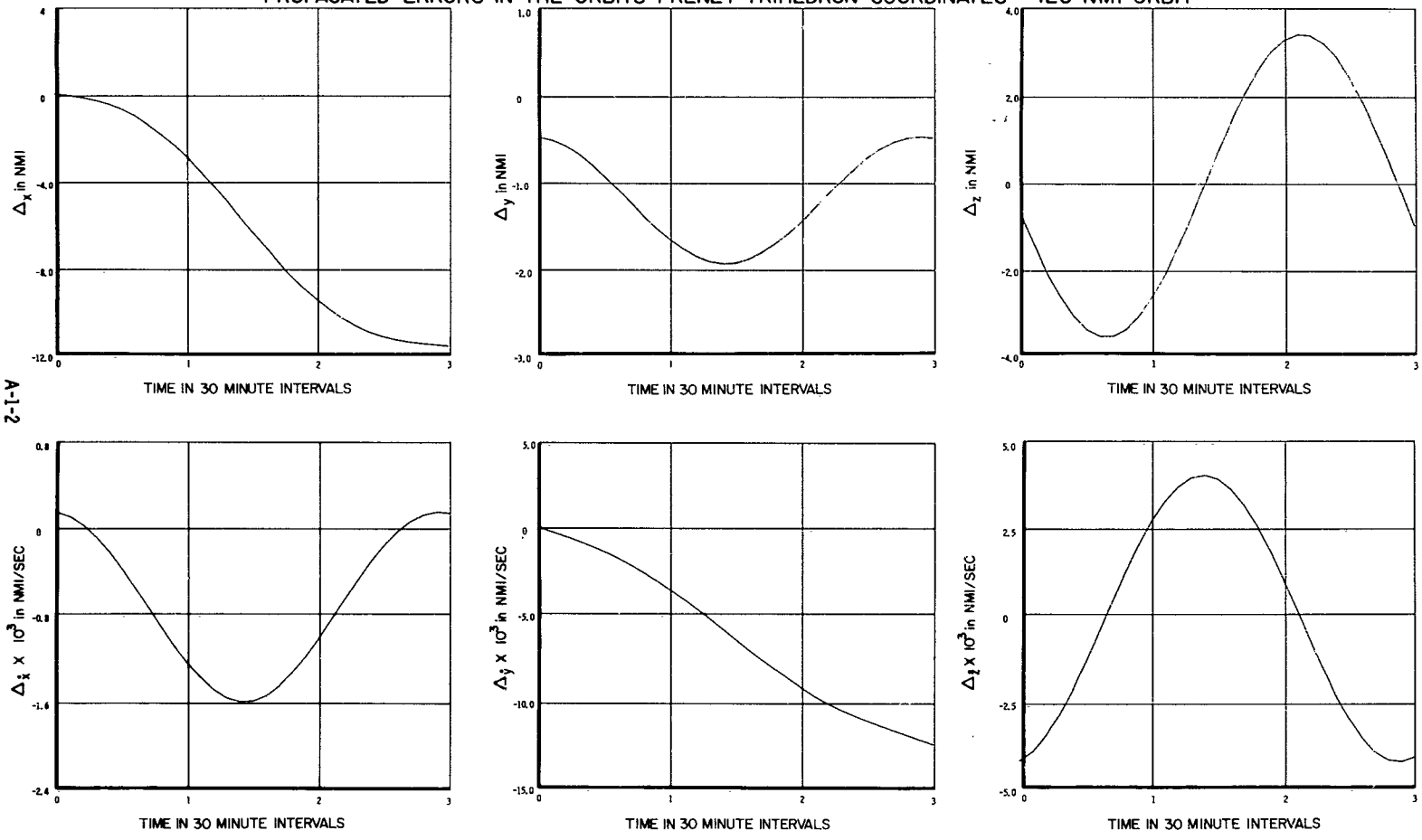


A-1-1

Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

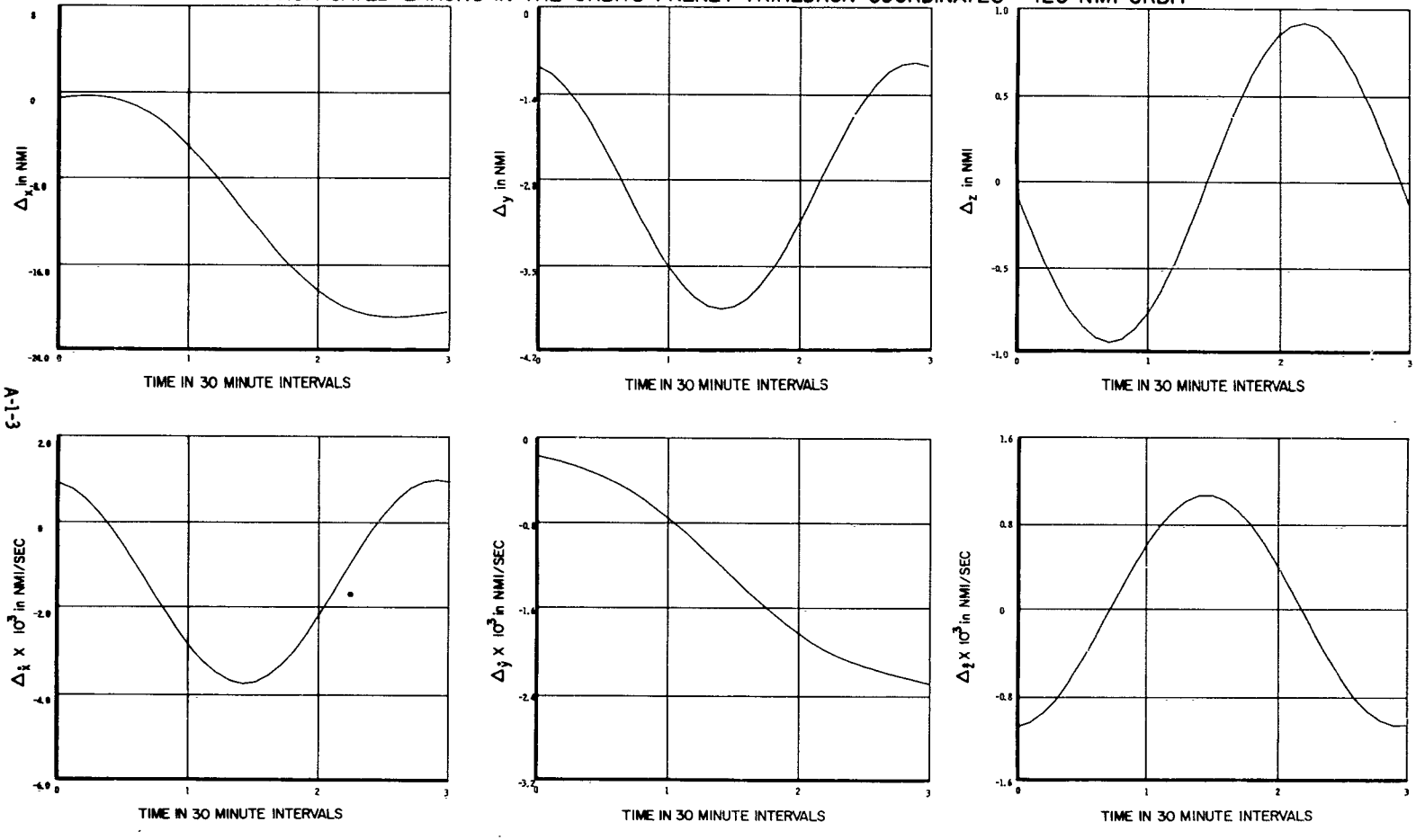
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

Tracking Through 120° of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



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Tracking Through 120^0 of Azimuth
Tracking From 1 Station

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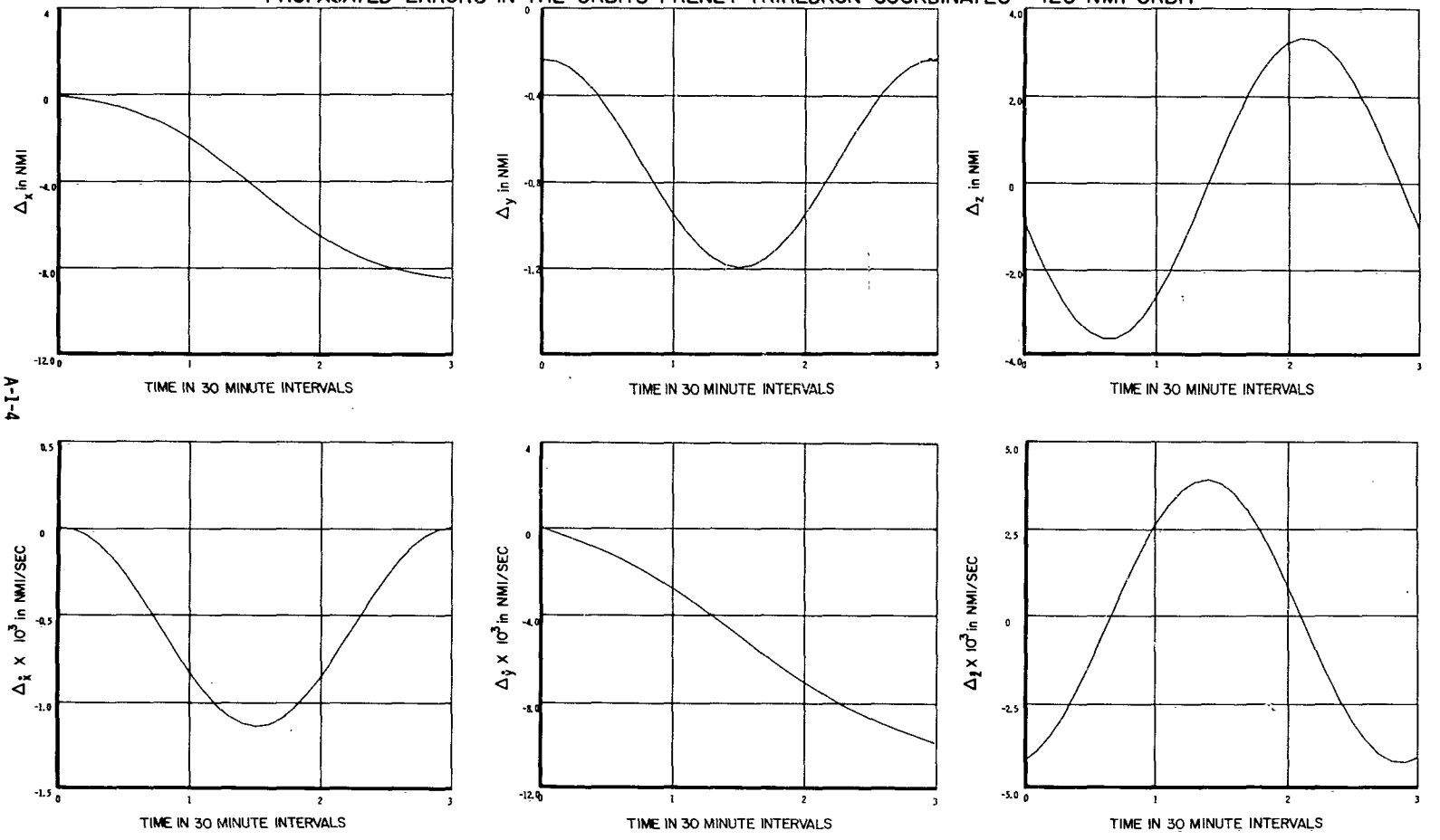
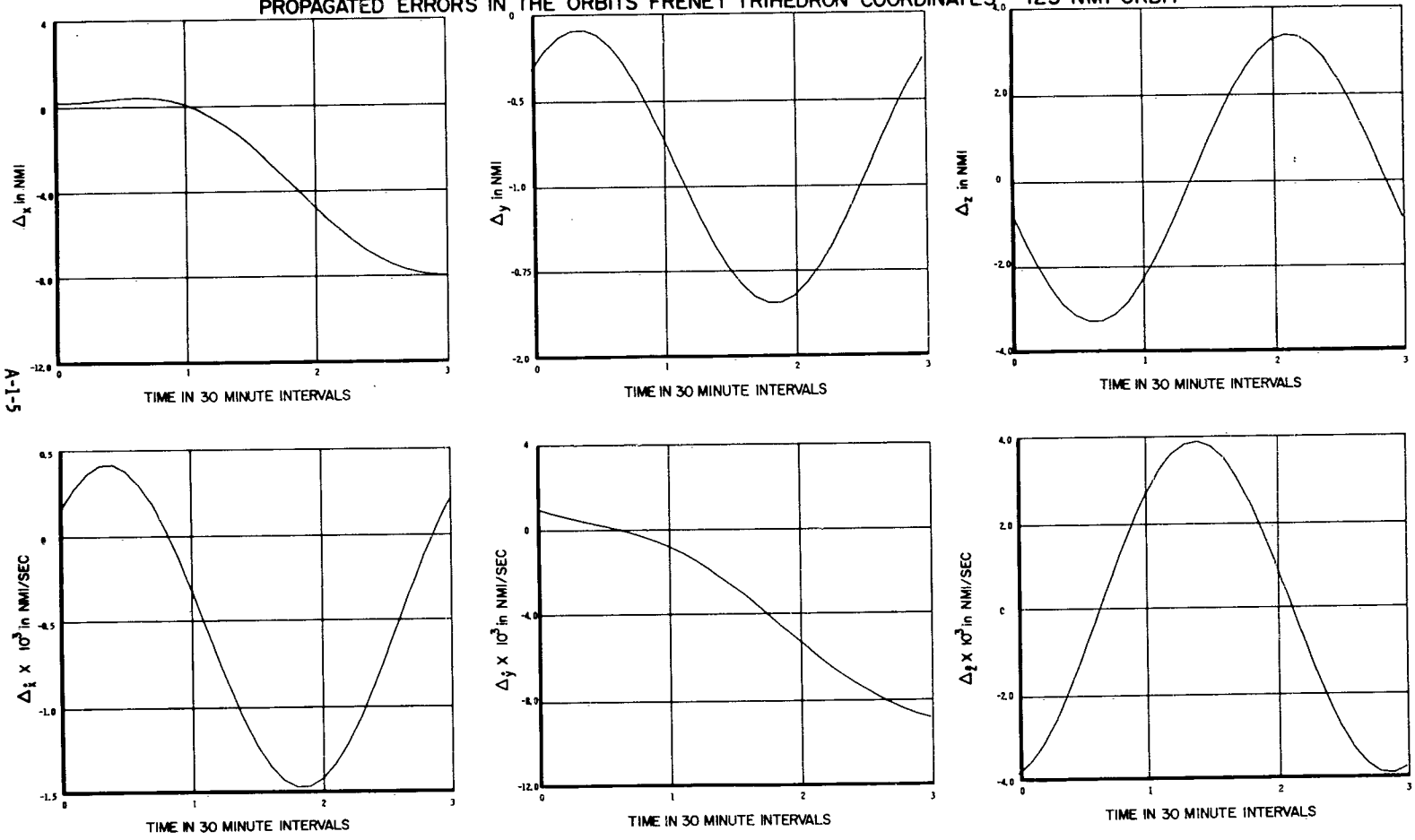


Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)
Tracking Through 120° of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

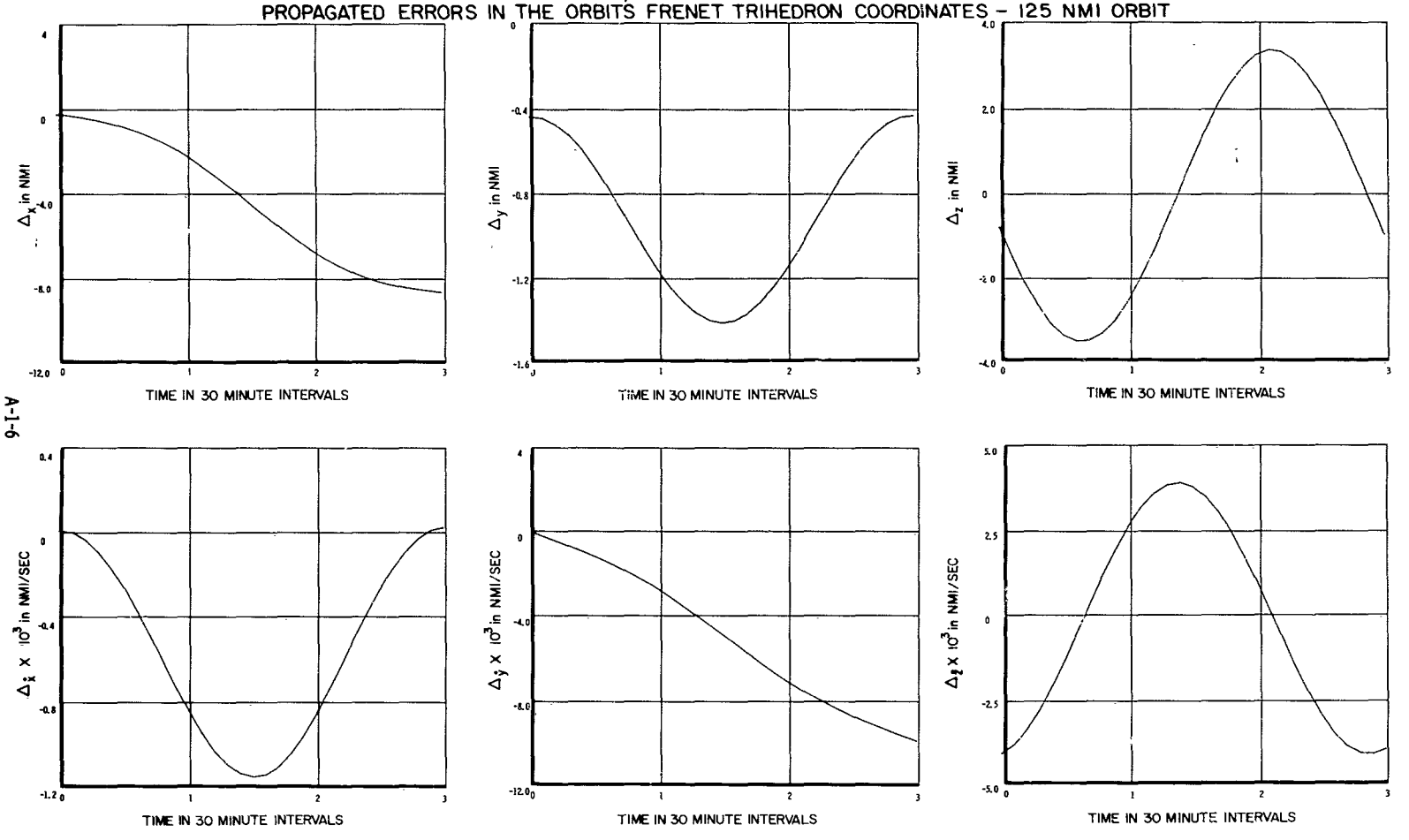


A-1-5

Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^{0} of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

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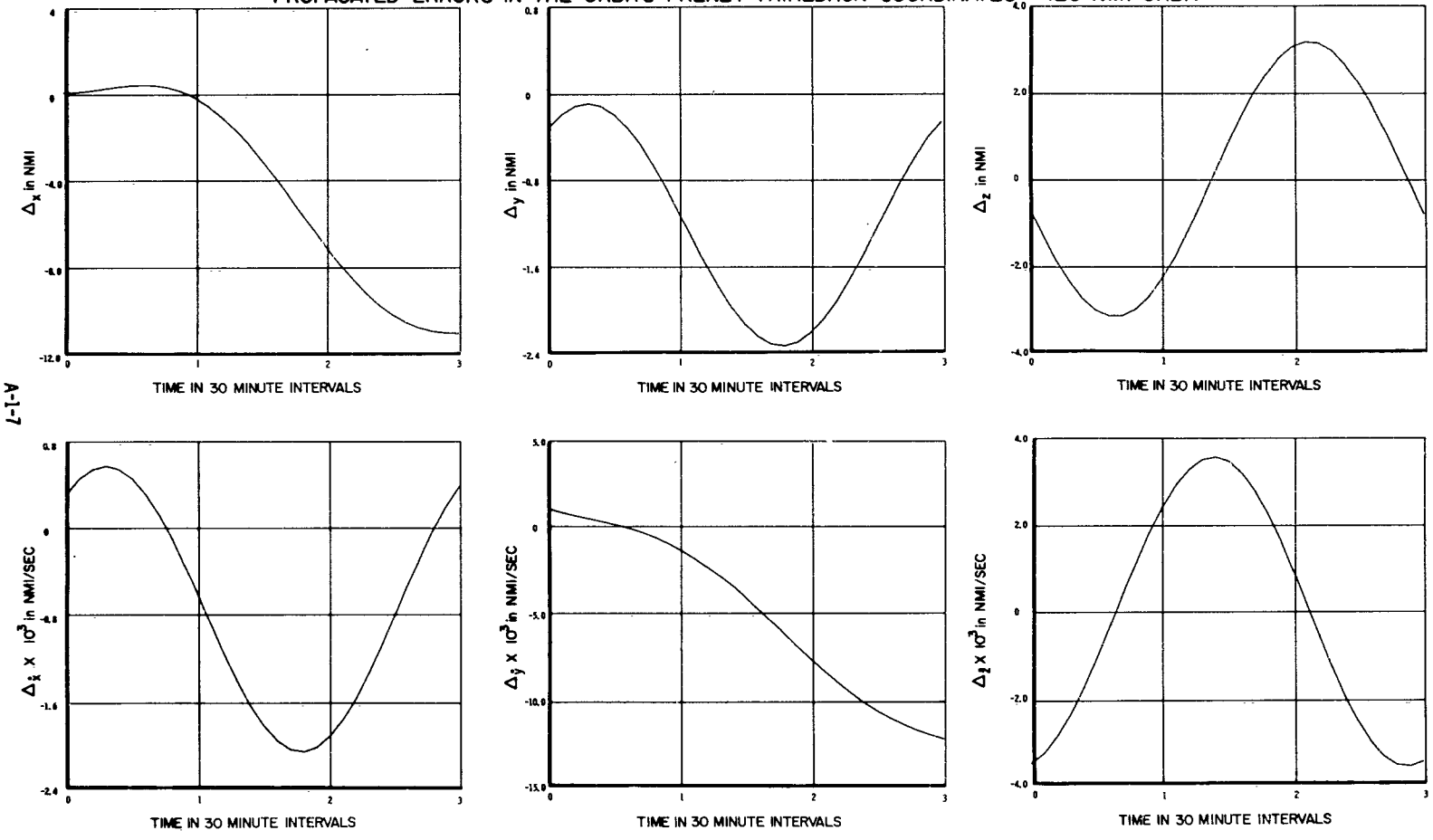

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Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

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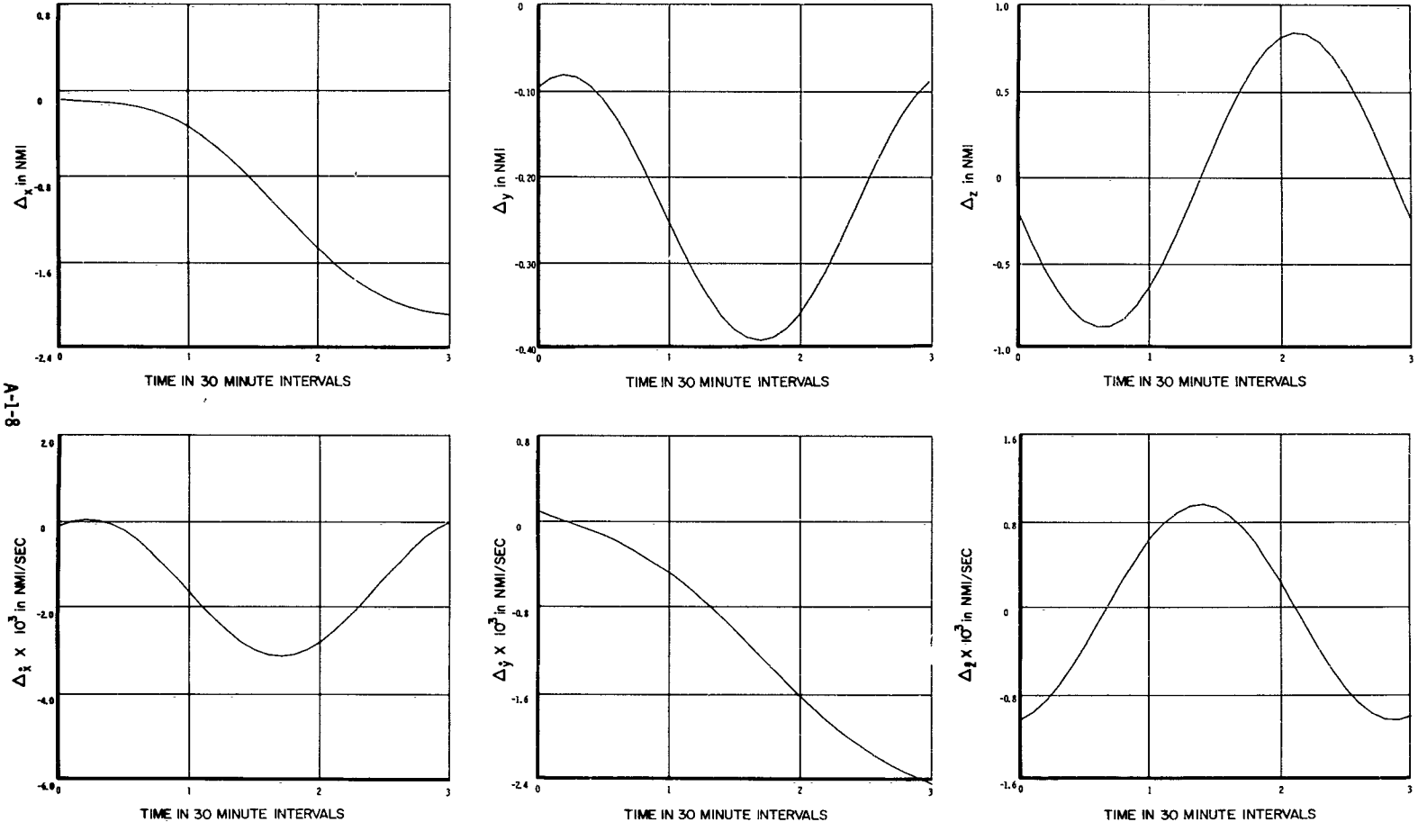

Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

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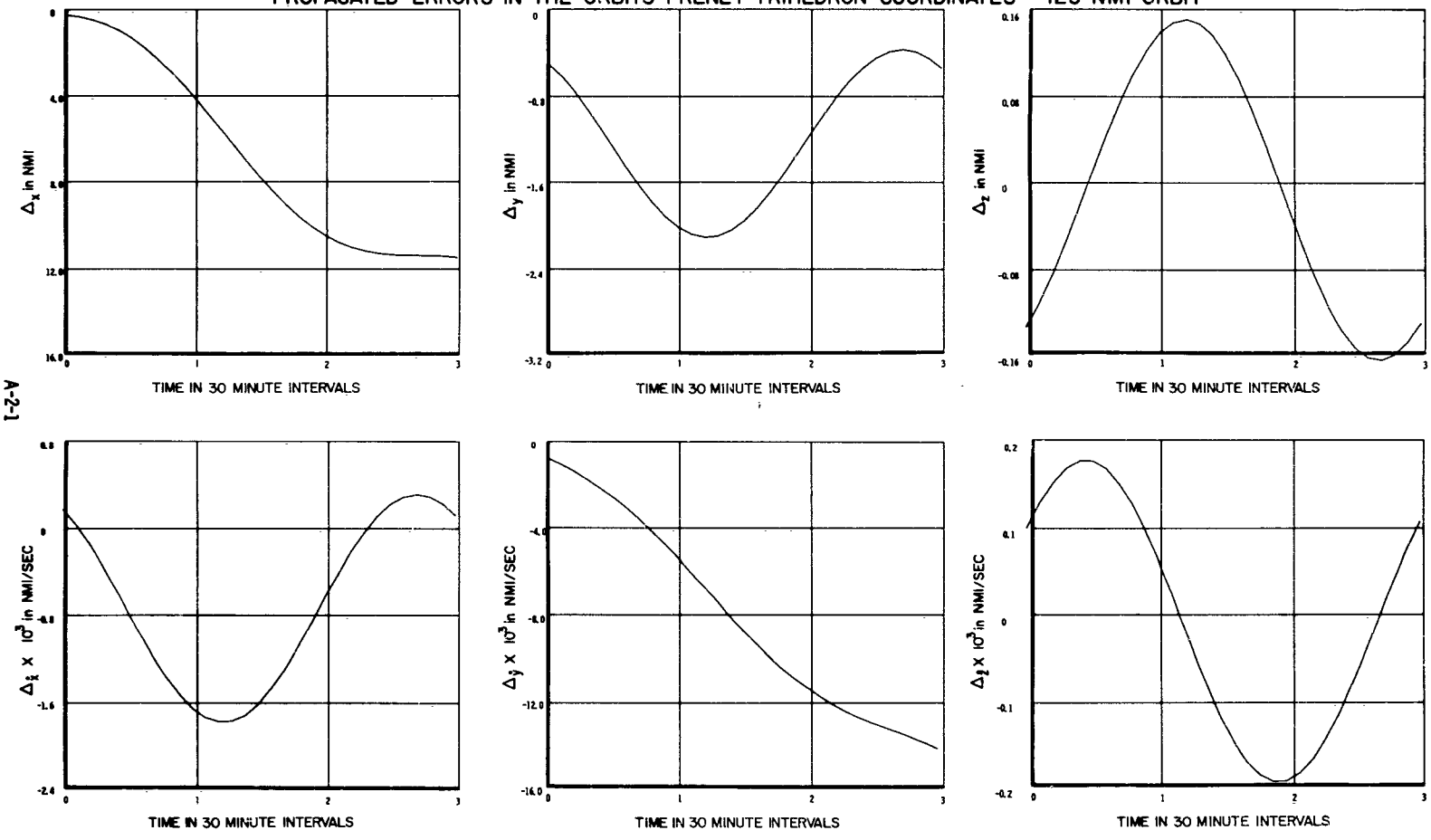

Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

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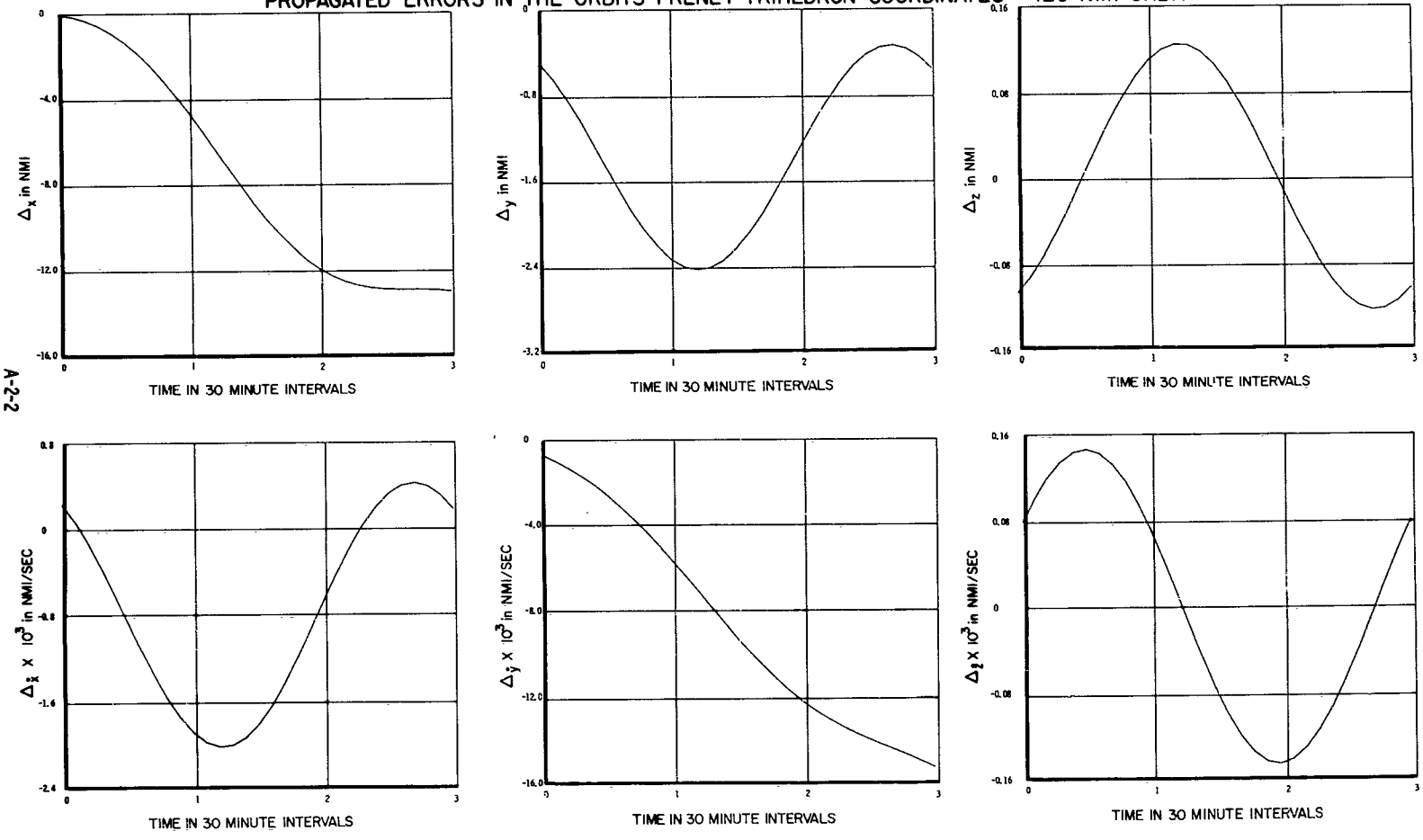

Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

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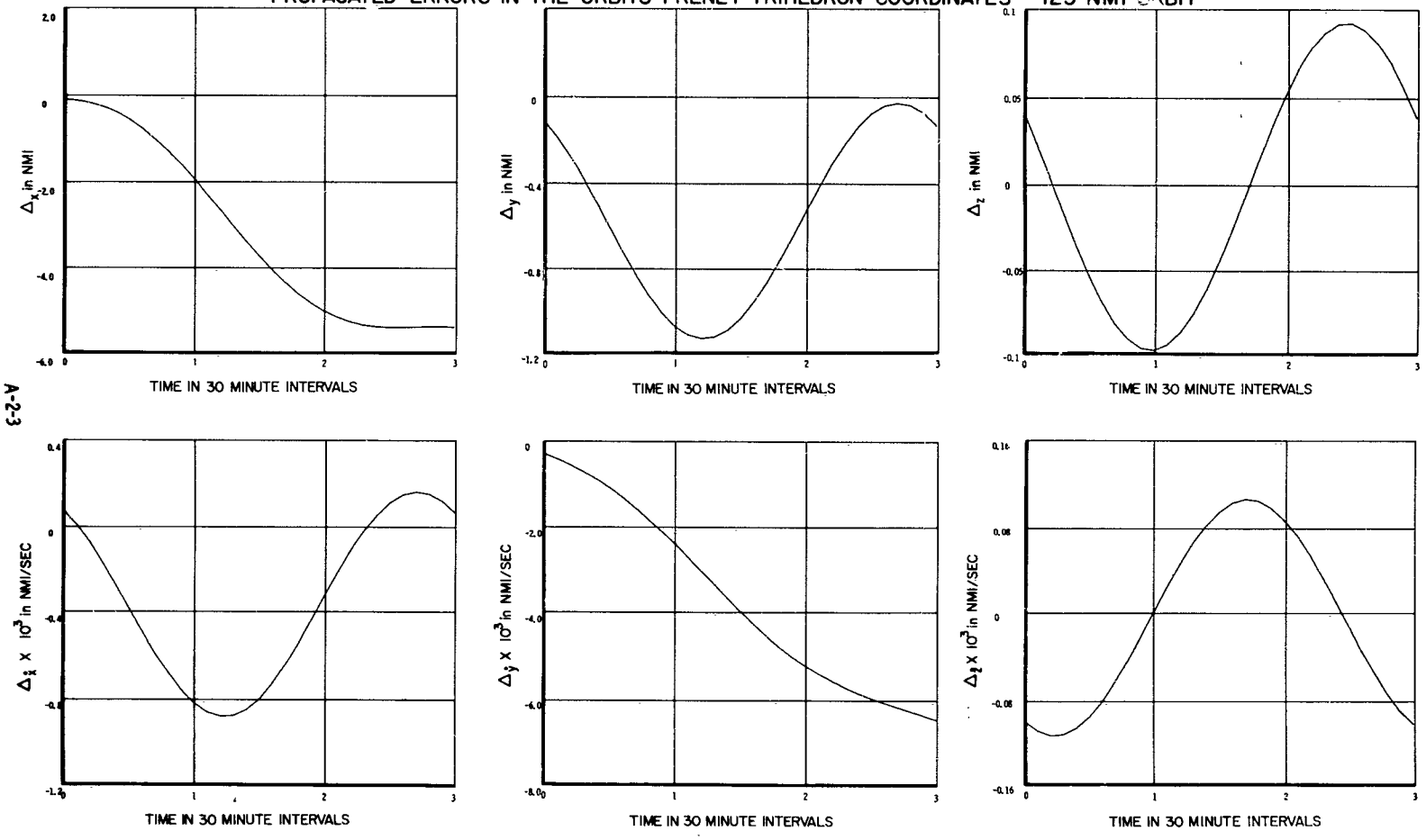

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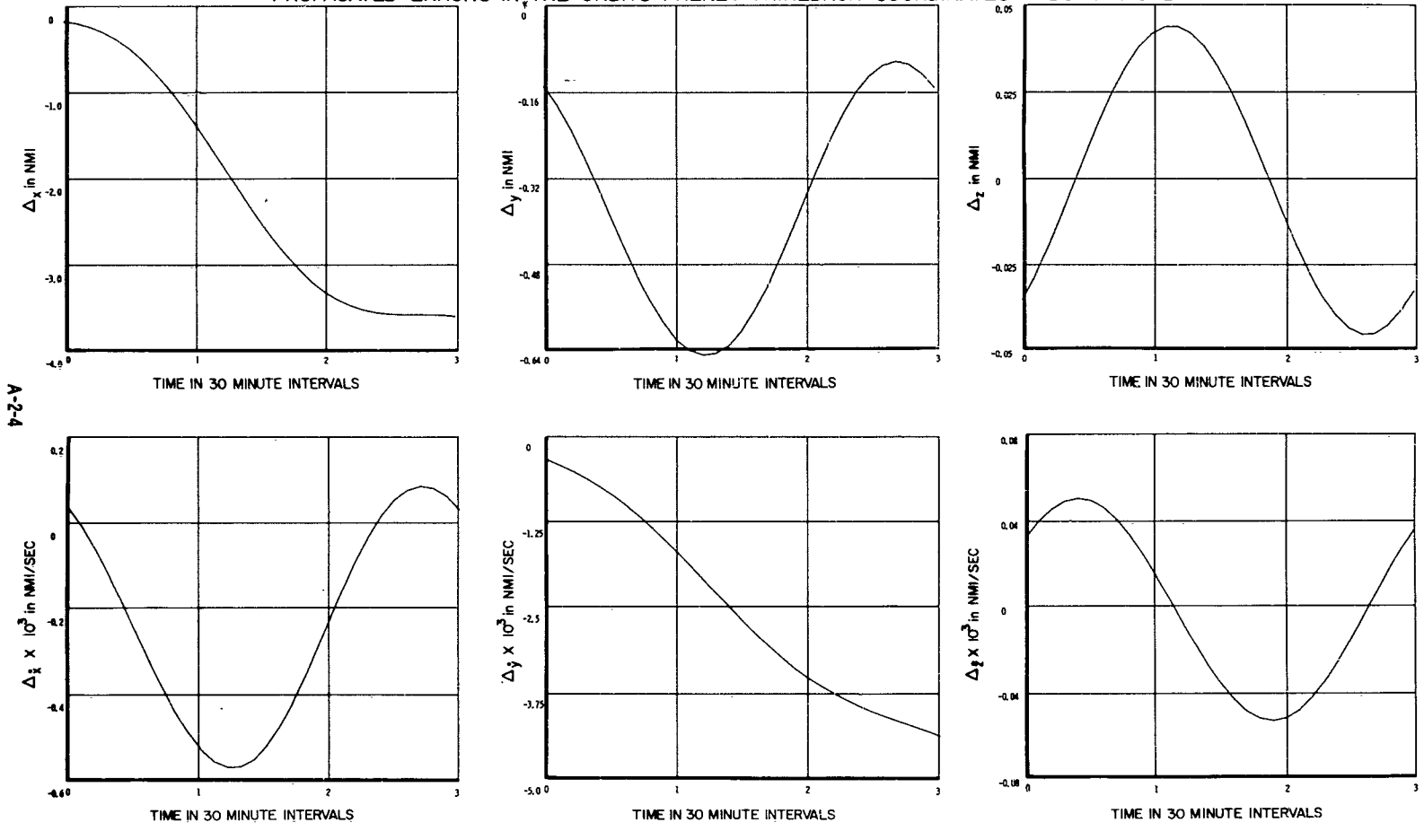
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)
Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

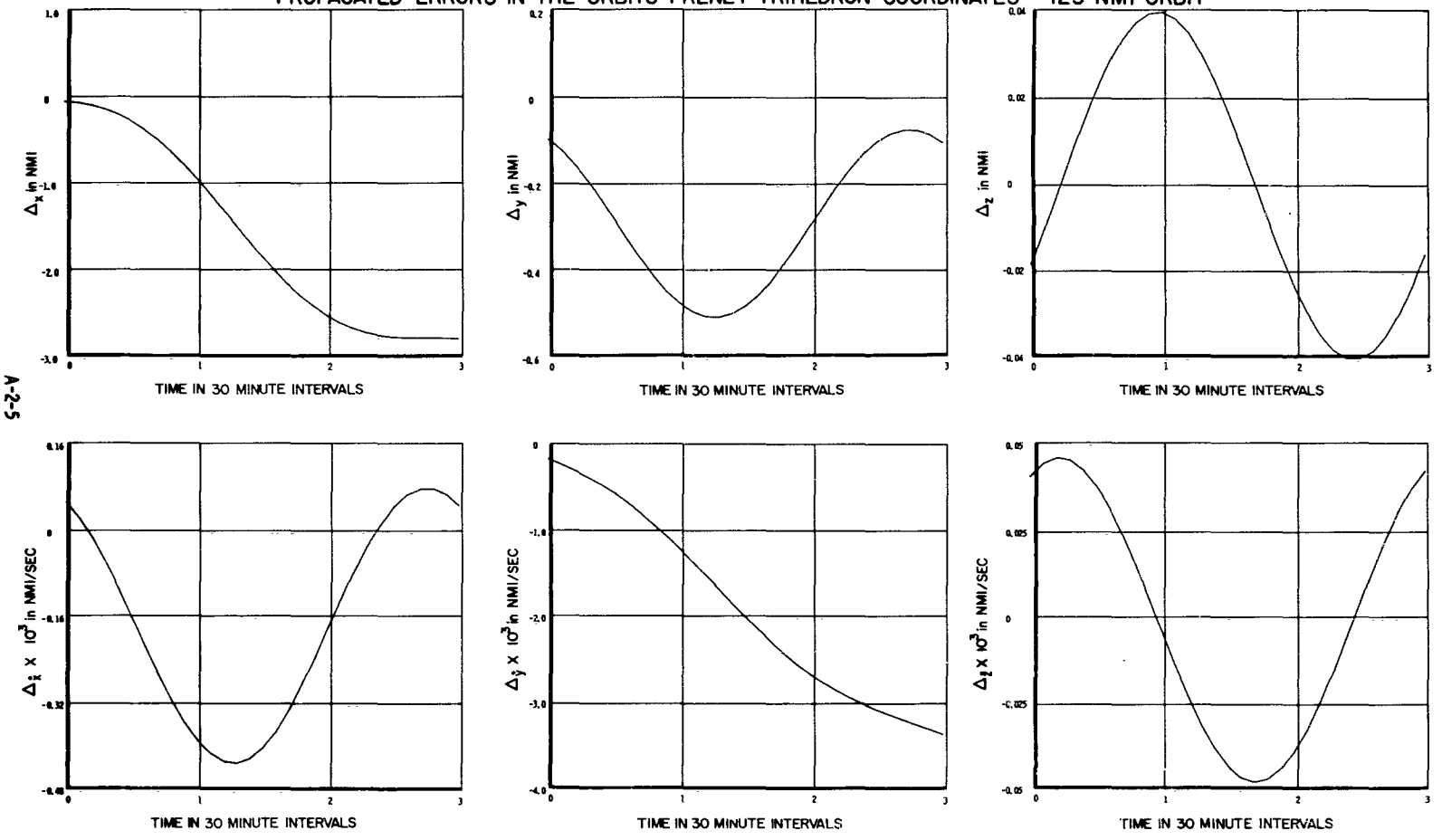
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



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Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

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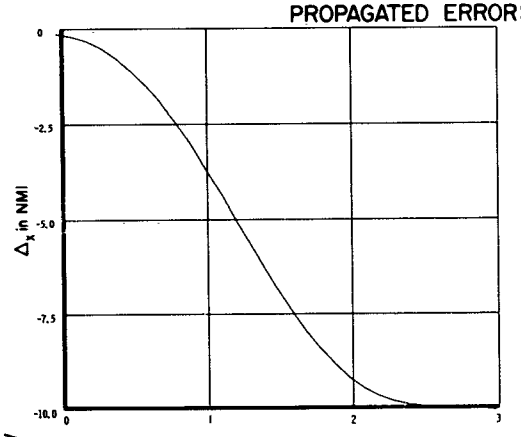
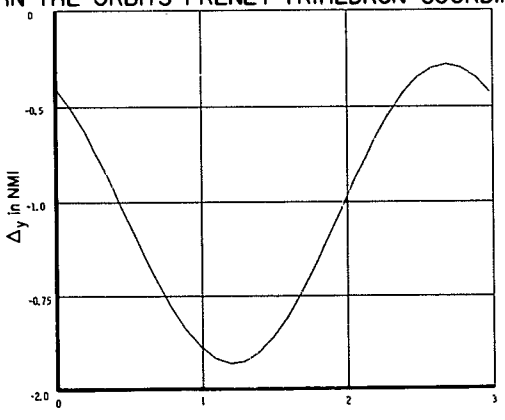
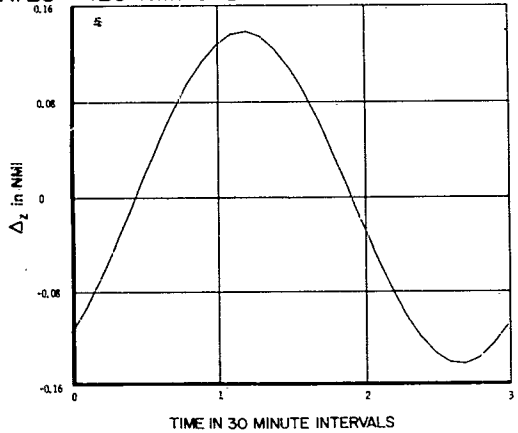
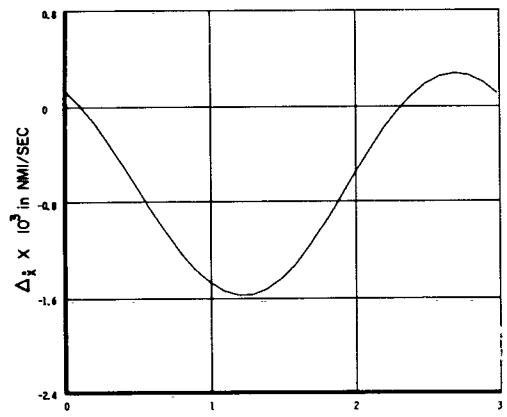
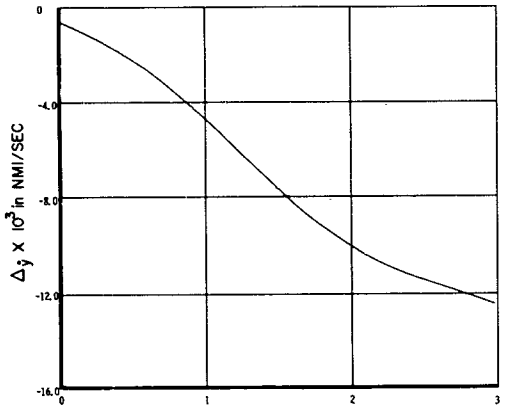
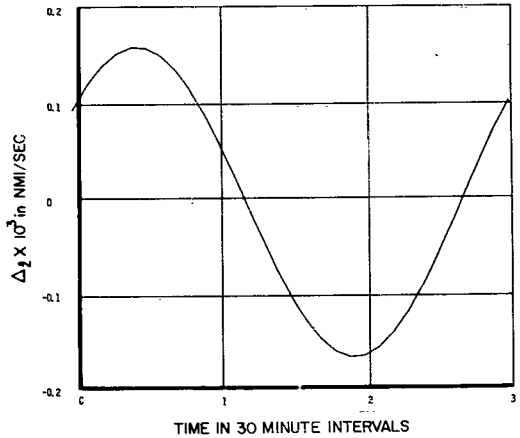








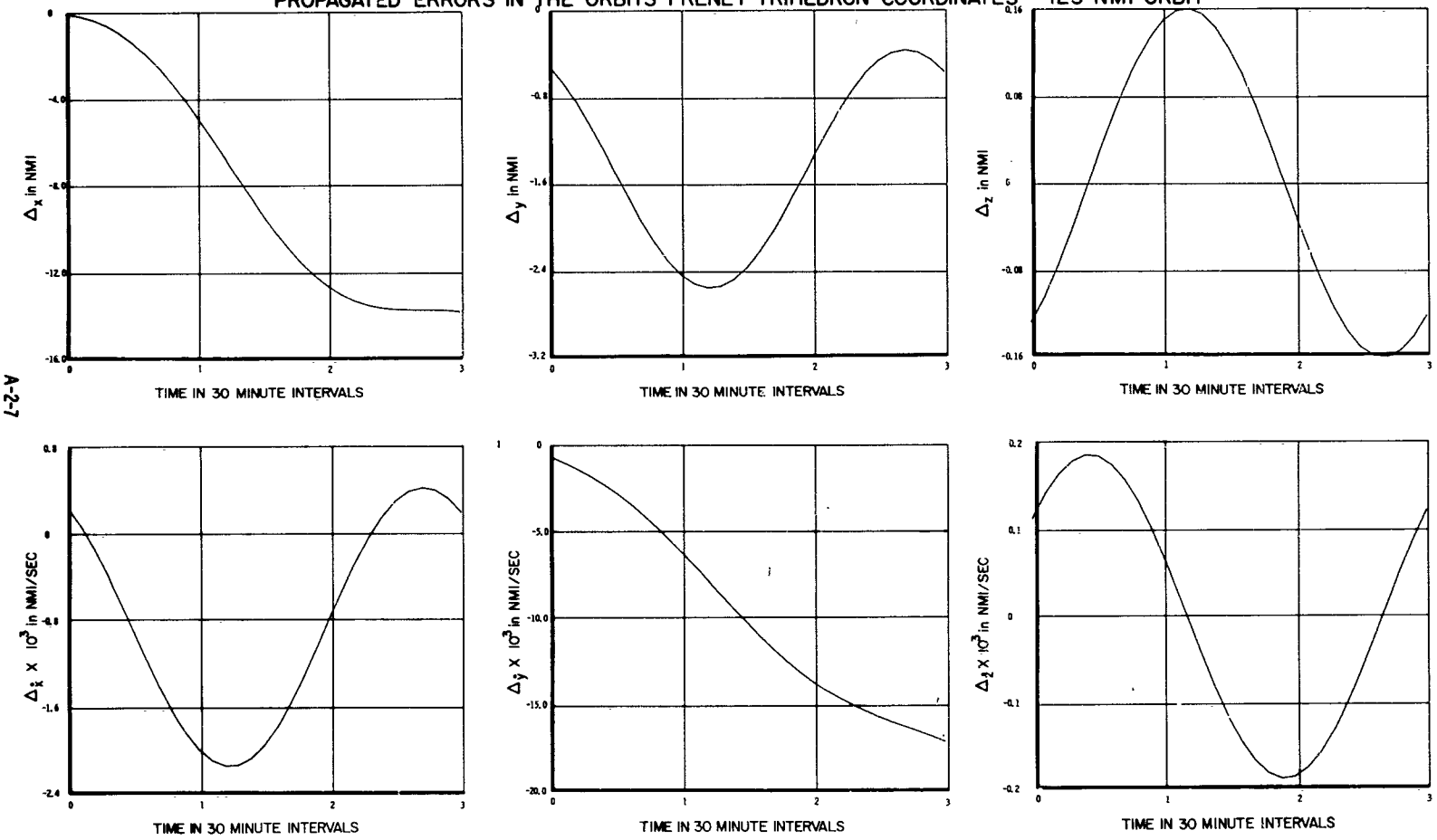




Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

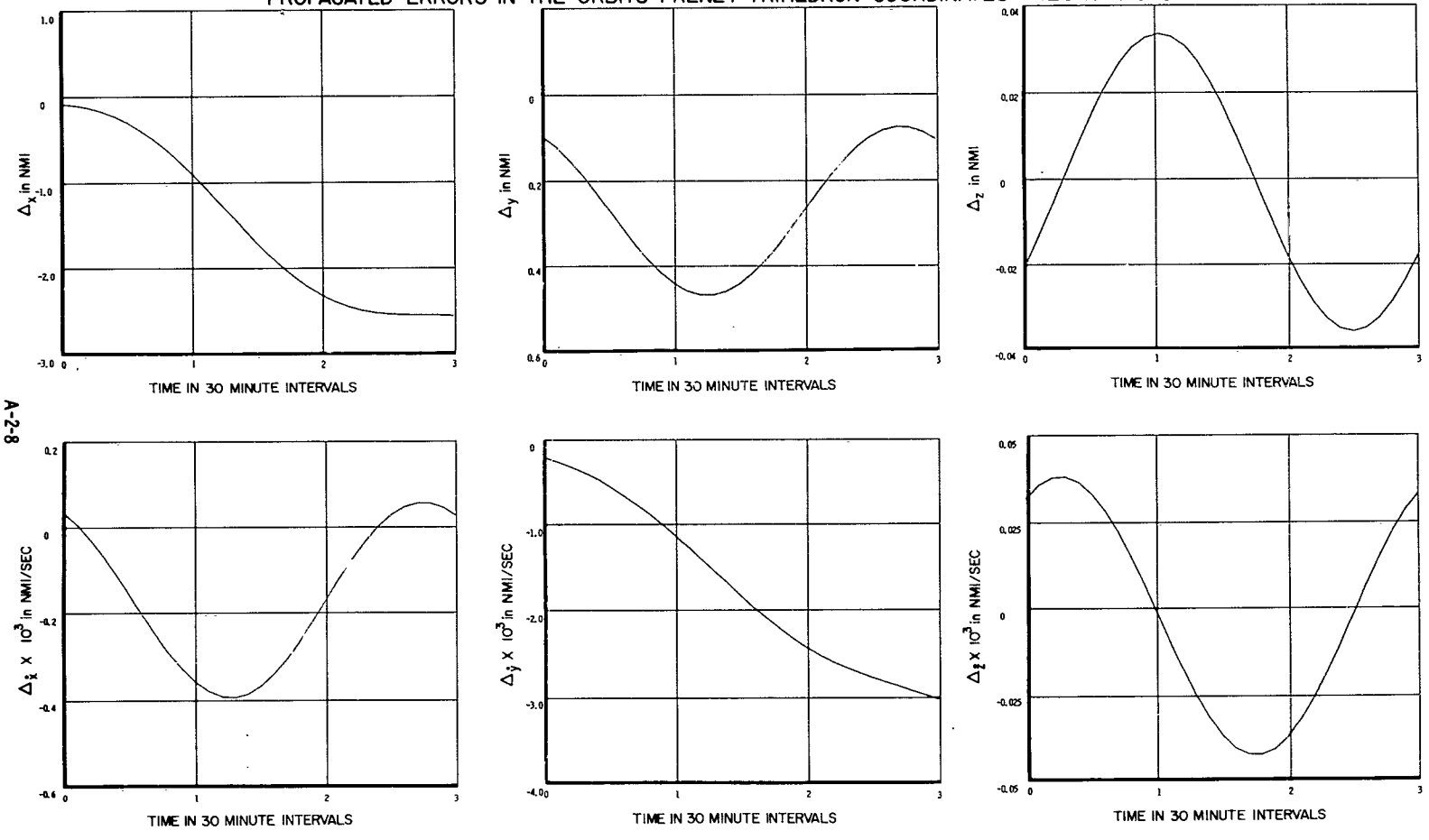


A-2-7

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

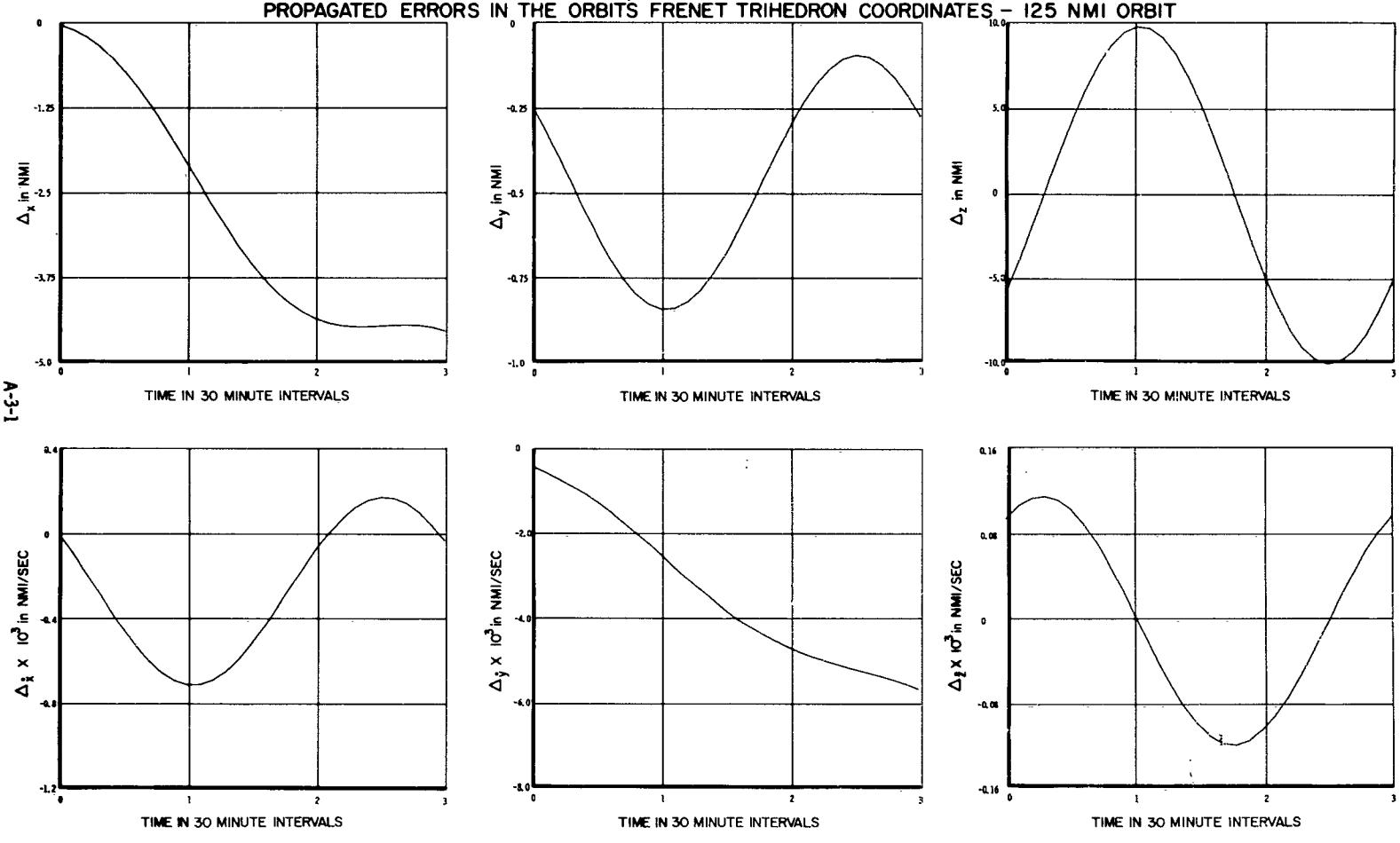
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

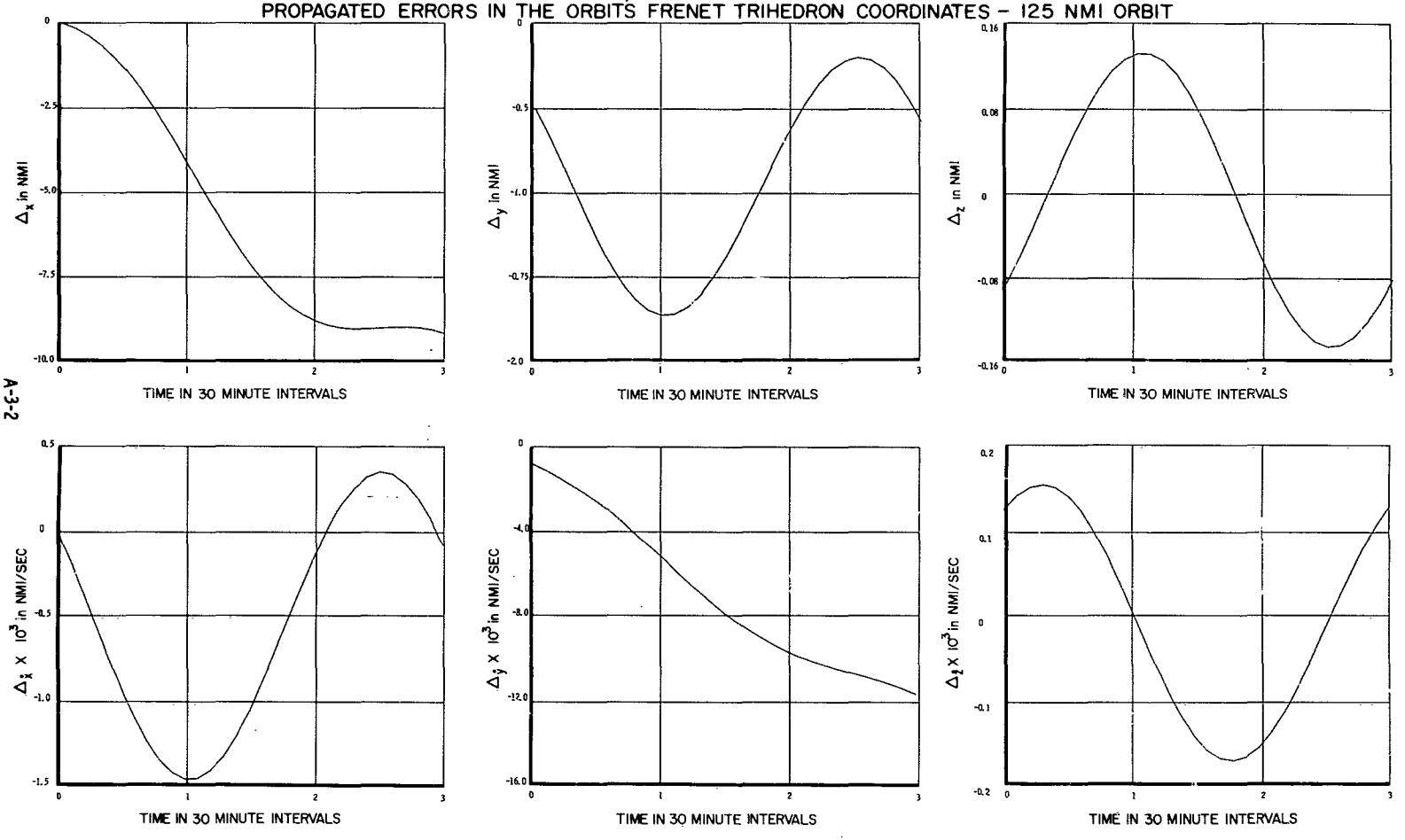
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

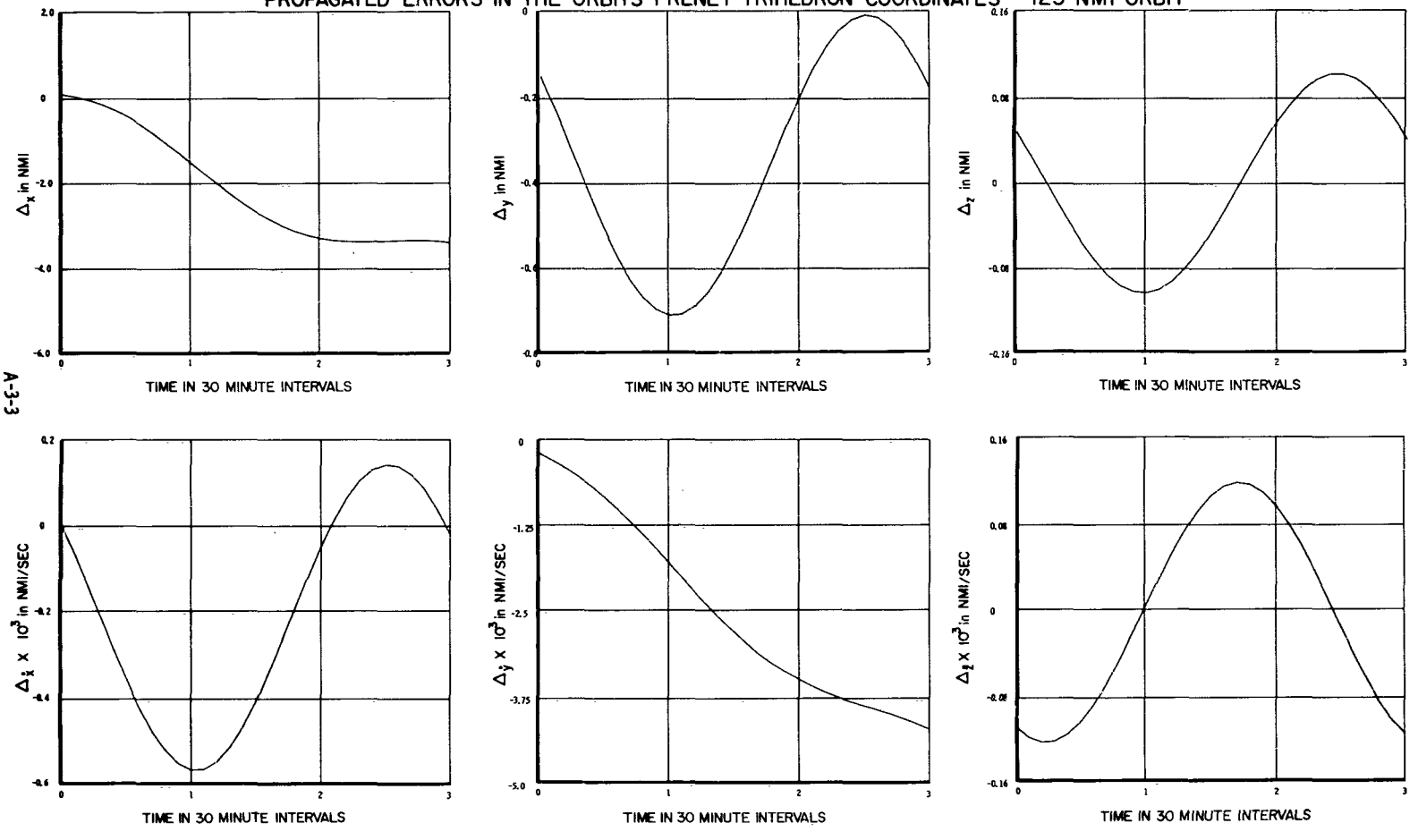
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

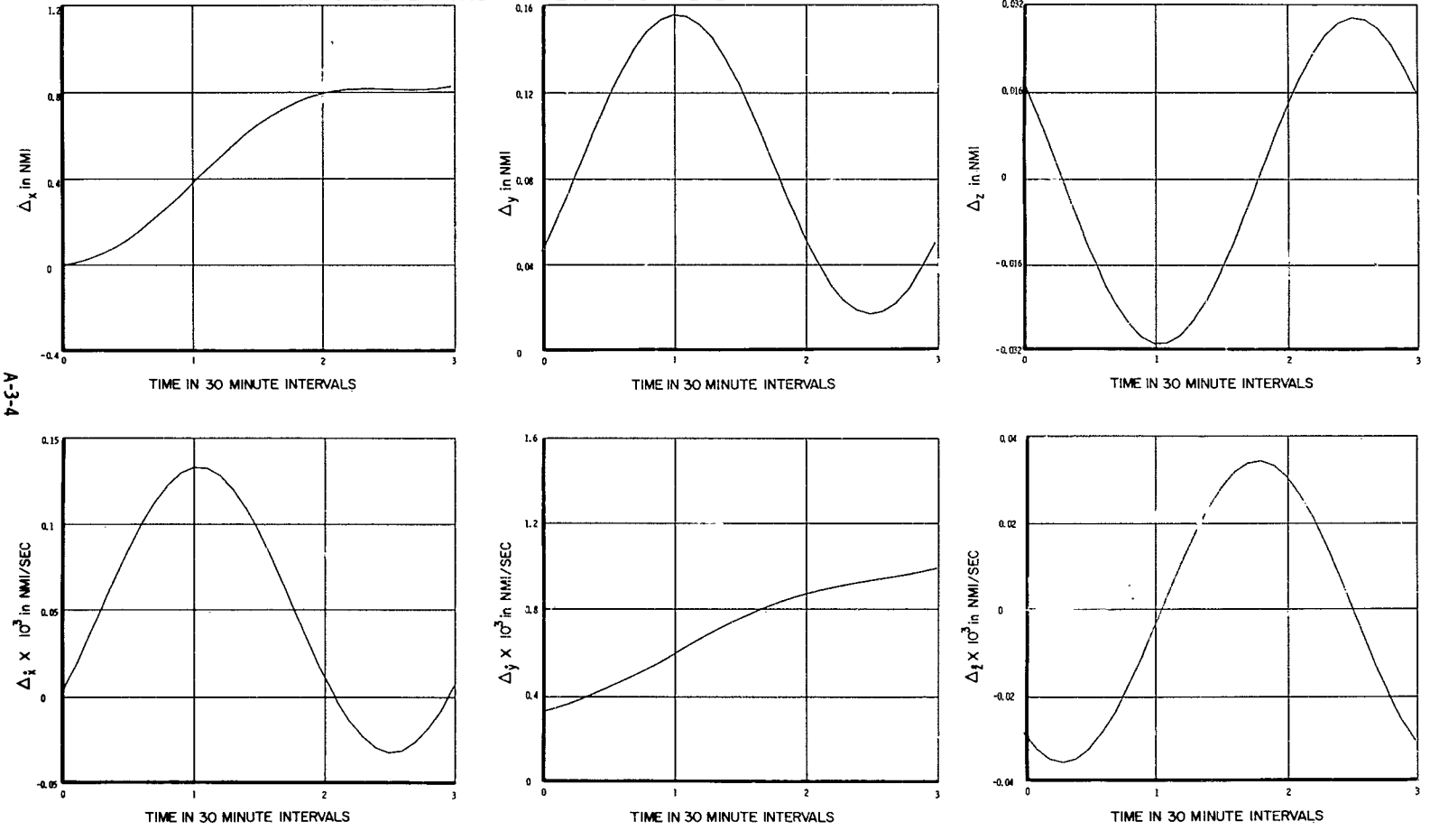
Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)
Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

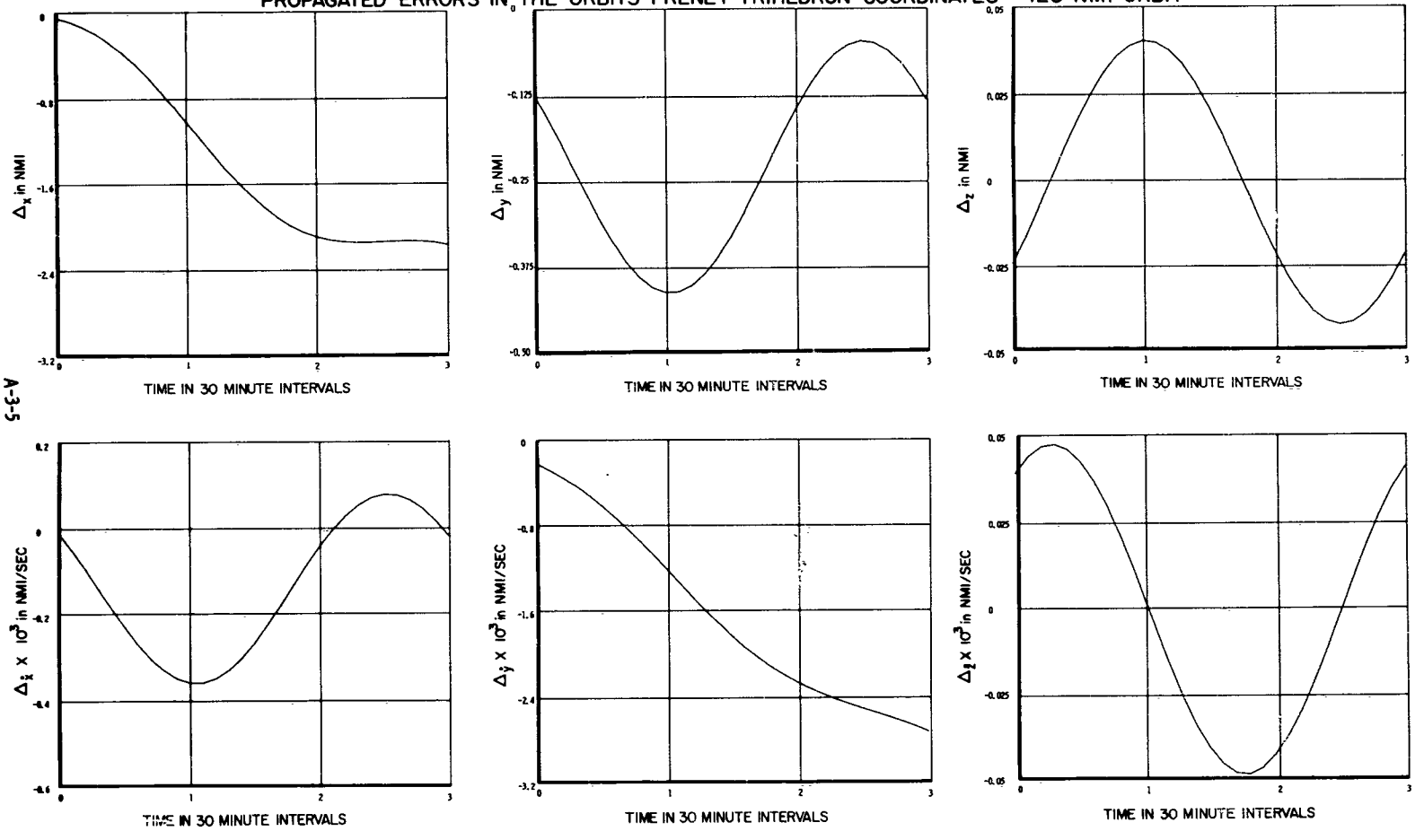
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

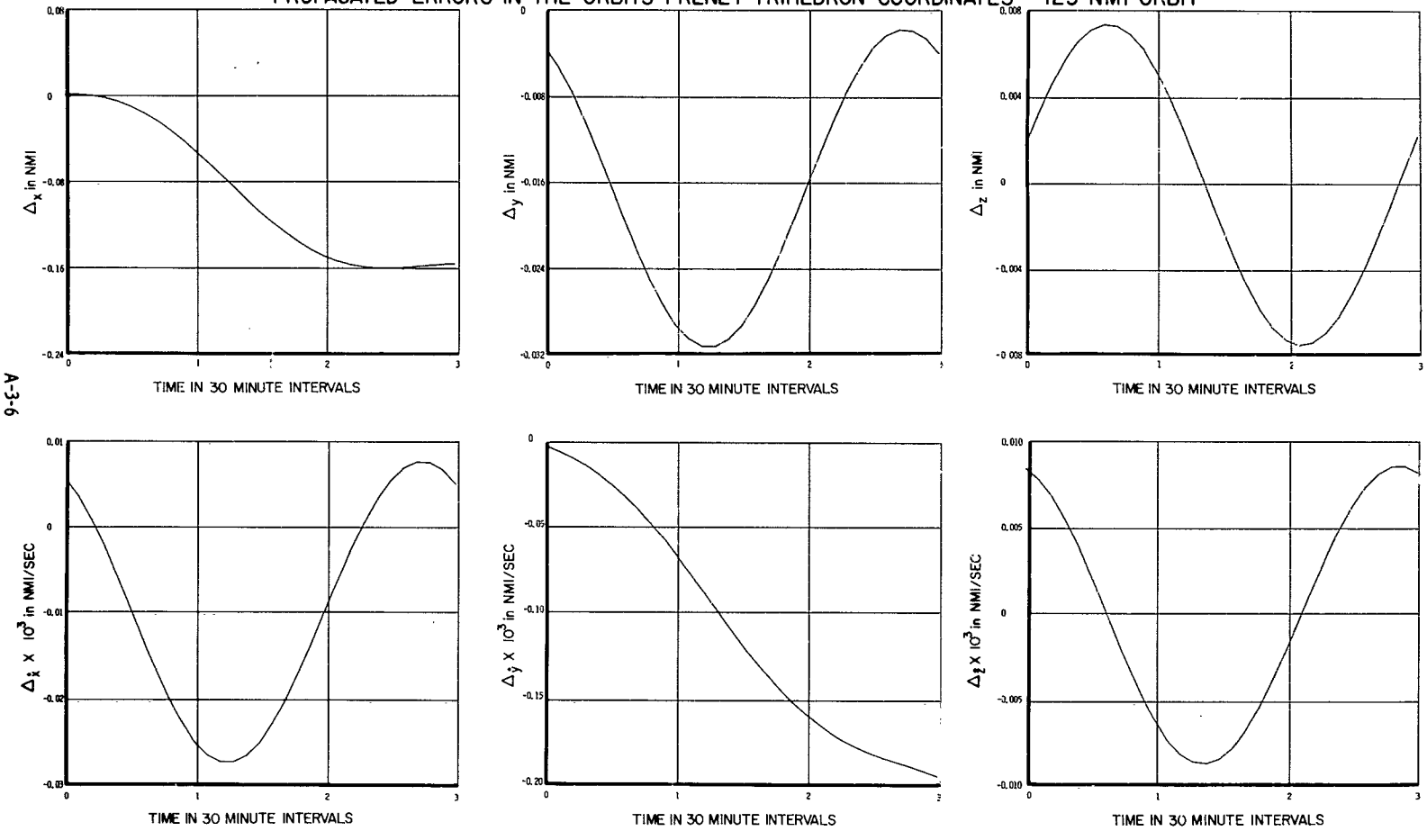
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

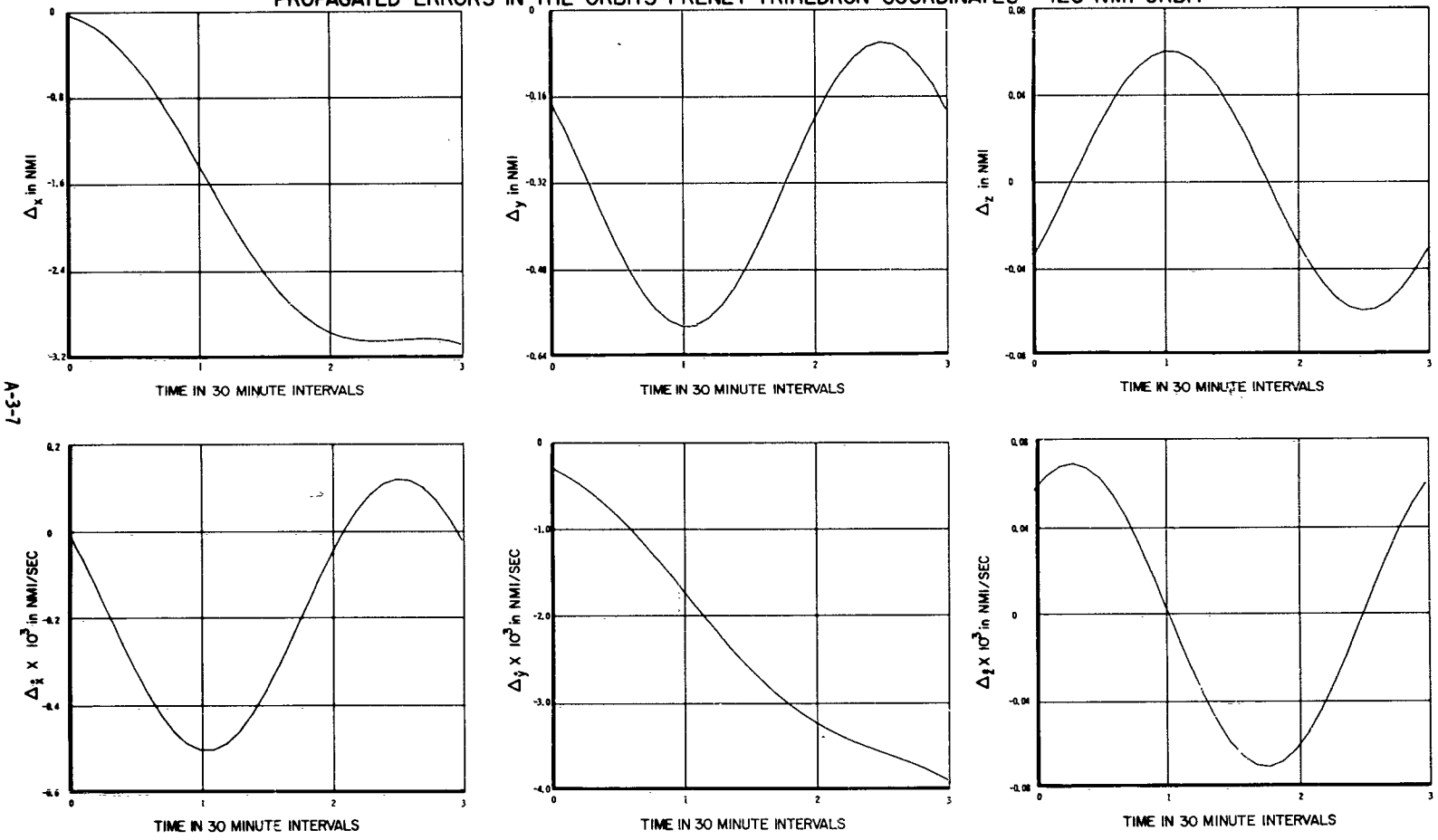
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

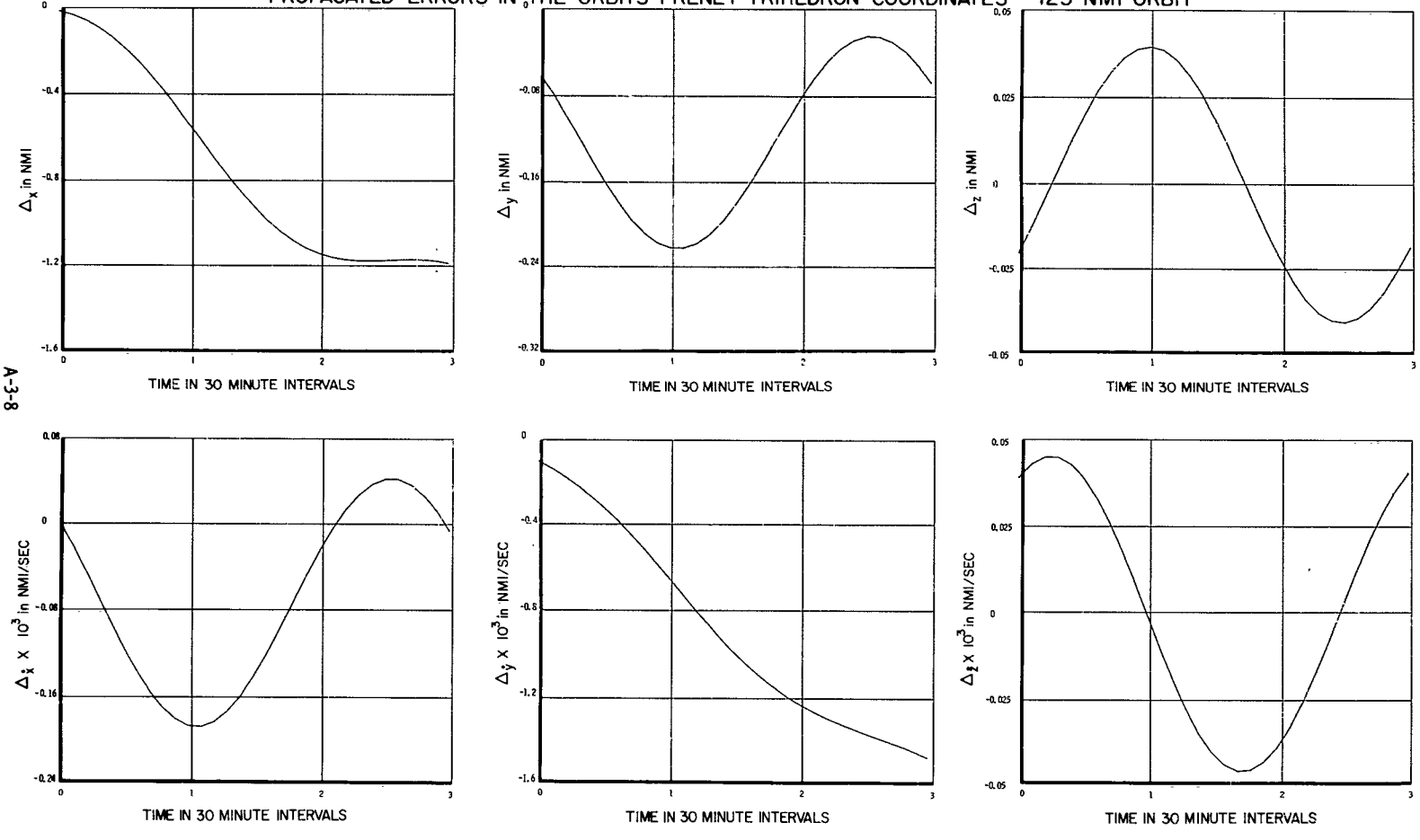
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

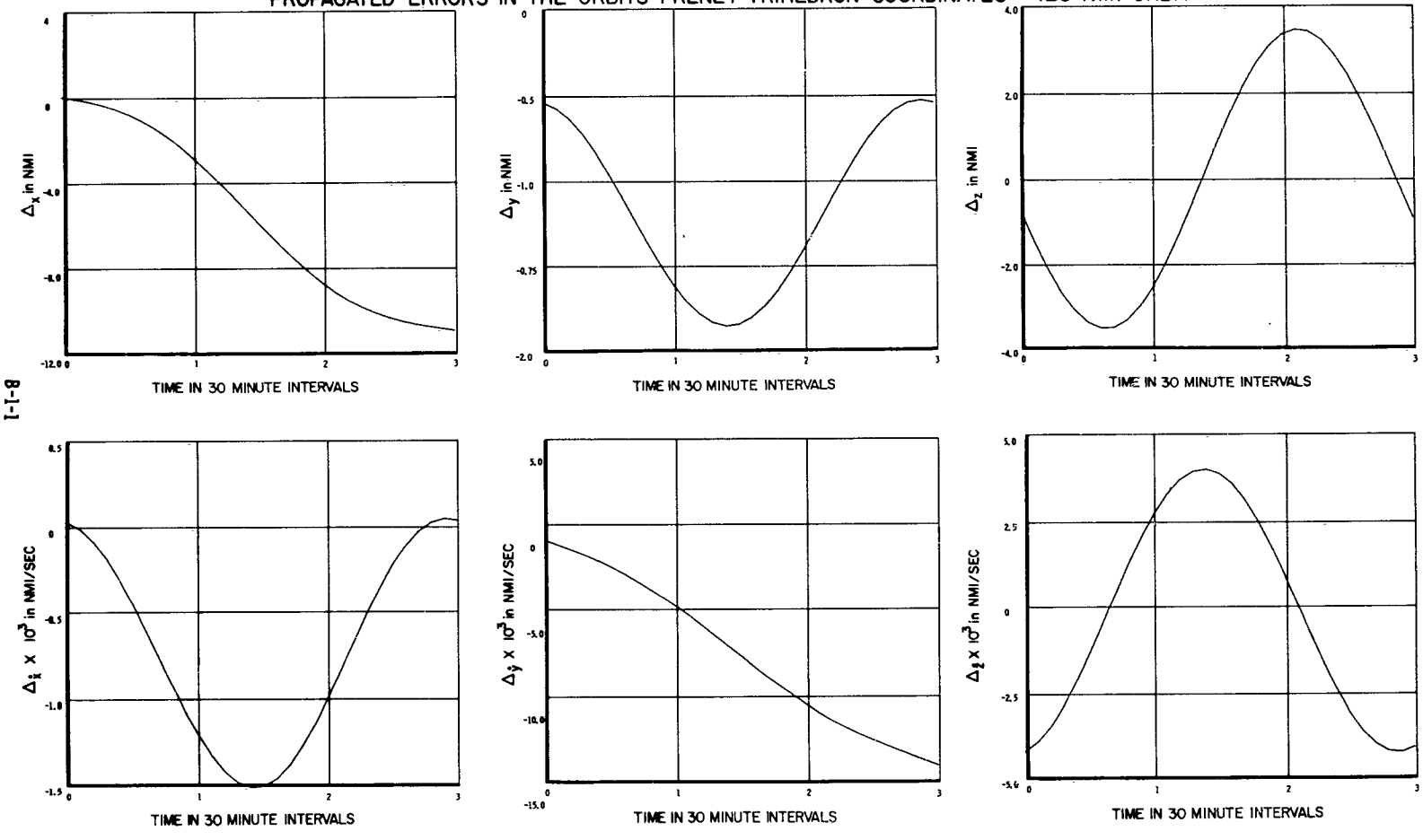
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

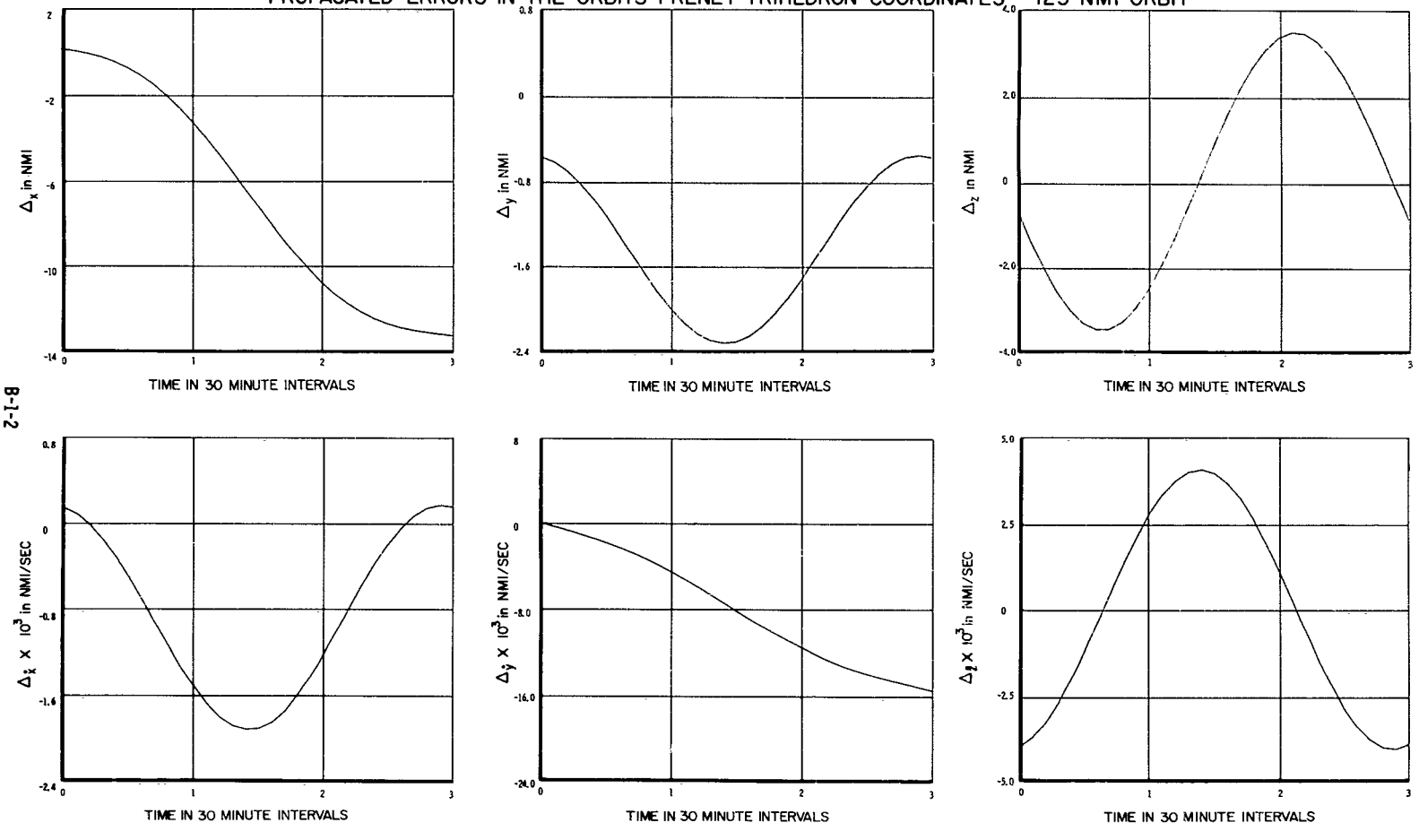
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 1 Station

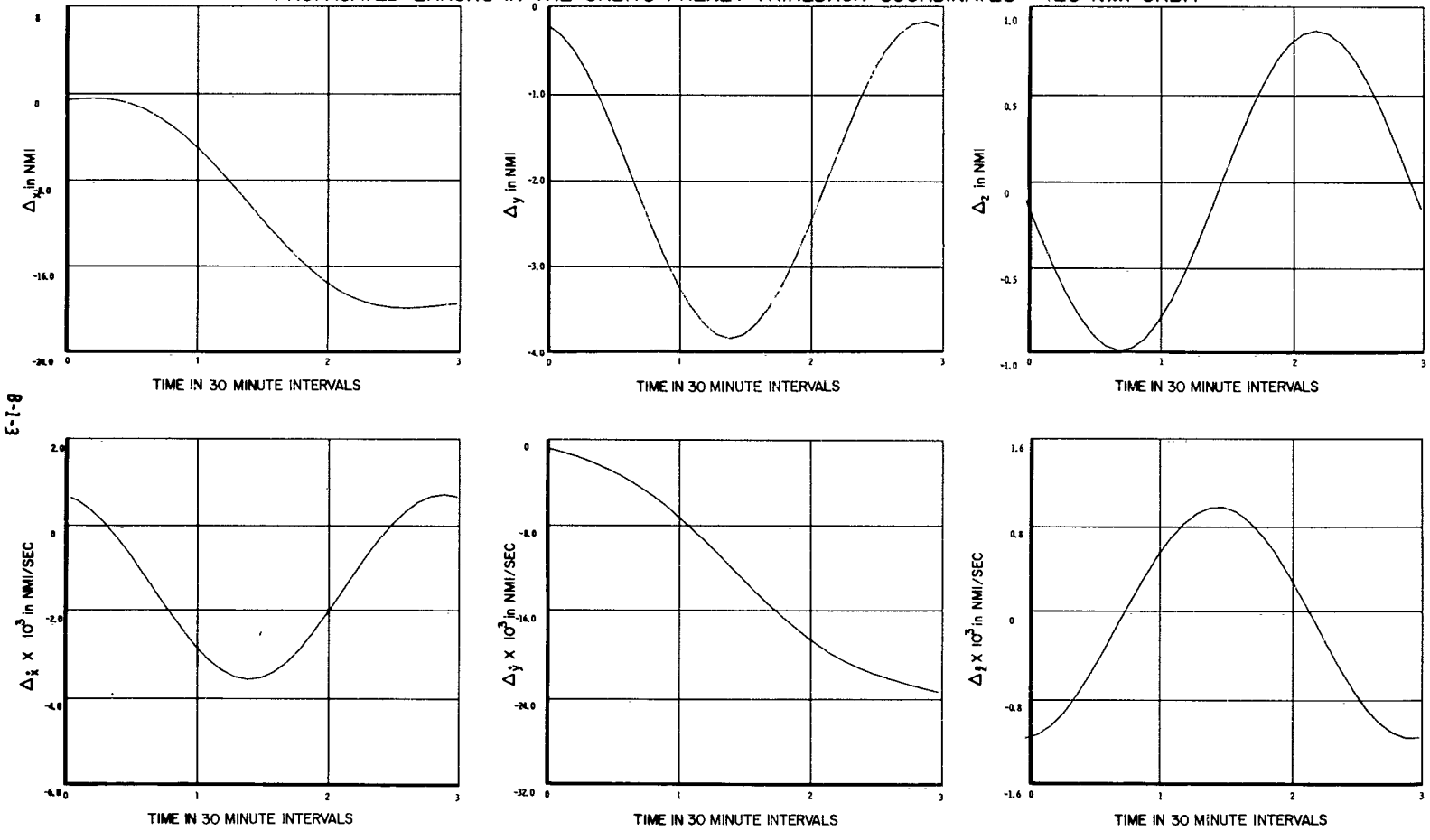
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

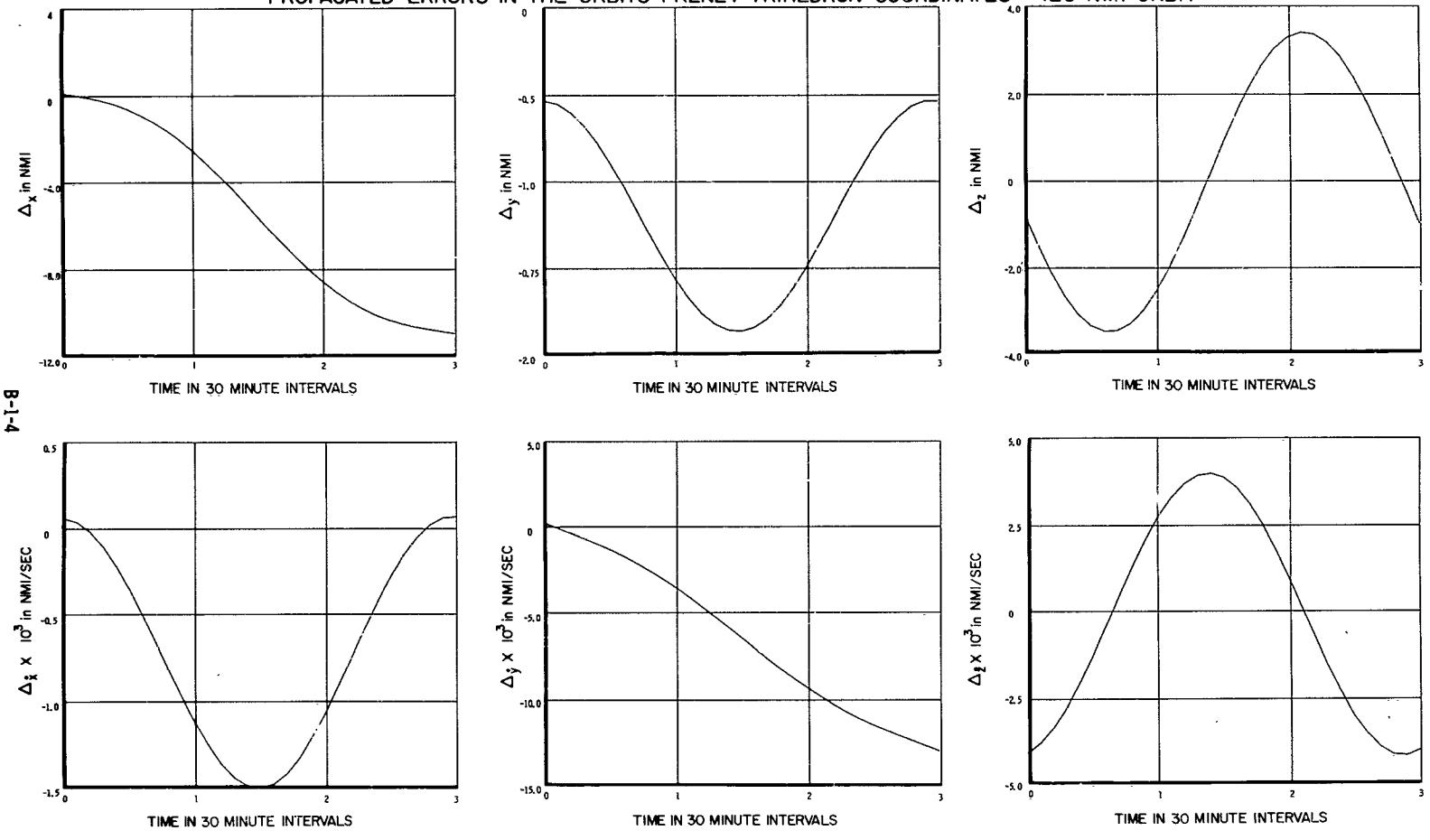
Tracking Through 90^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)
Tracking Through 90^0 of Azimuth
Tracking From 1 Station

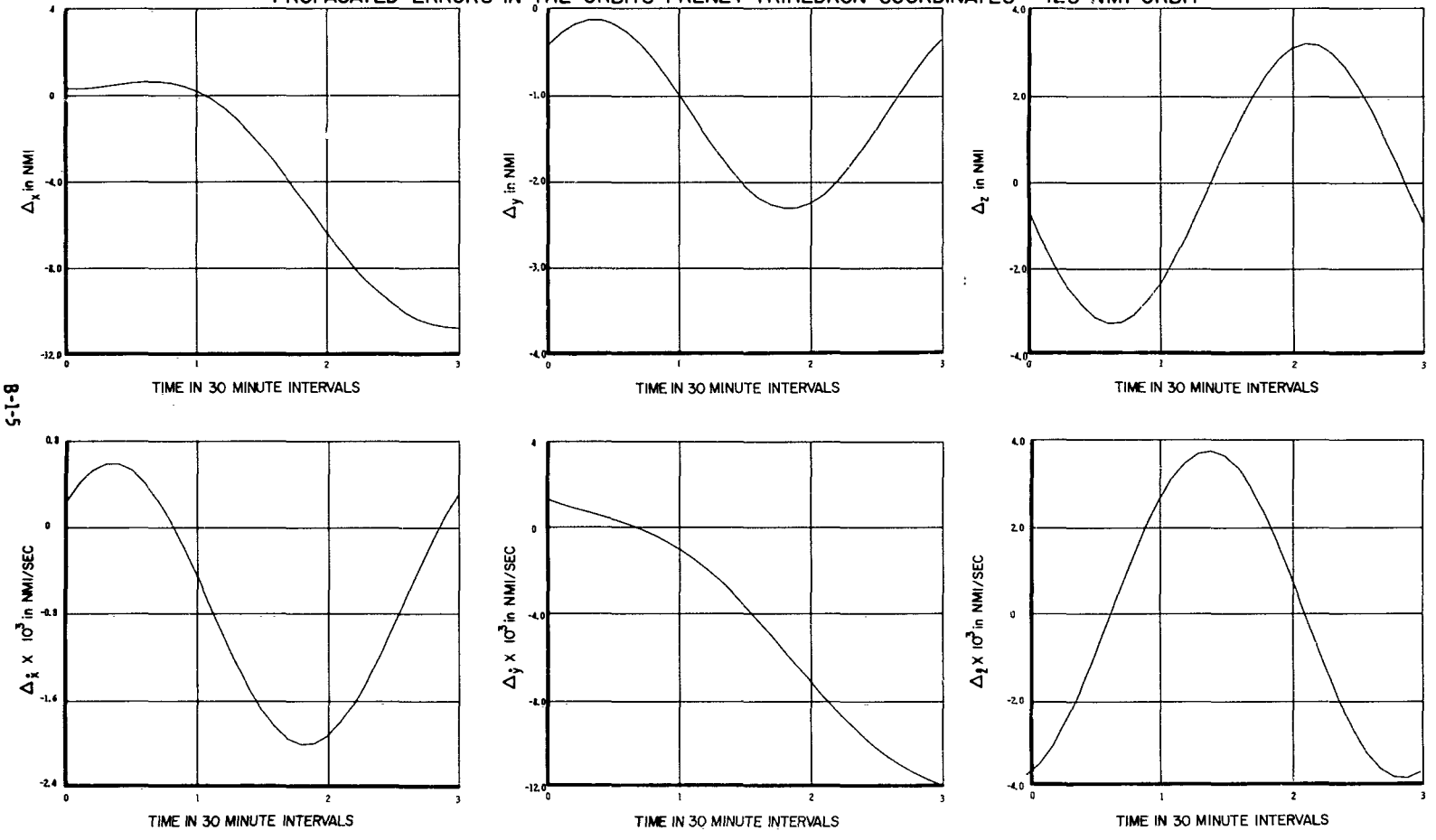
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

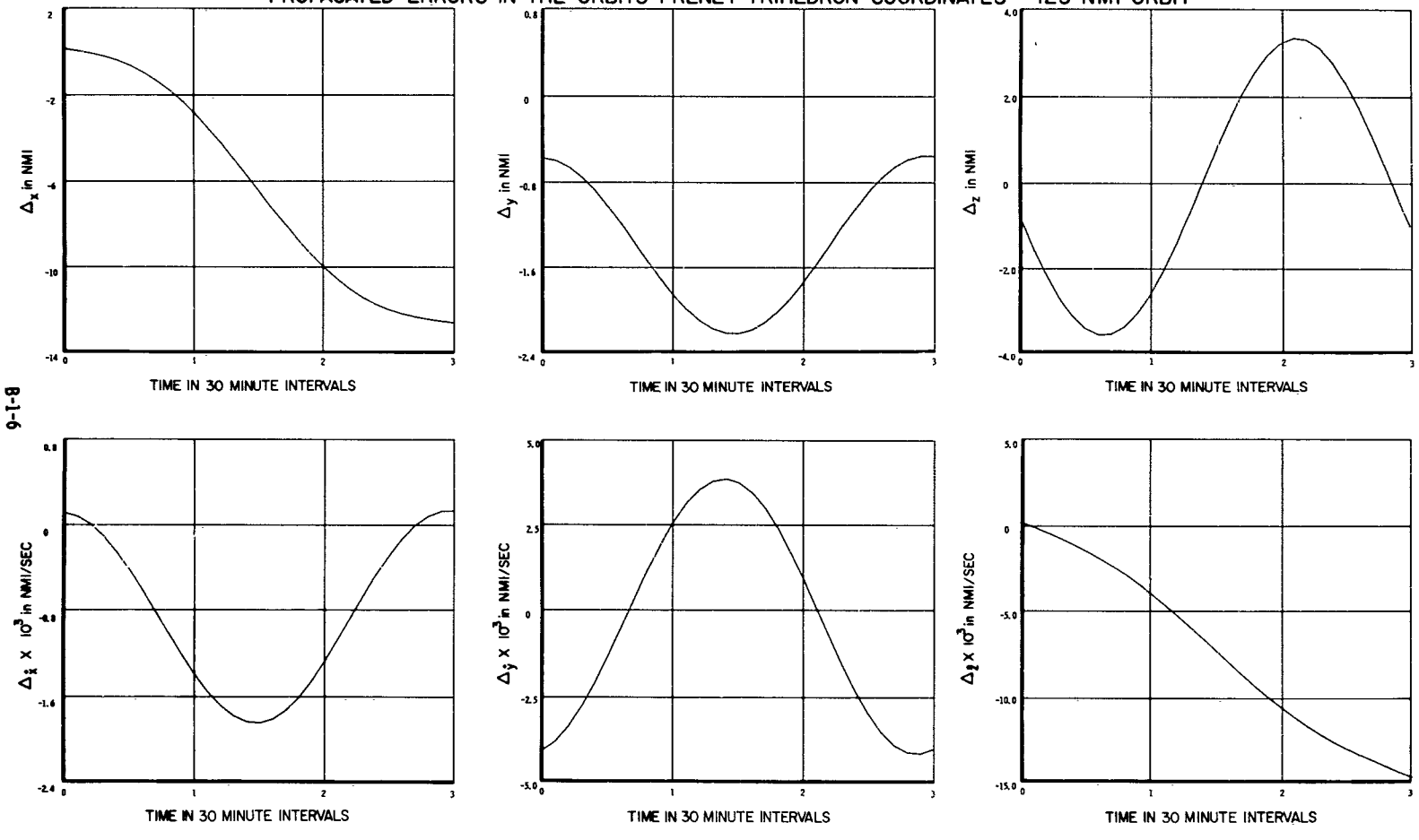


8-1-5

Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

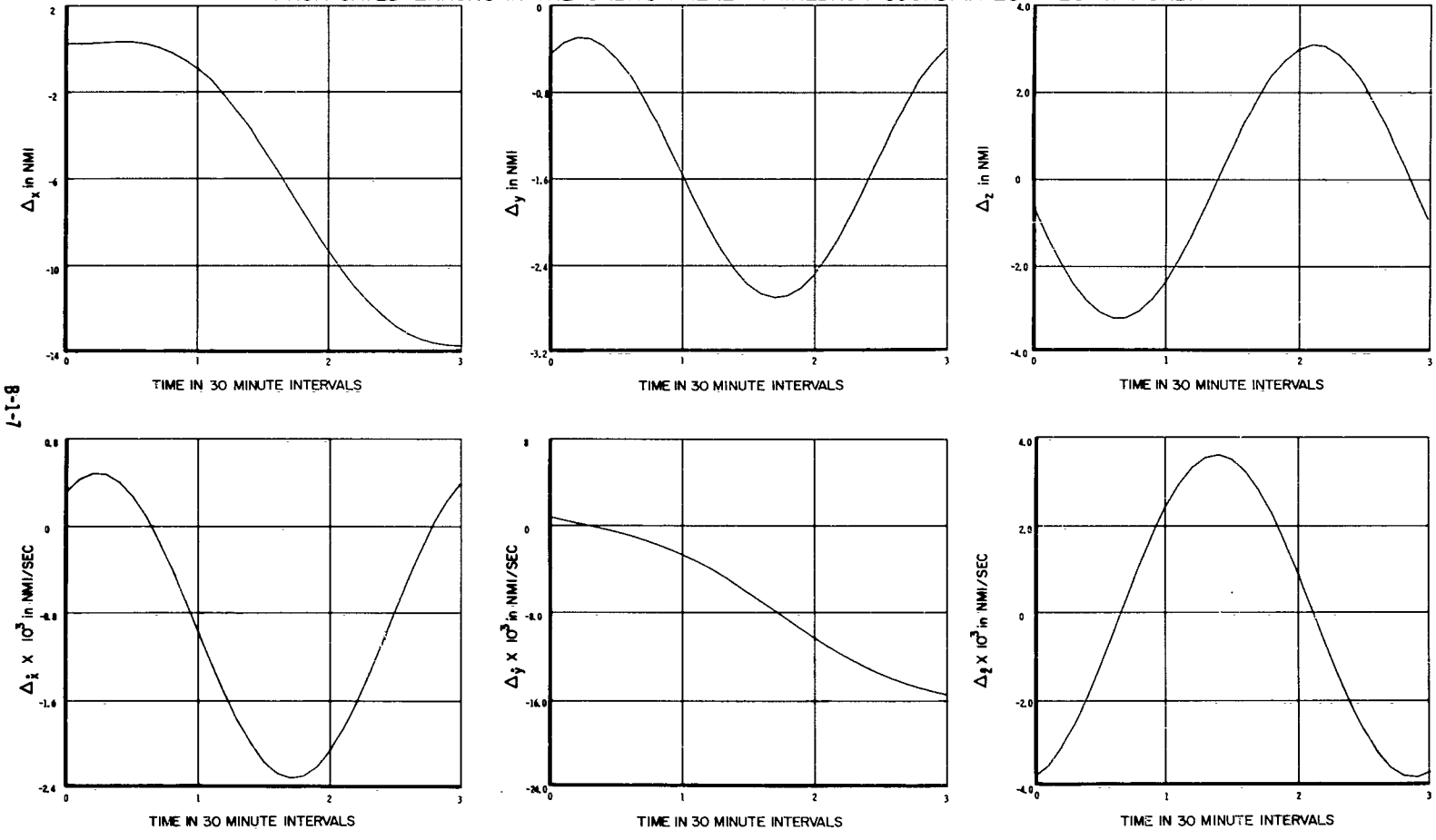


9-1-8

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 1 Station

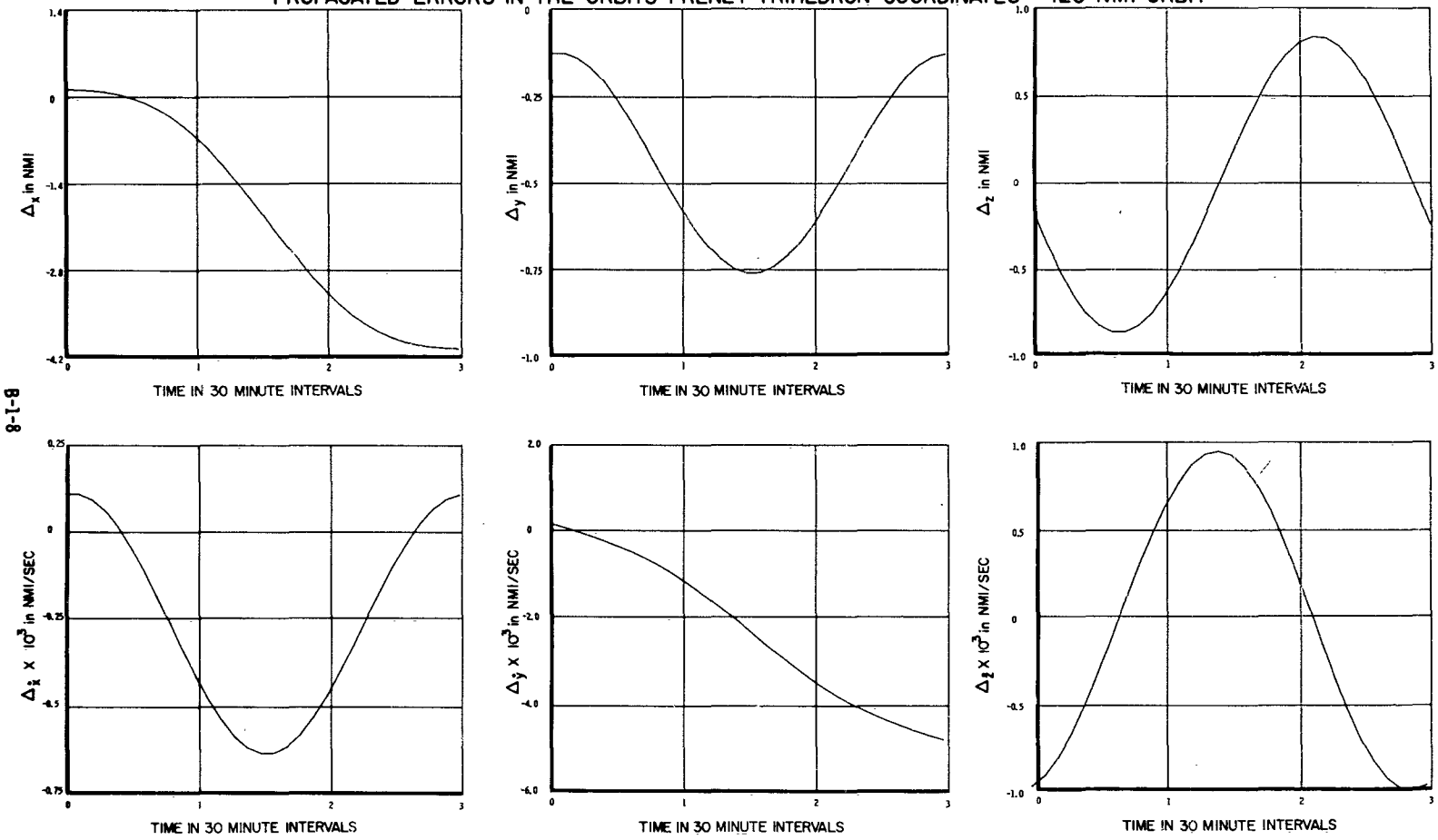
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90° of Azimuth
Tracking From 1 Station

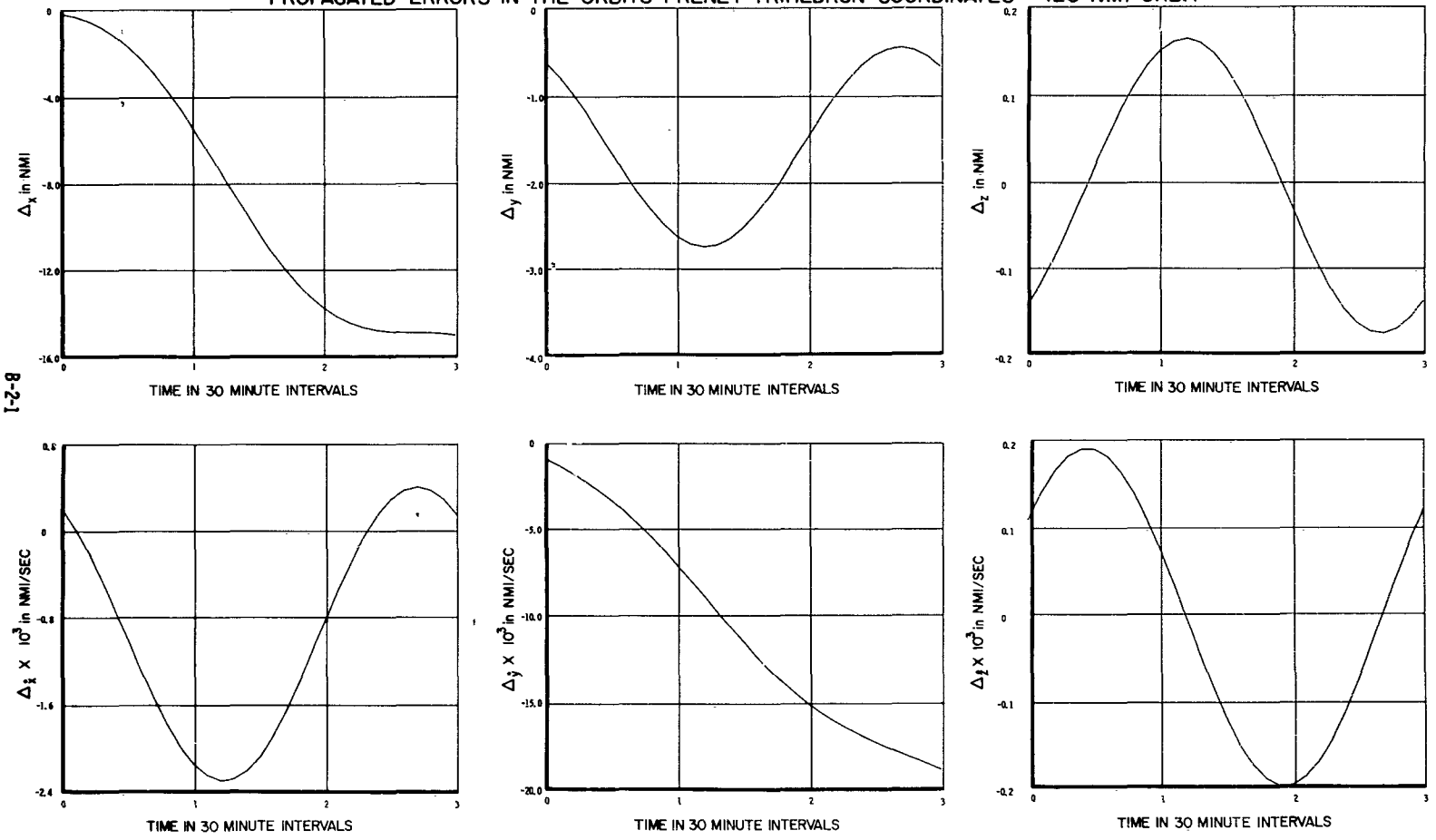
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error)

Tracking Through 90° of Azimuth
Tracking From 1 Station

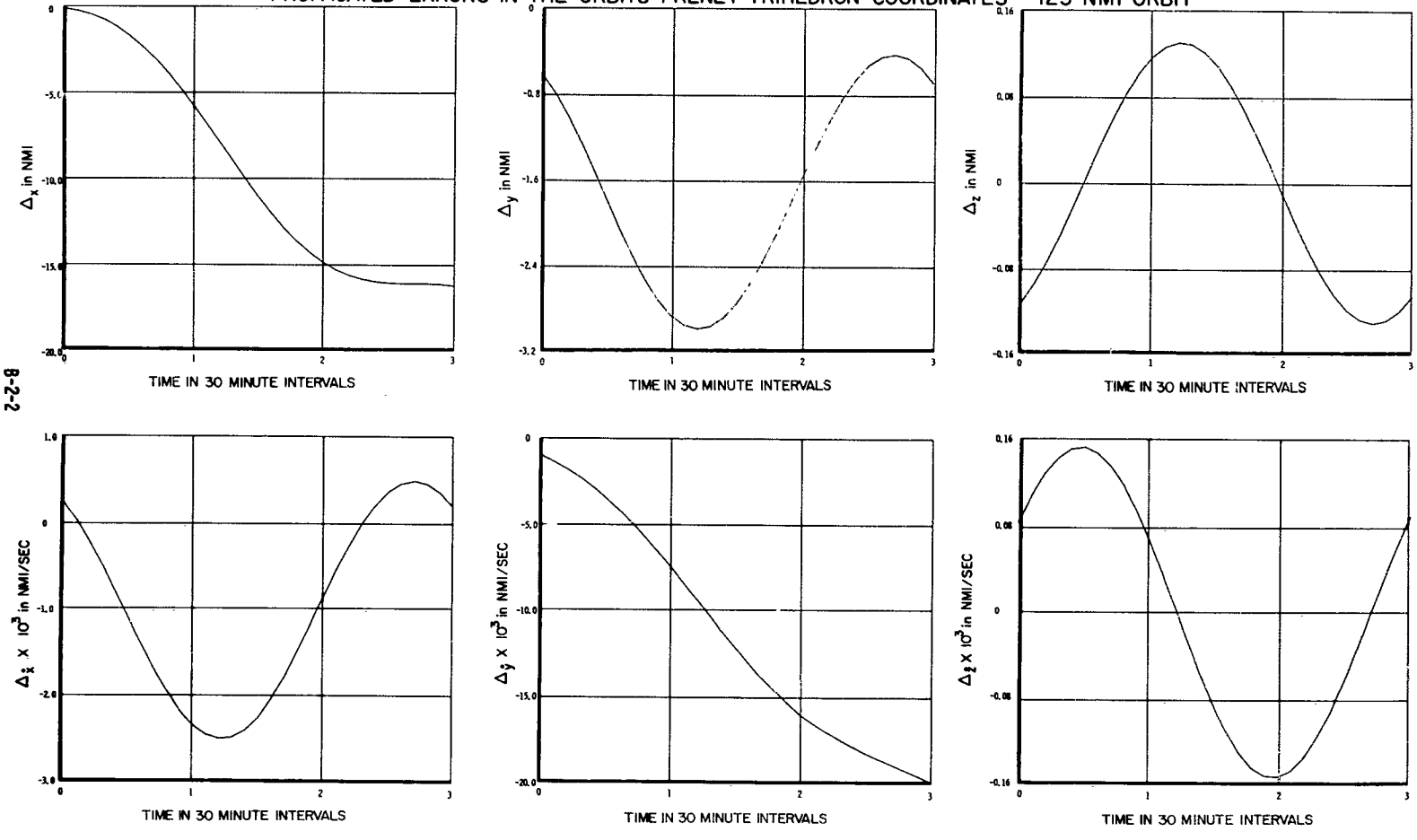
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Error: 50 ft, 1 Milliradian (Fixed Error)

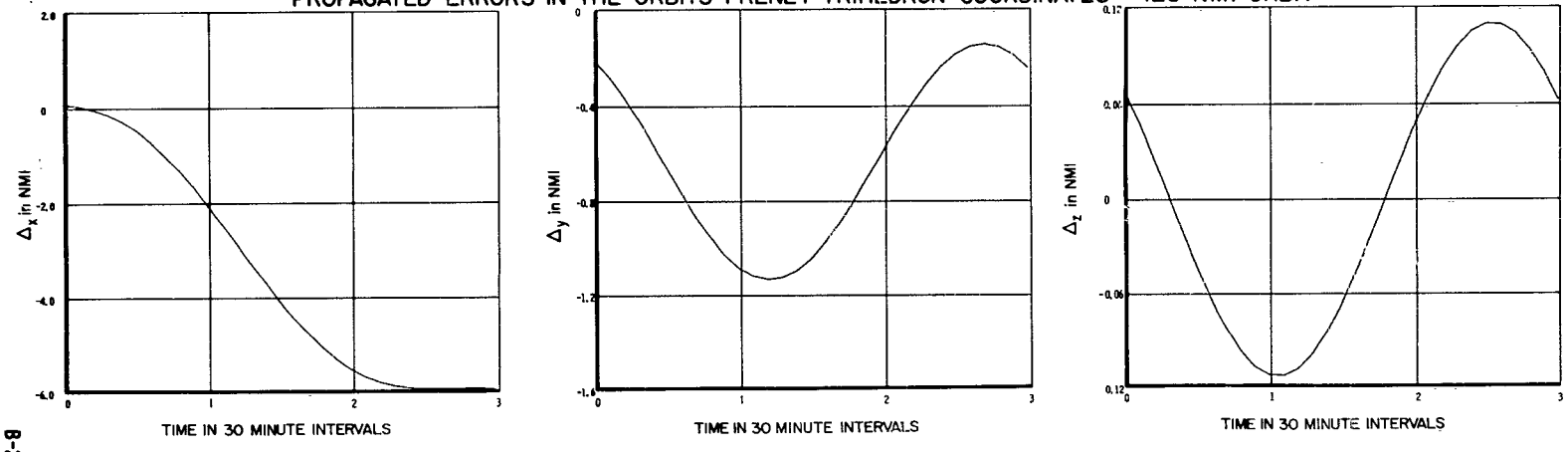
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

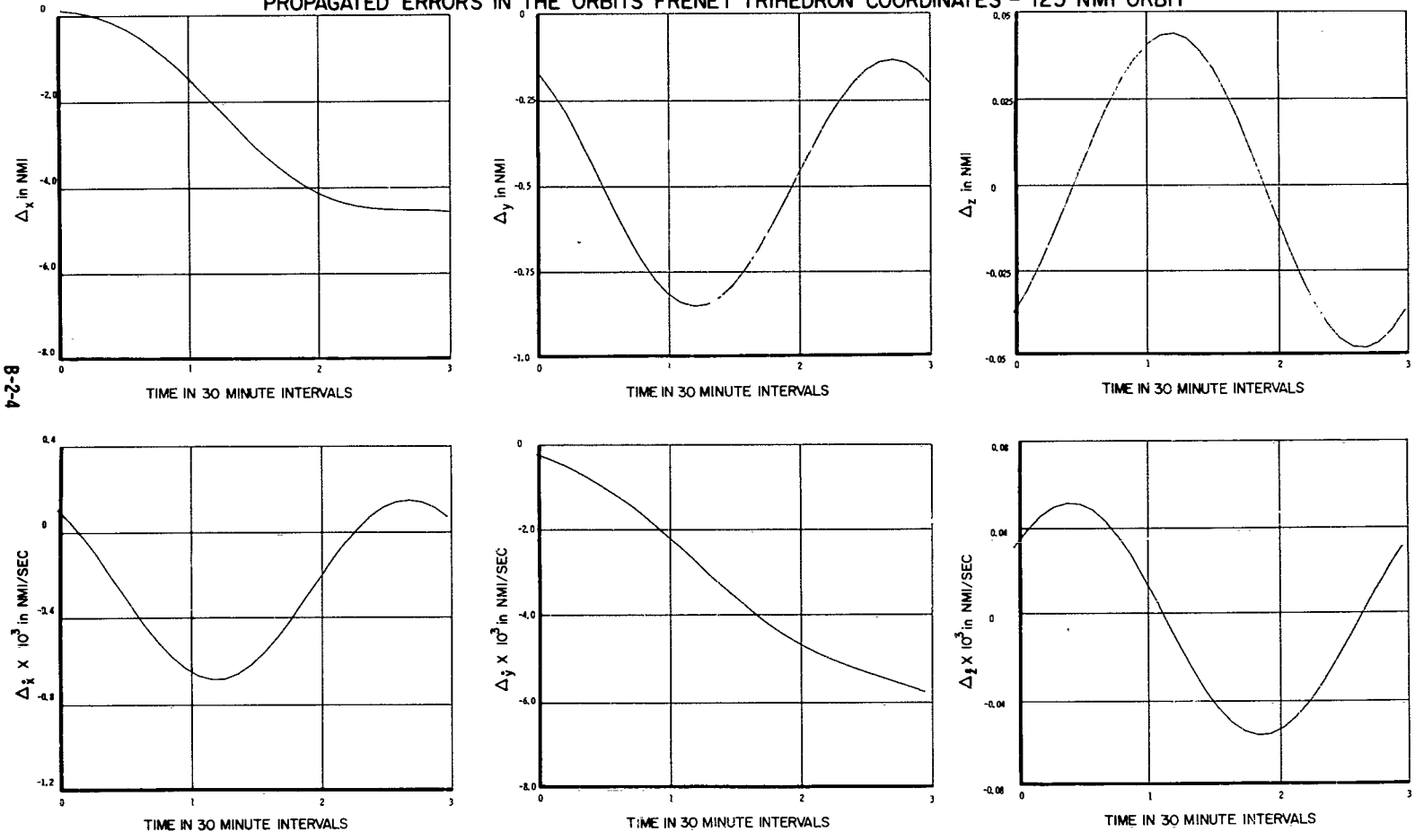
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



B-2-3

Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

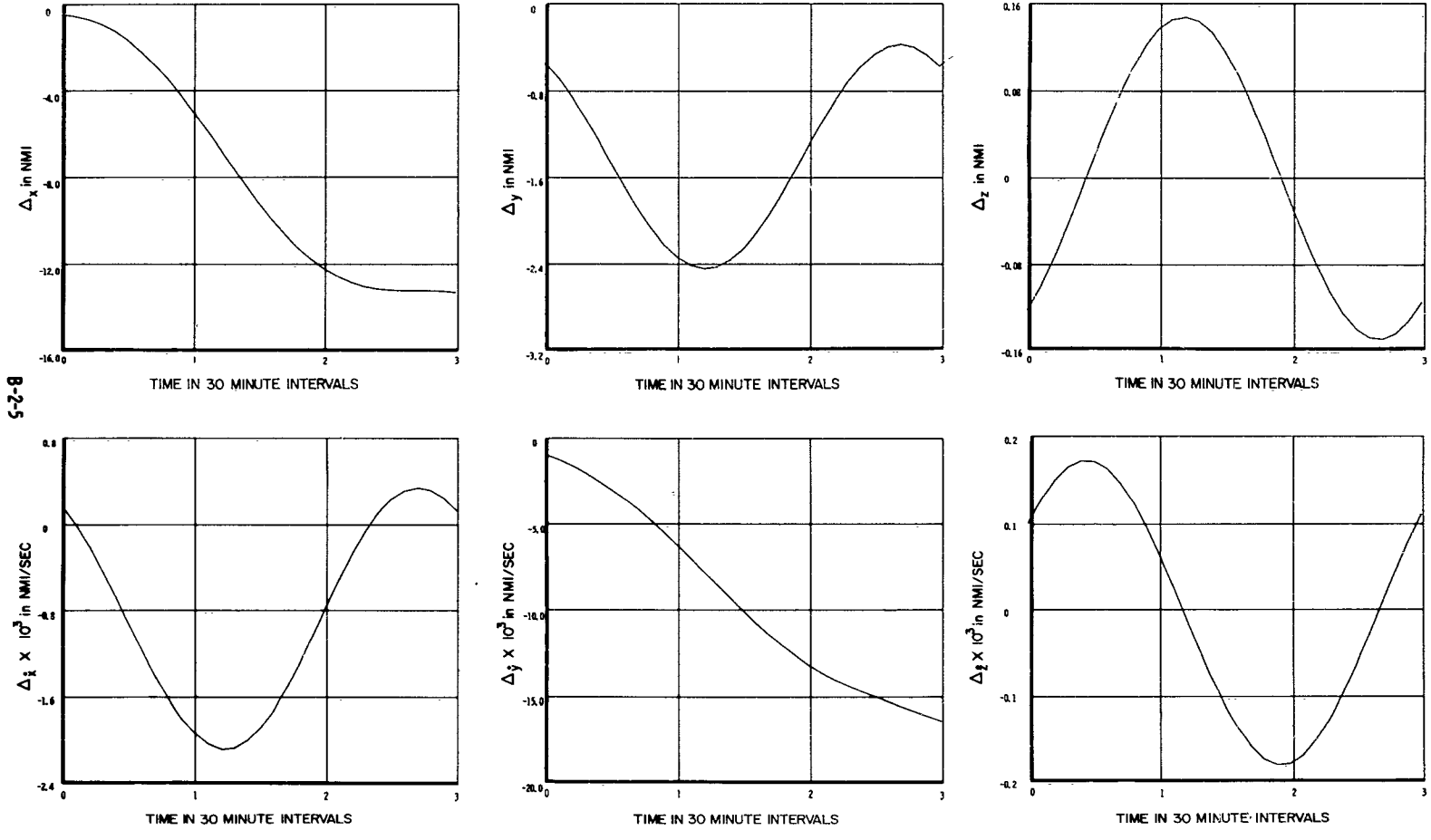
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

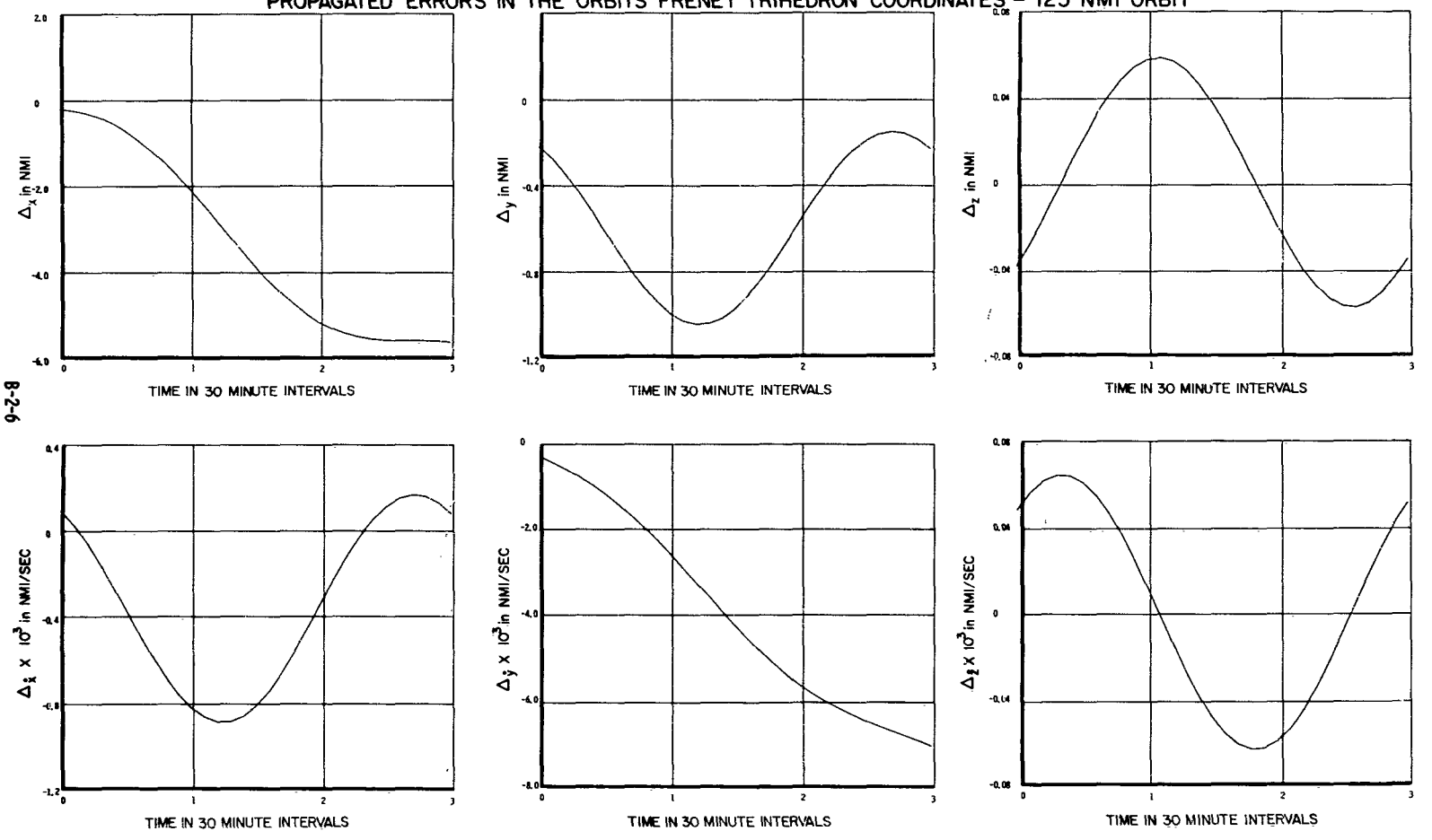
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

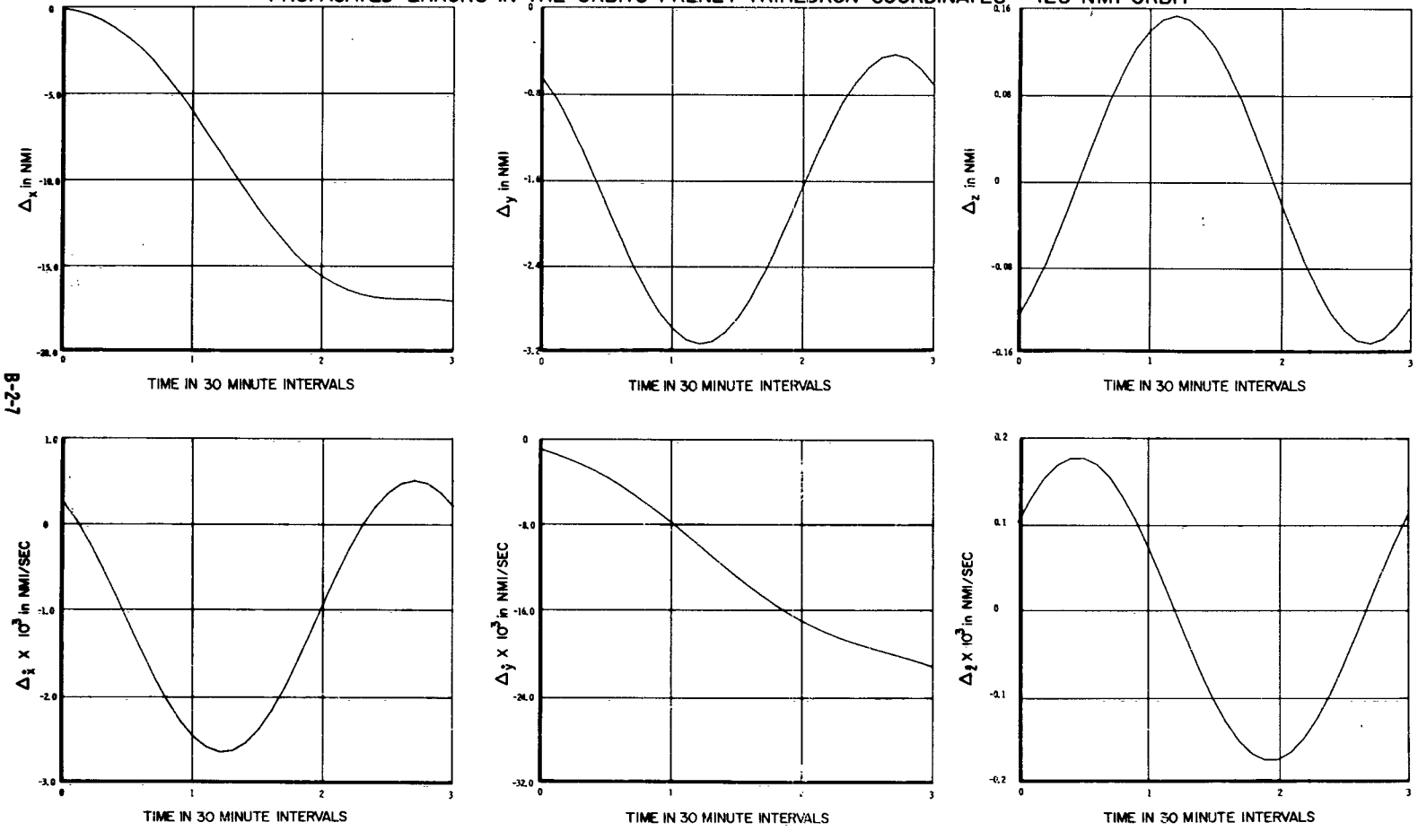


9-2-8

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

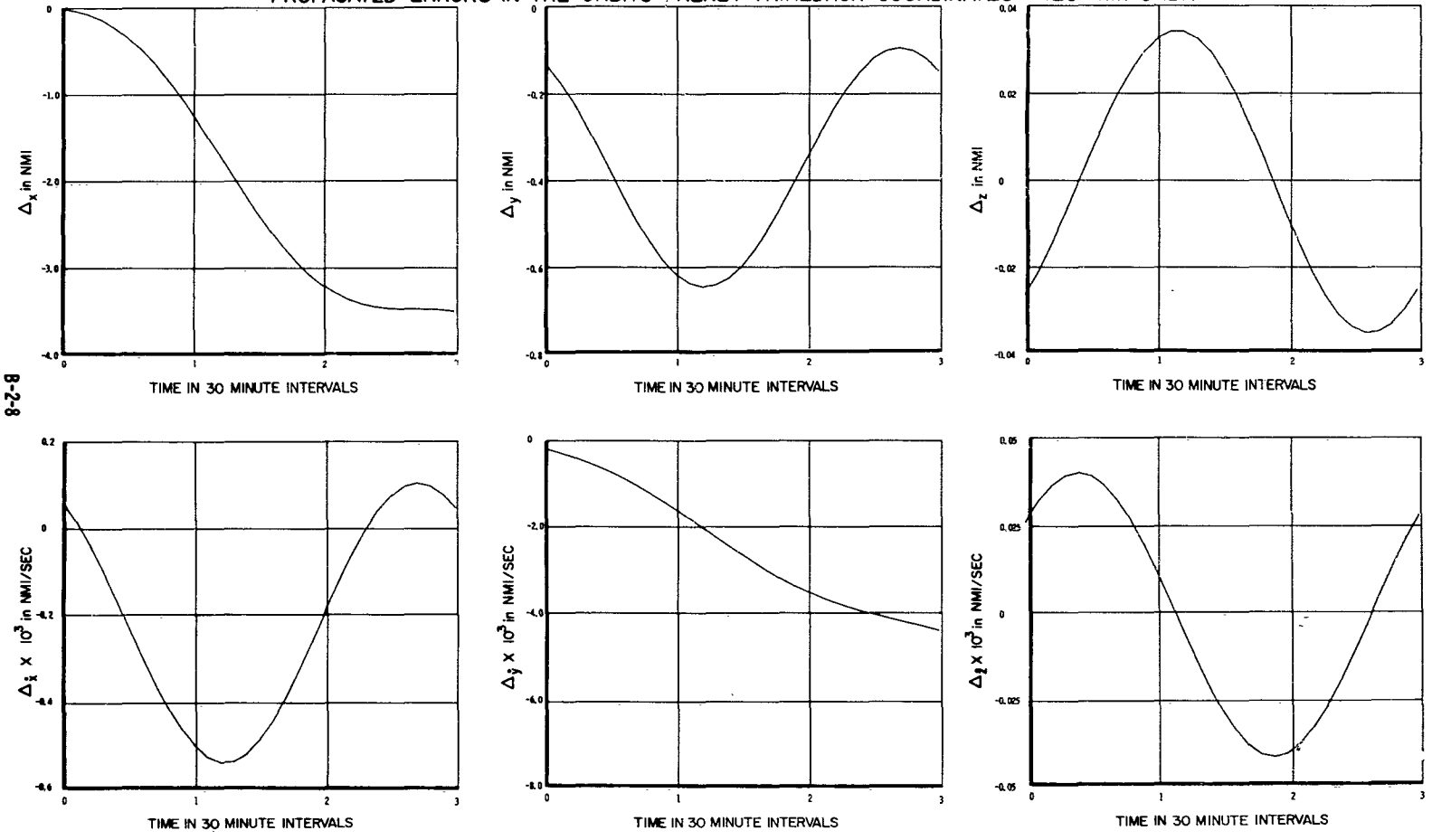
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

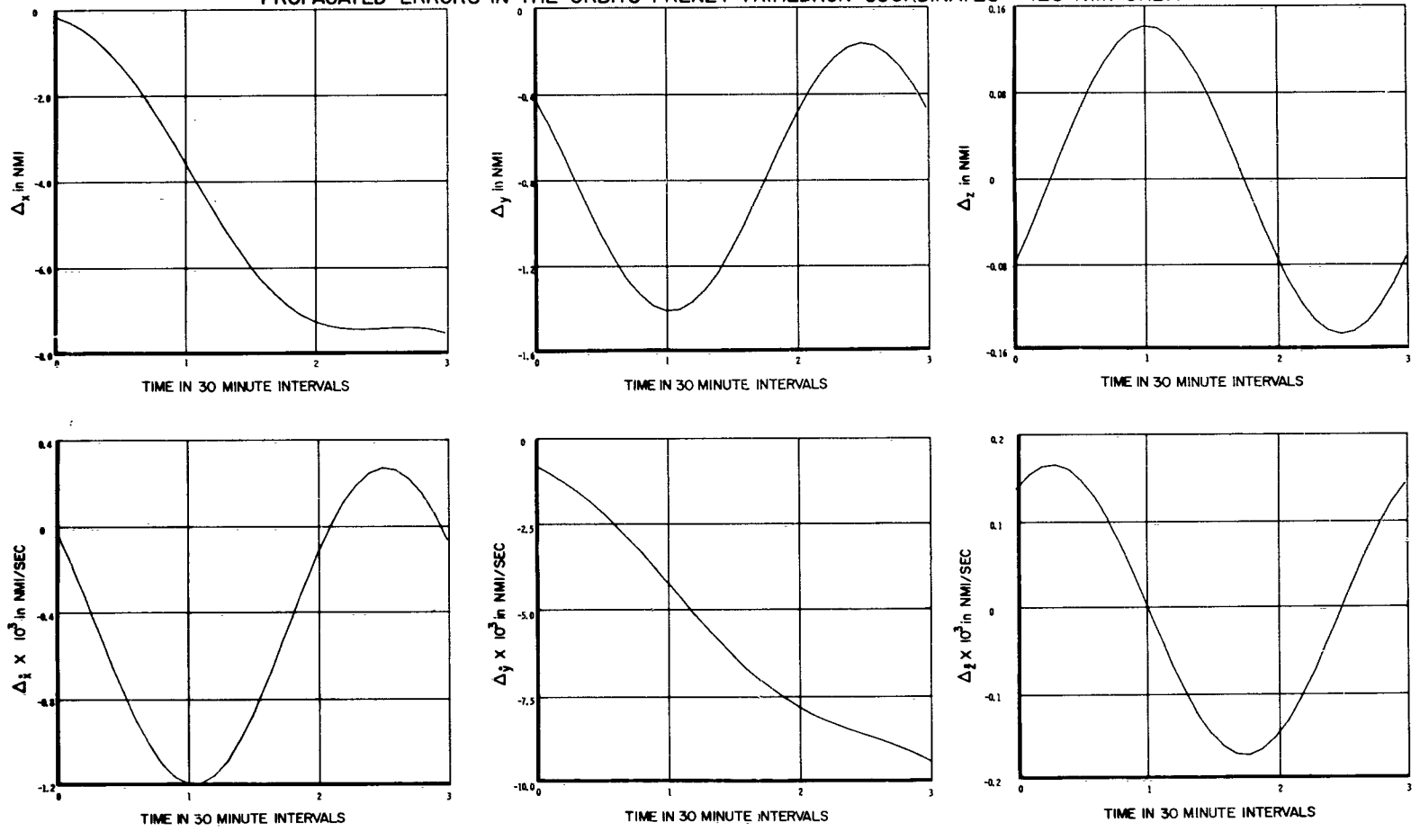


8-2-8

Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error

Tracking Through 90° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

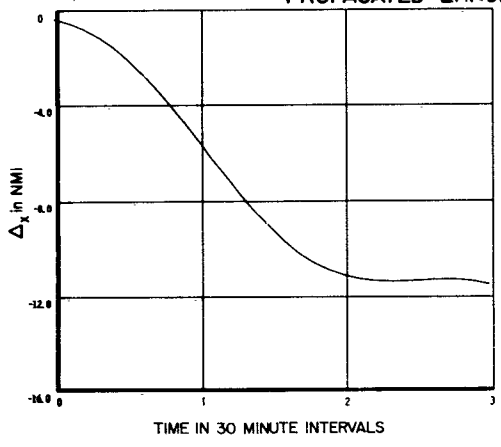
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

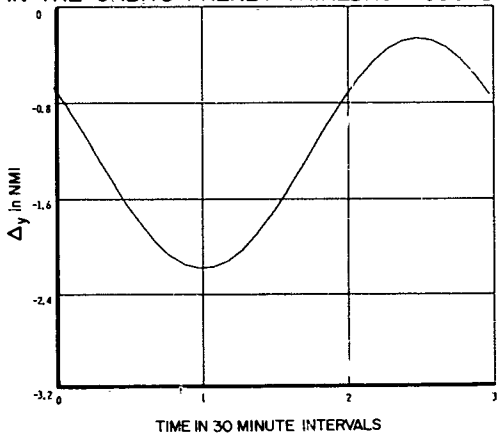


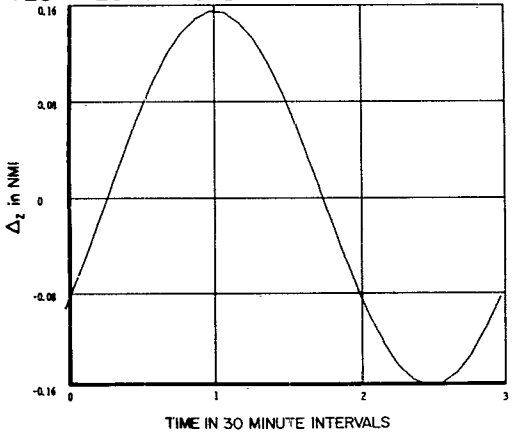
Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

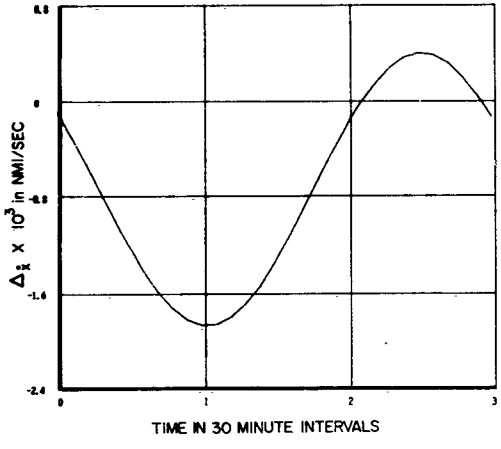
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

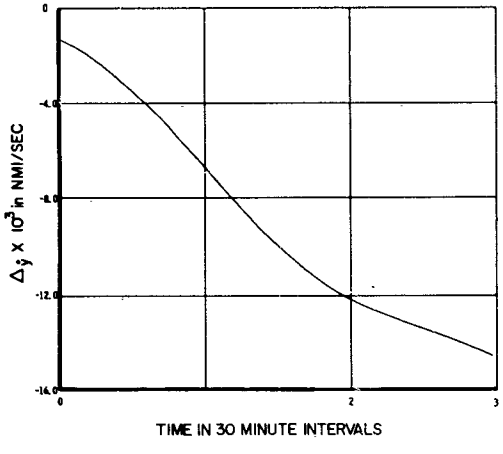
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

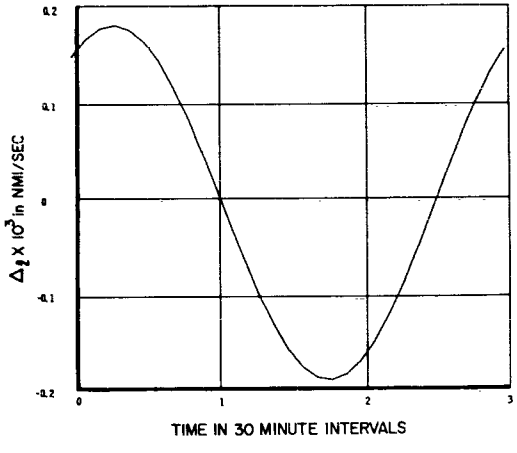








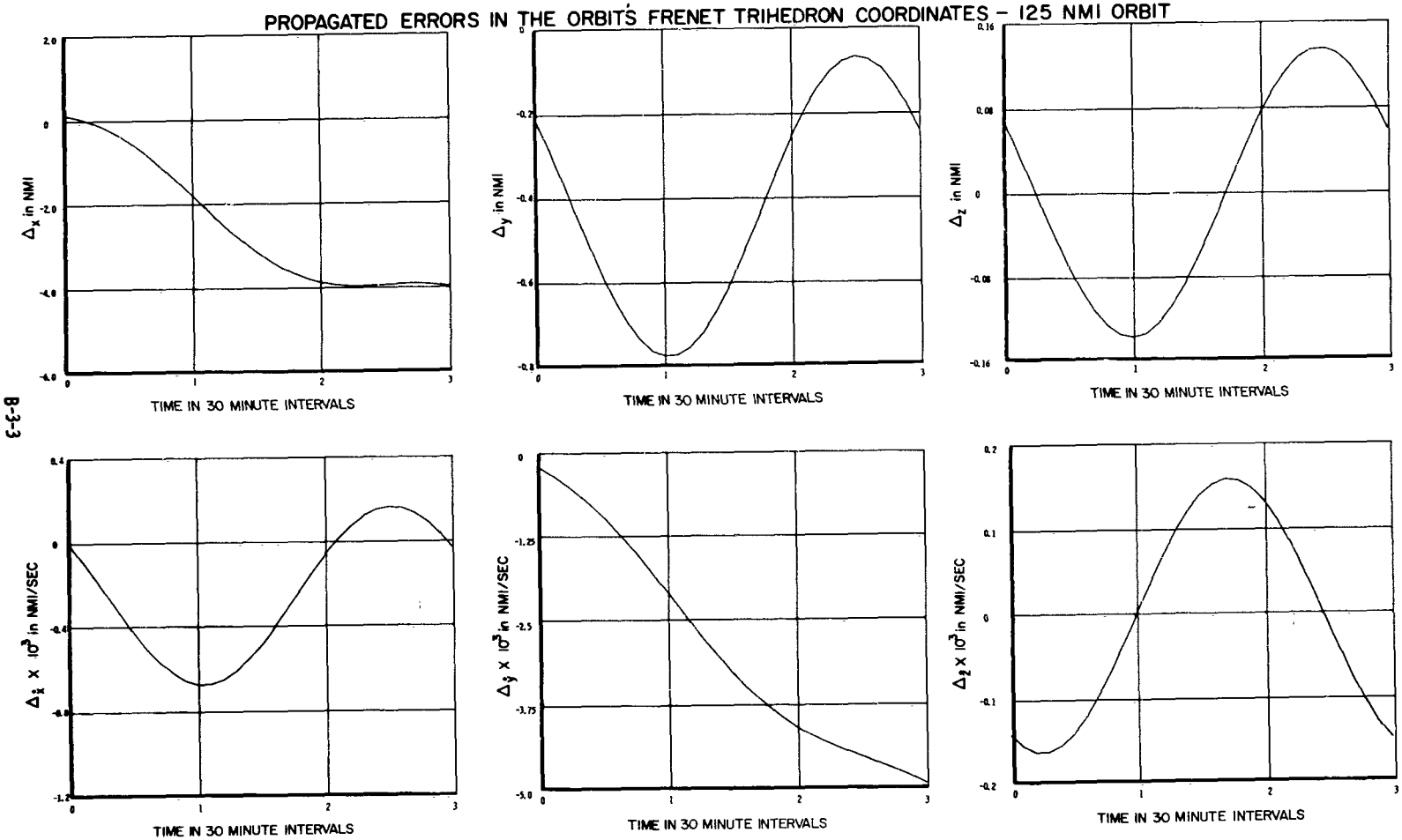




Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

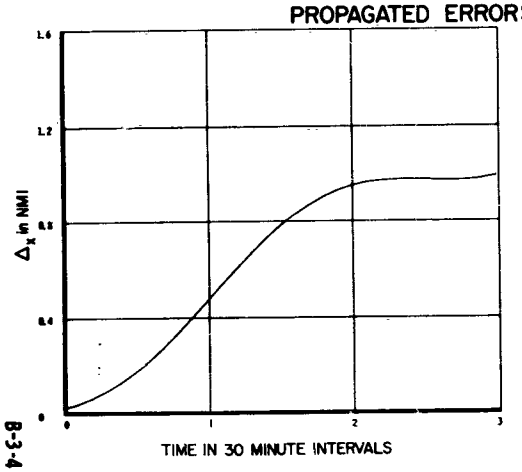


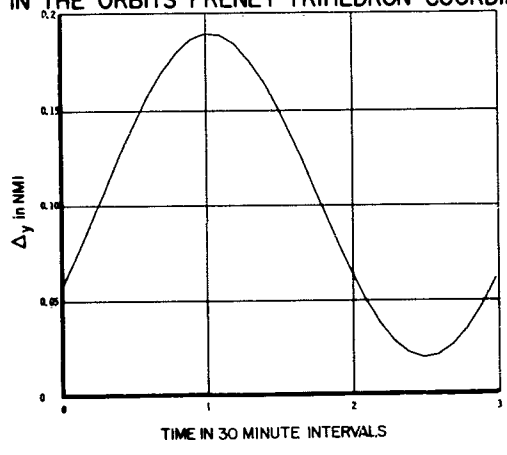
B-3-3

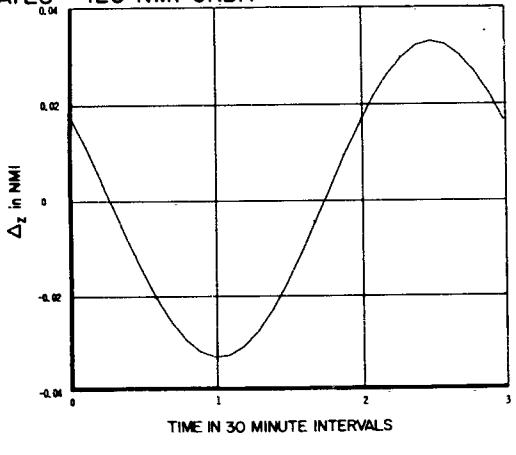
Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)

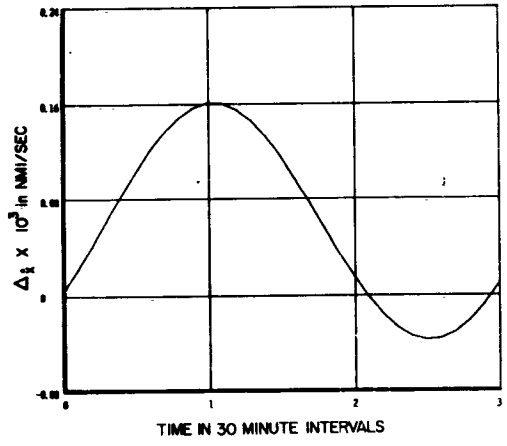
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

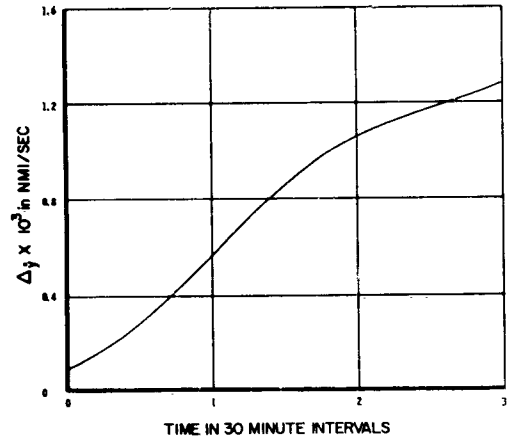
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

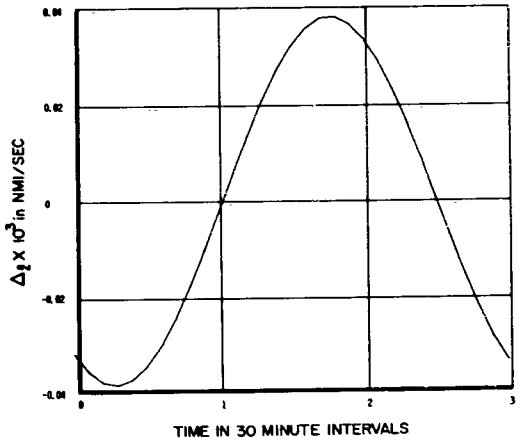








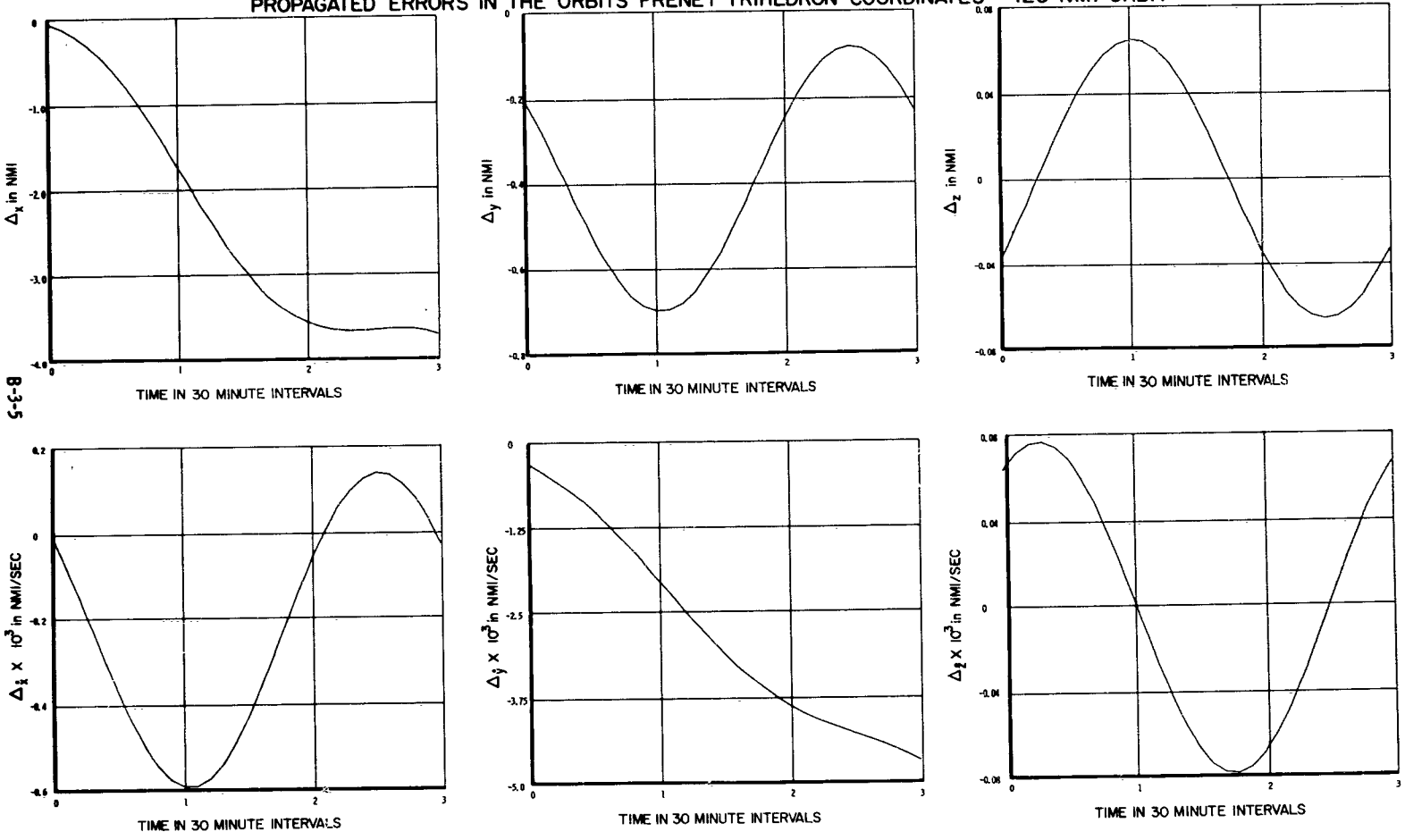




Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

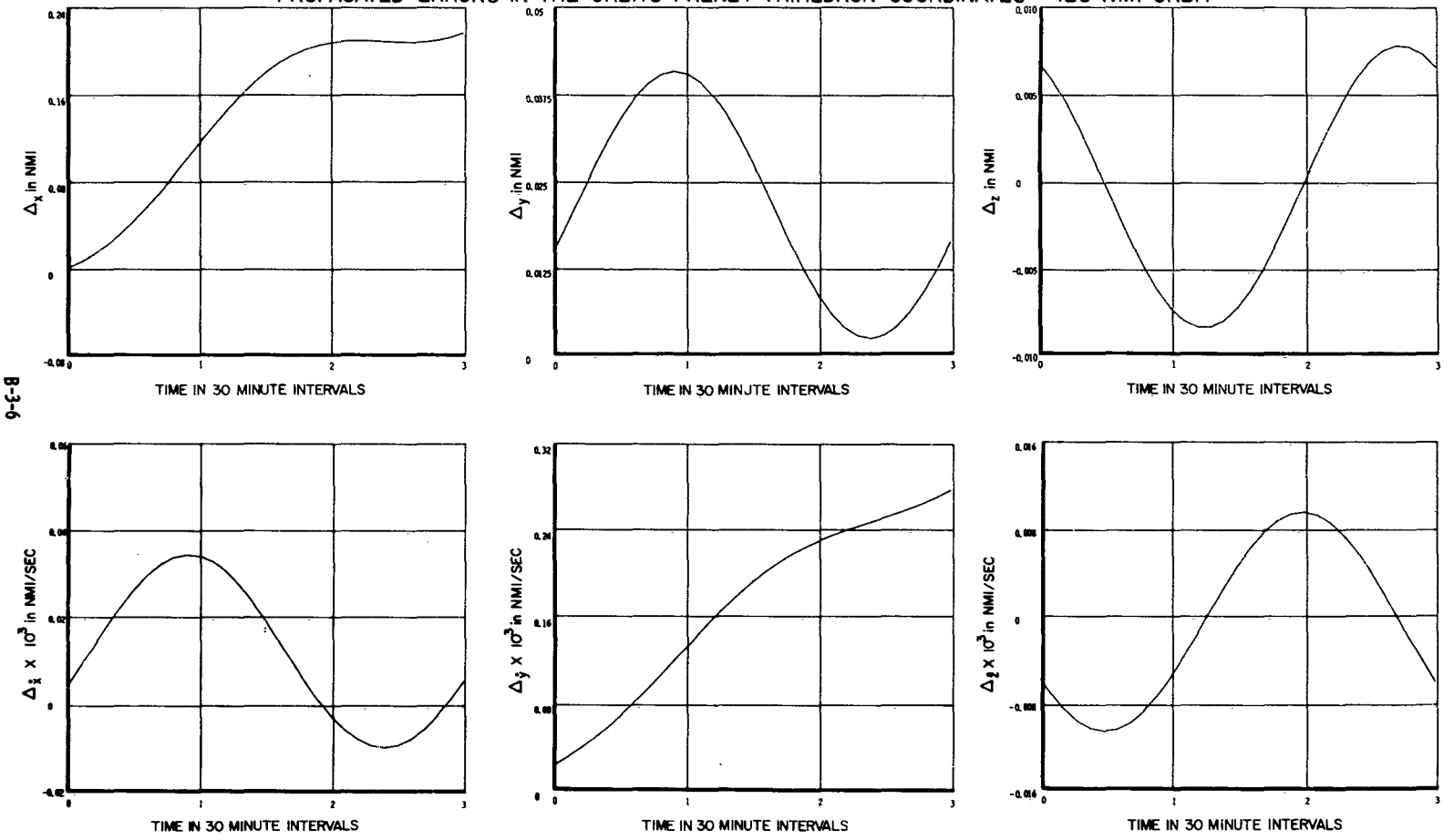
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90° of Azimuth
Tracking From 2 Stations (90° Latitude Separation)

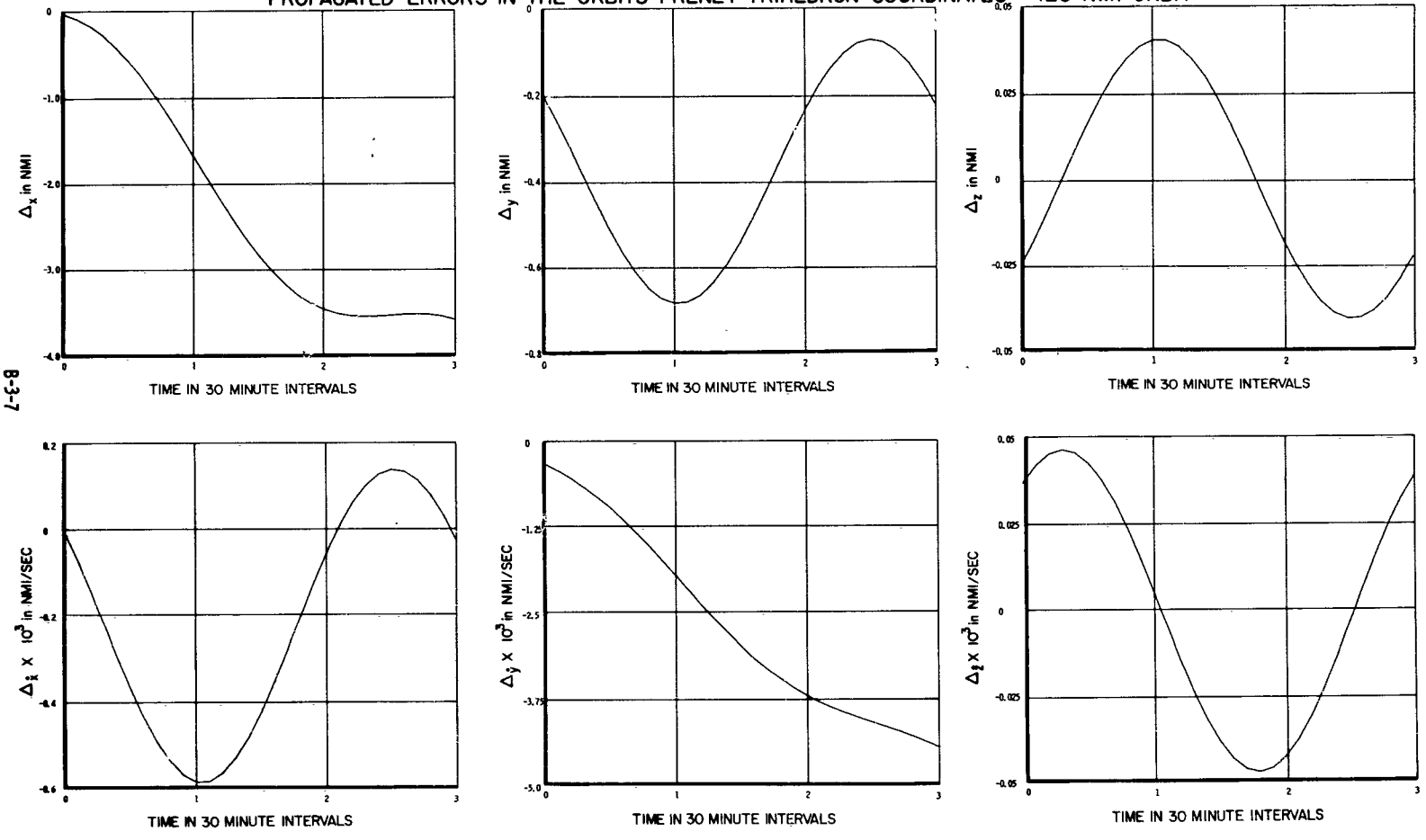
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft./sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

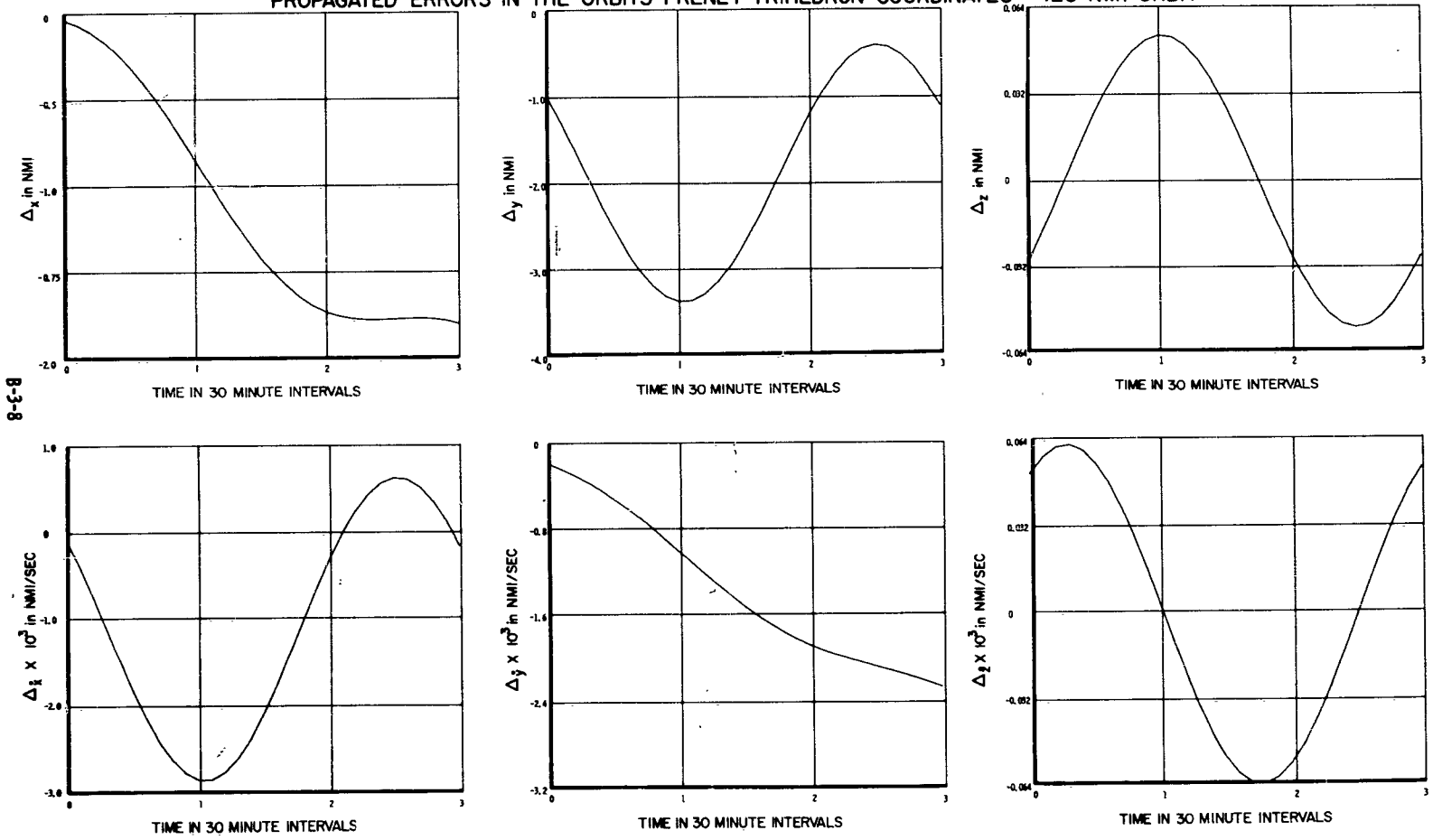
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

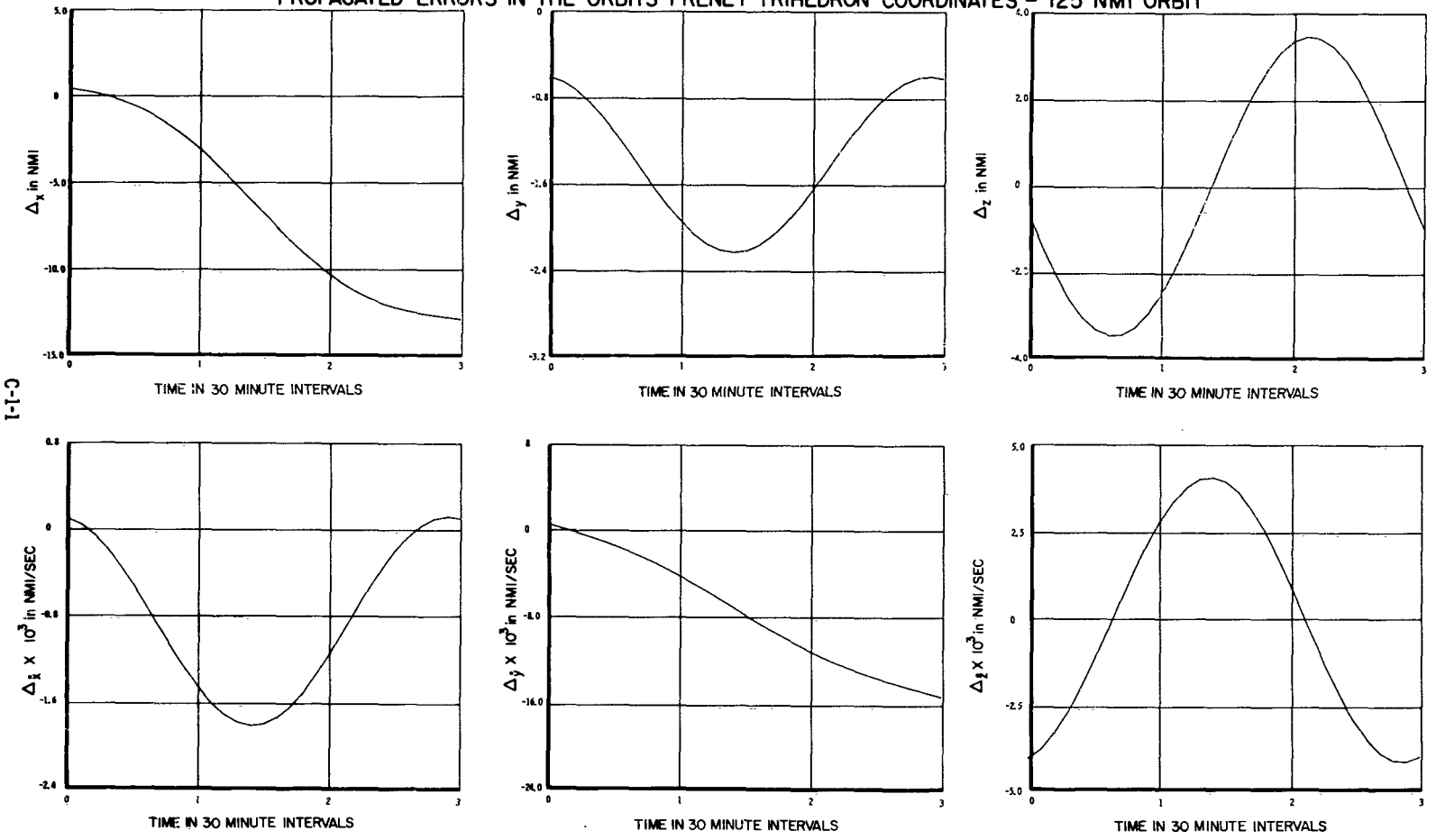
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

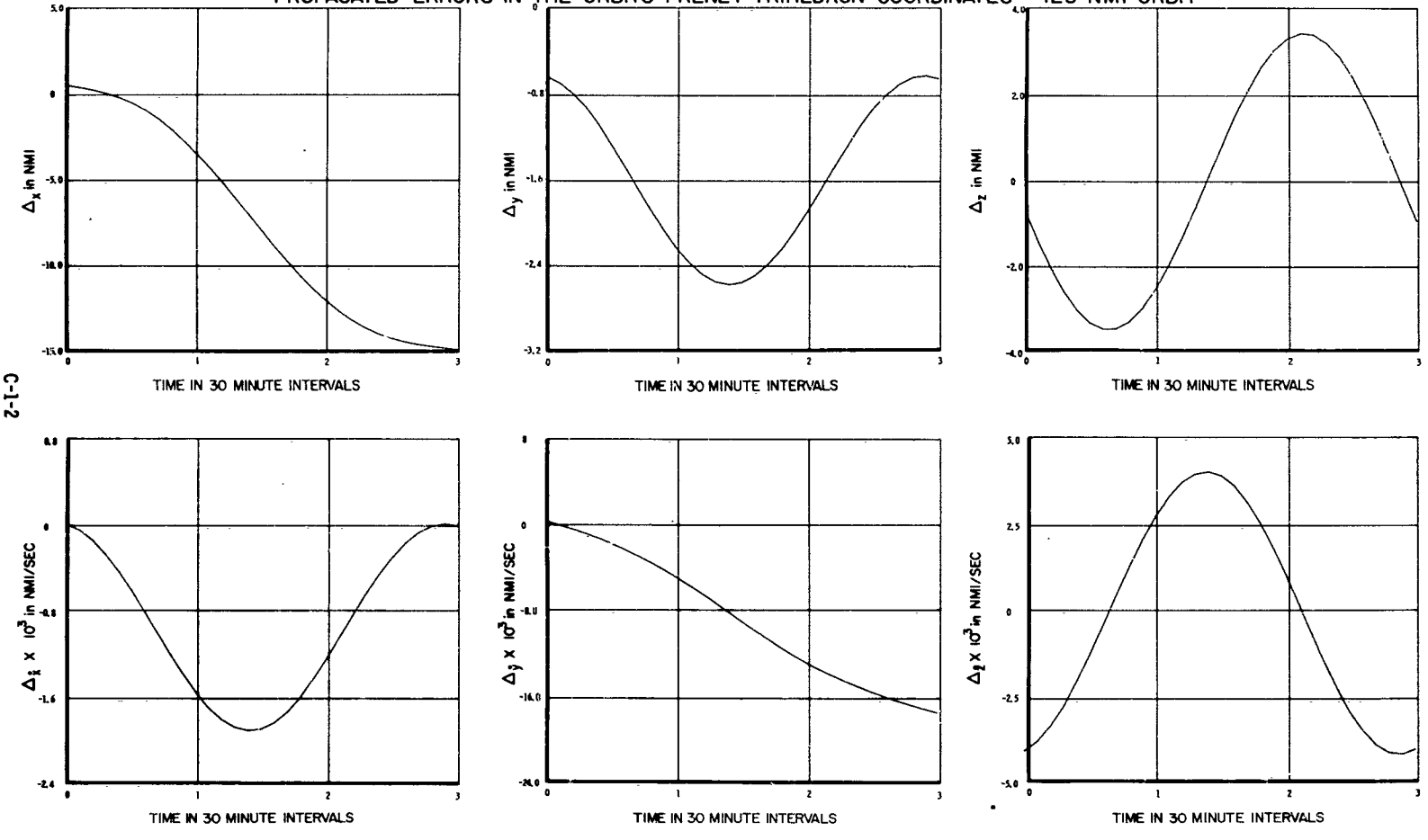


I-1-3

Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

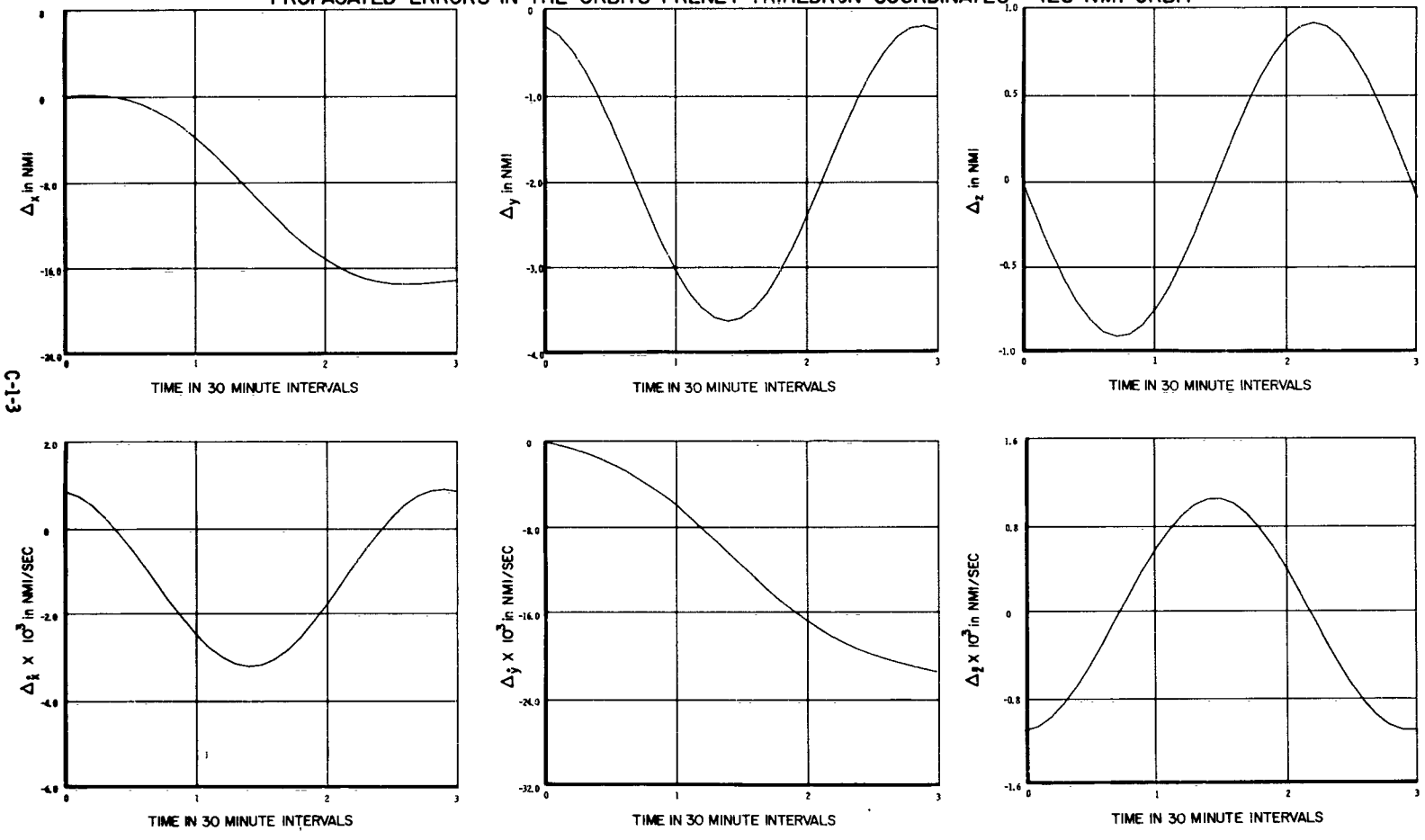
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

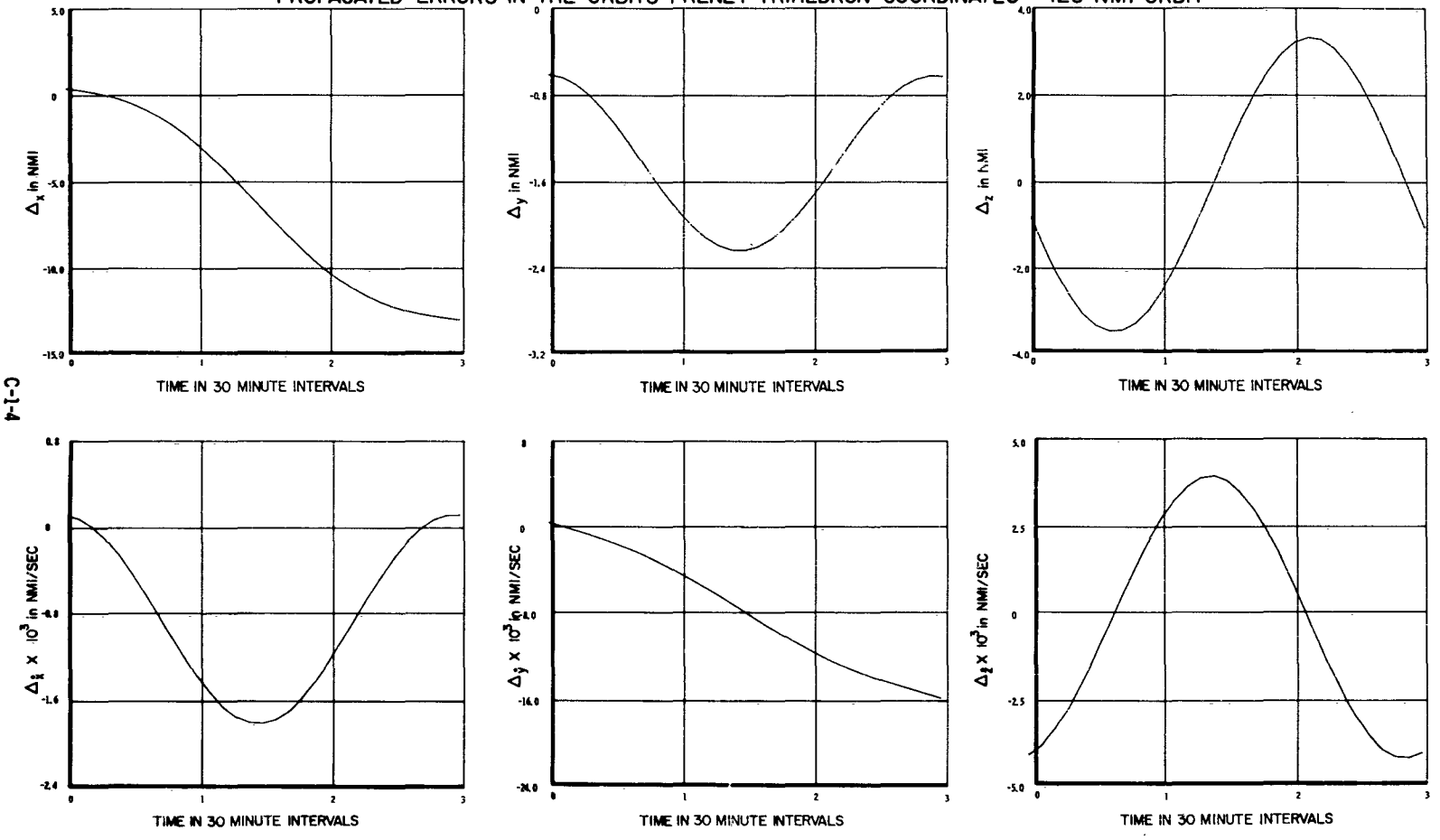


C-1-3

Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

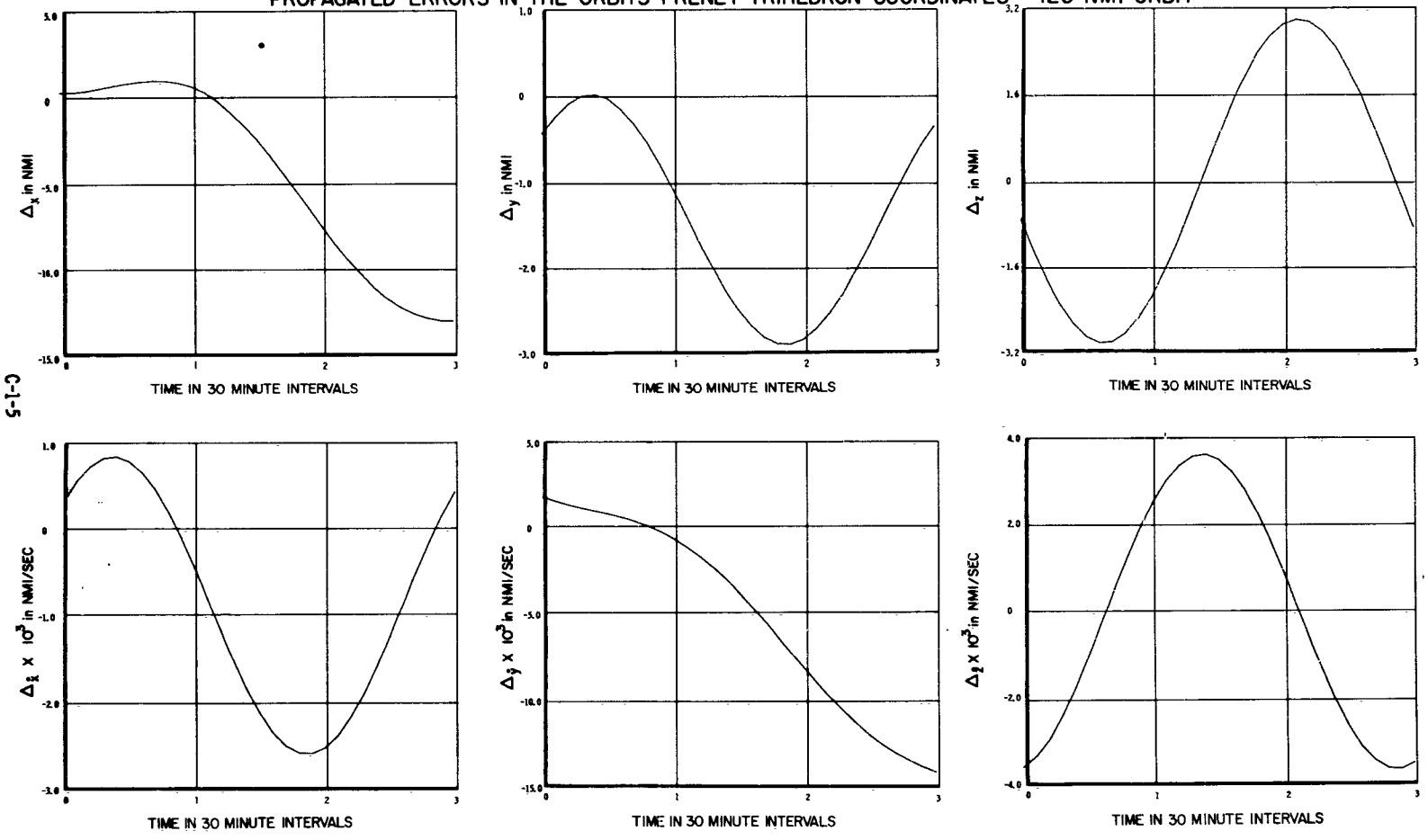
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

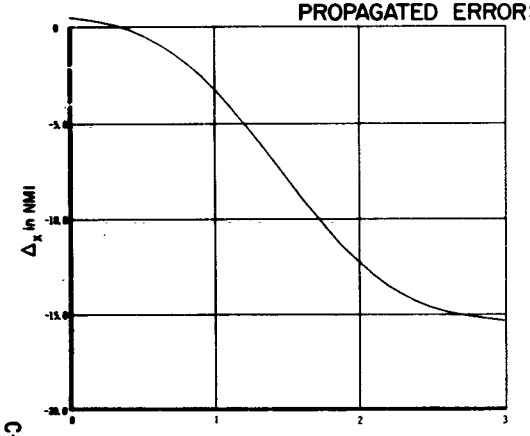


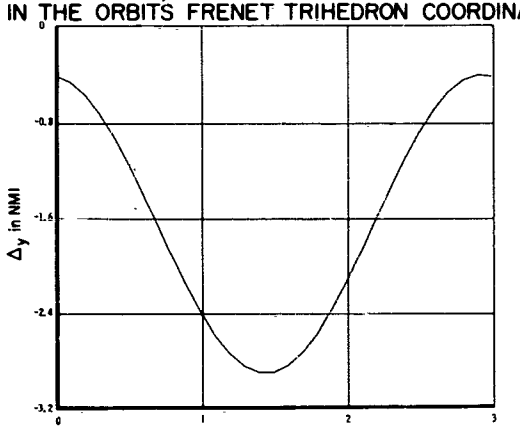
C-1-5

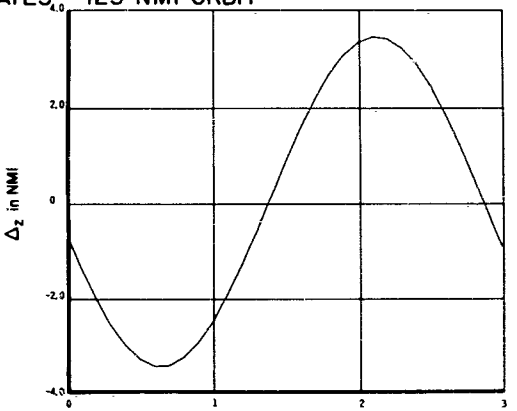
Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

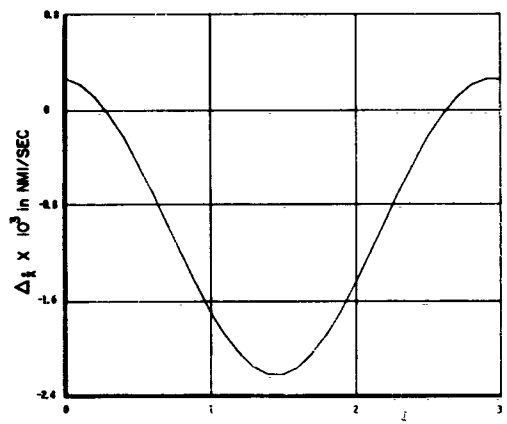
Tracking Through 60^0 of Azimuth
Tracking From 1 Station

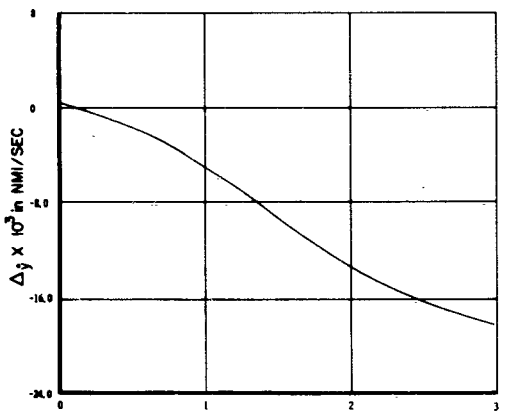
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

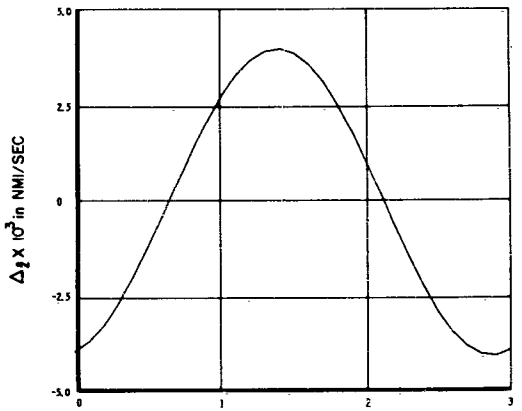










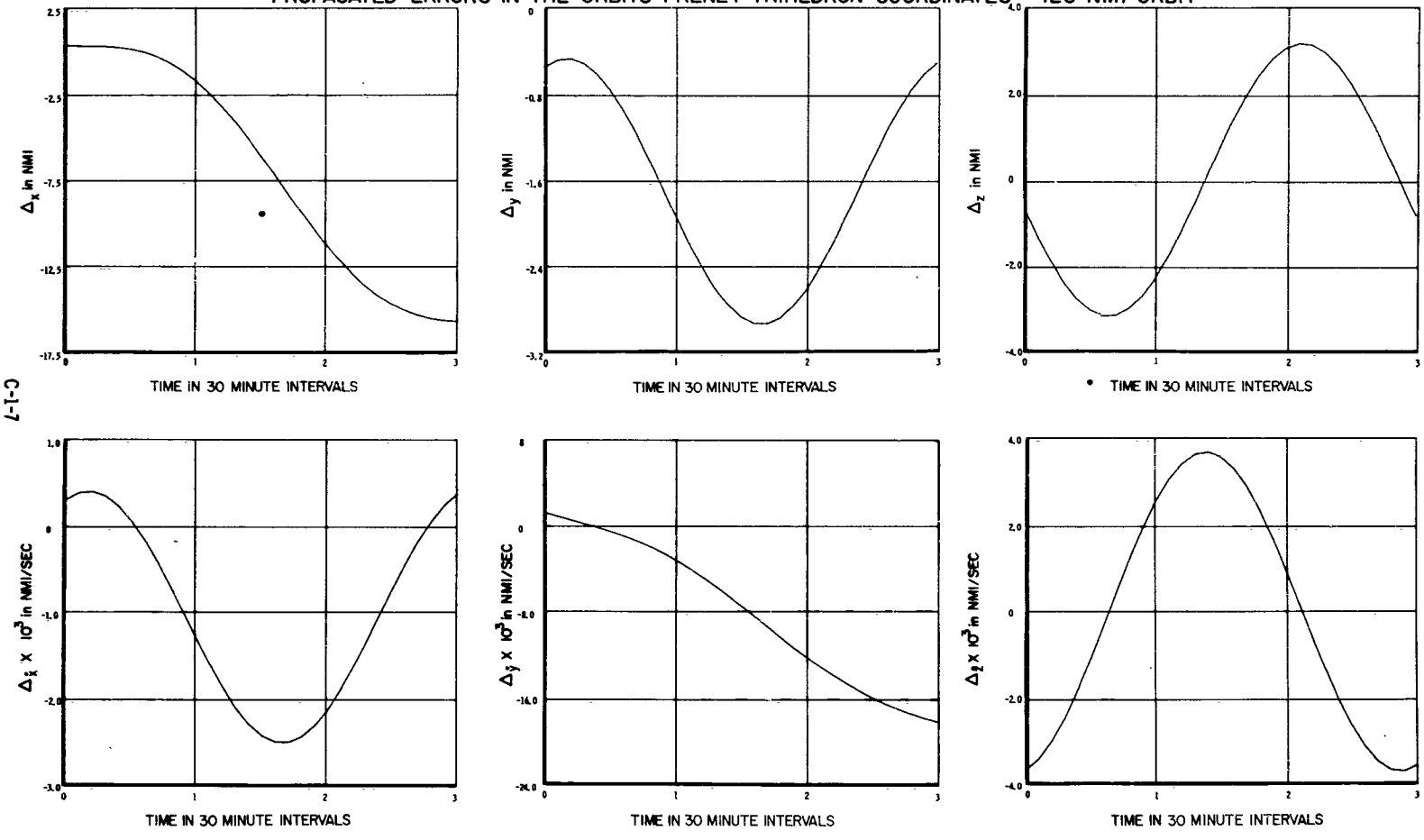


C-1-6

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

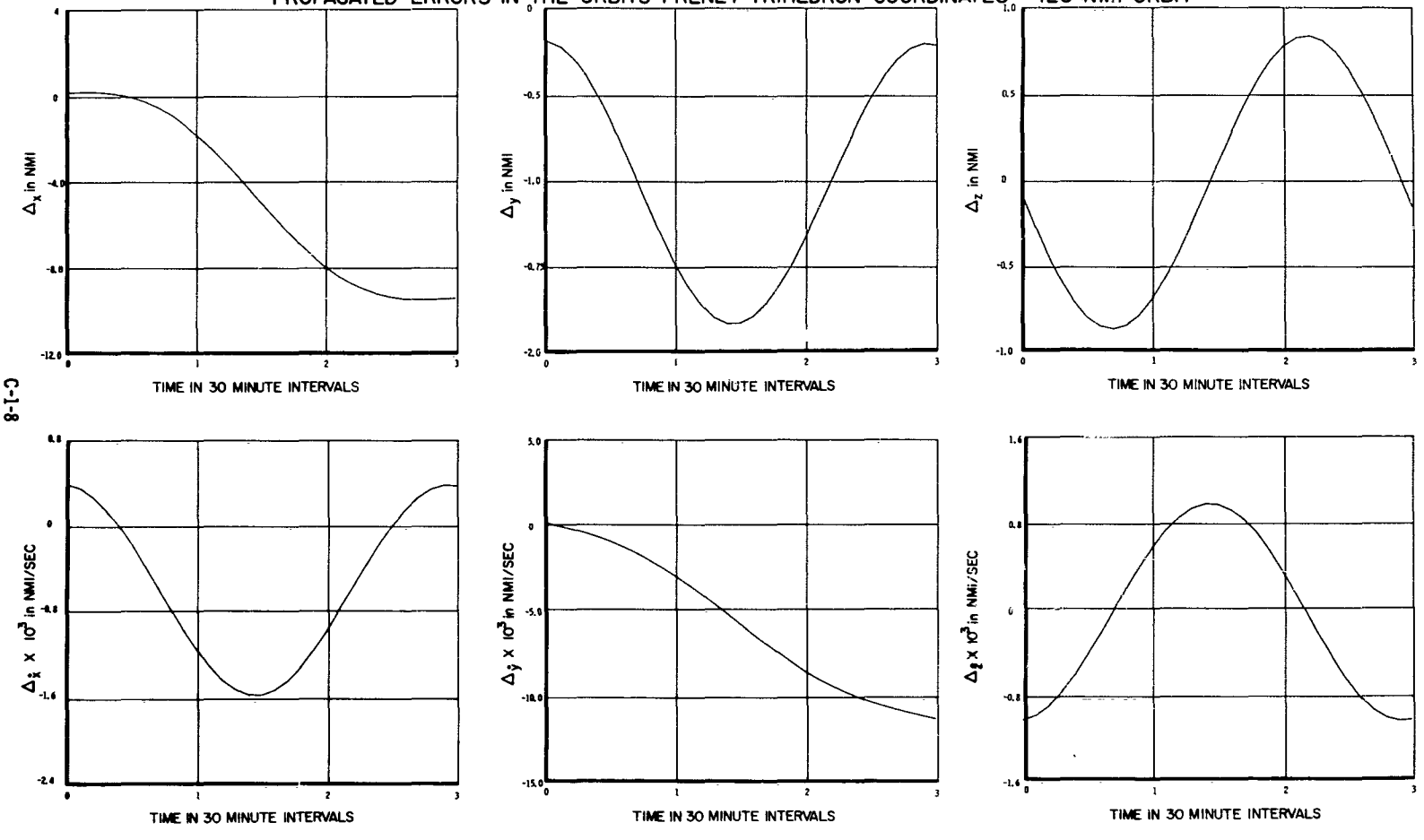
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

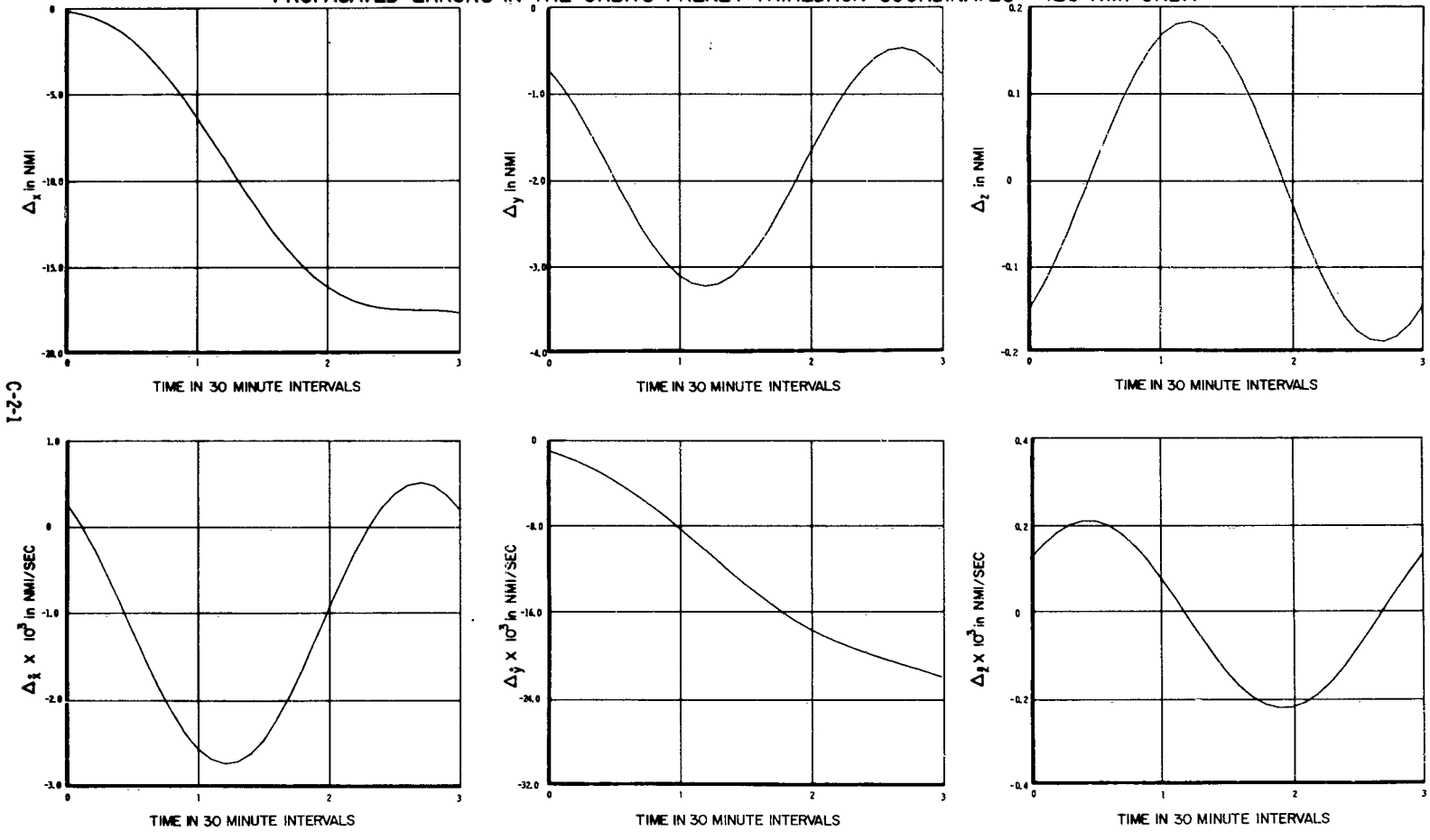
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

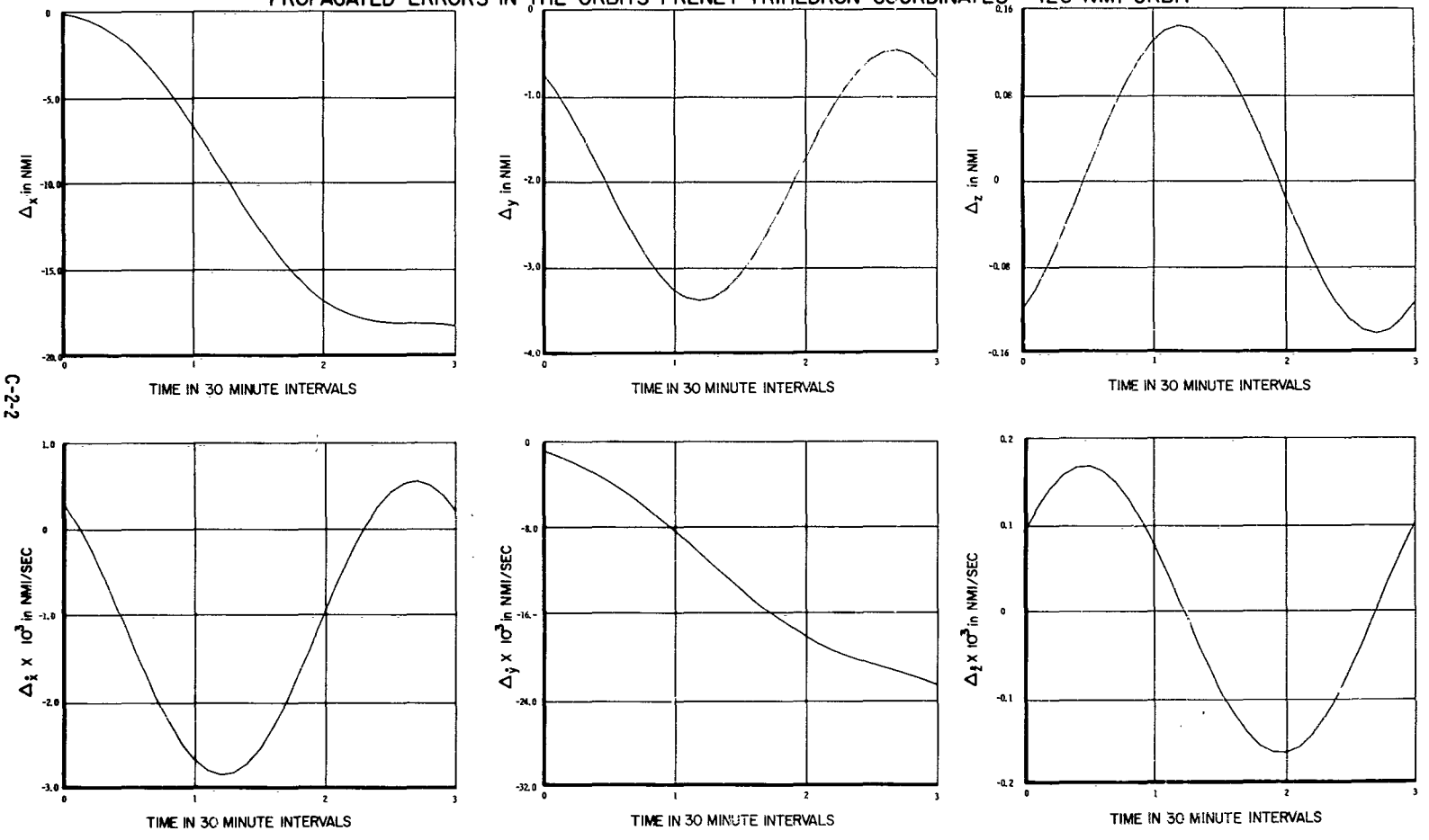
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

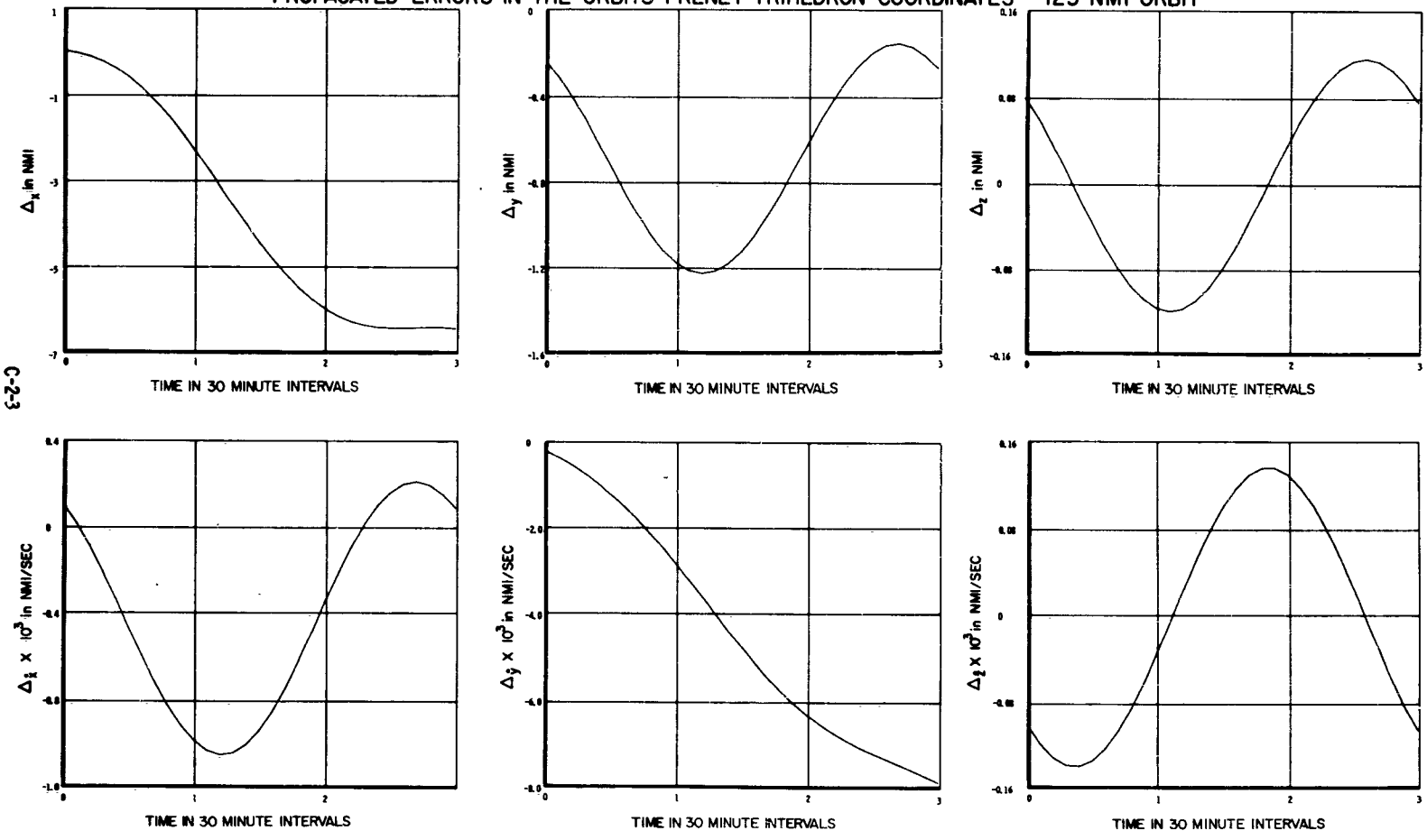
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

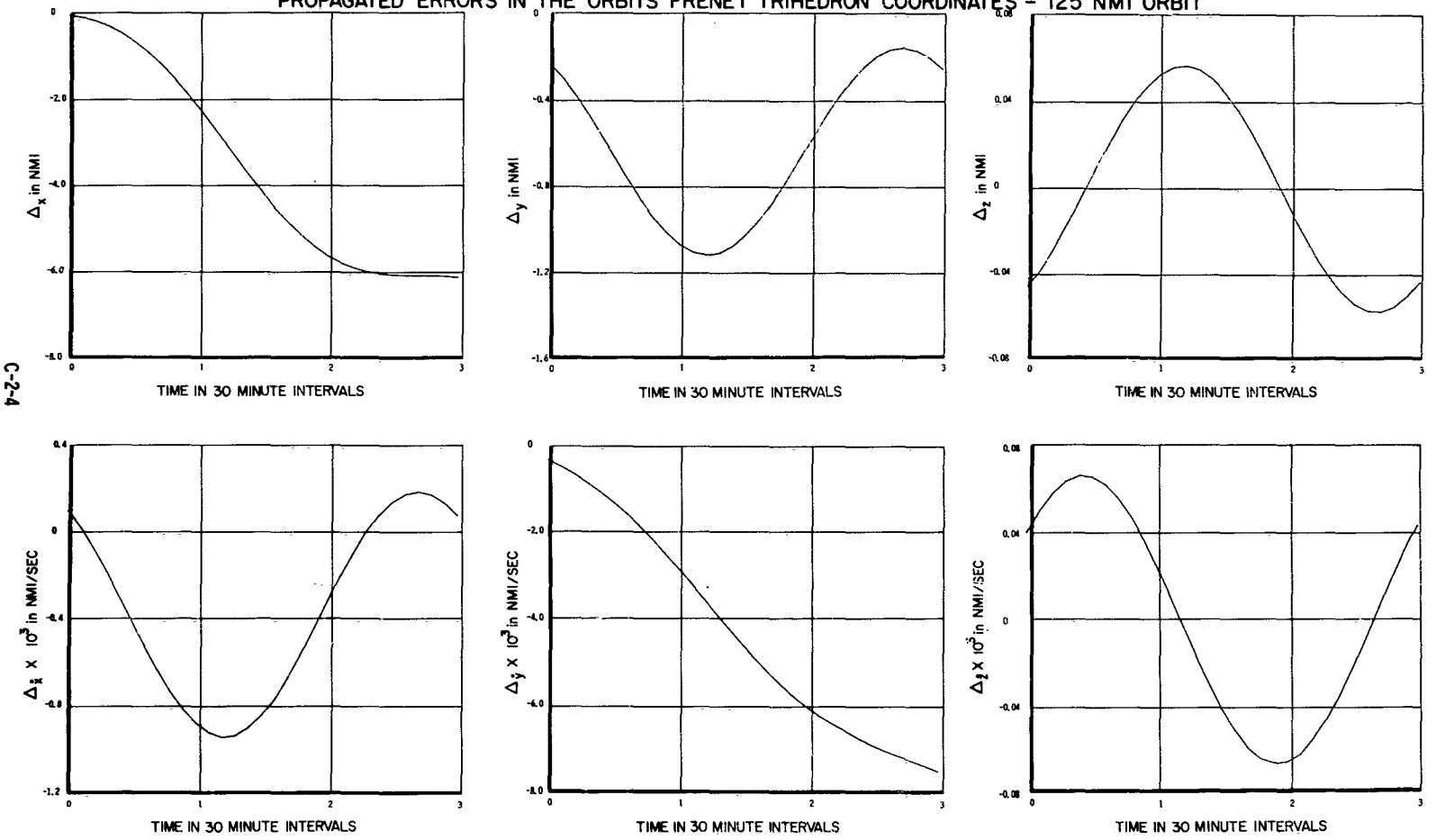
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

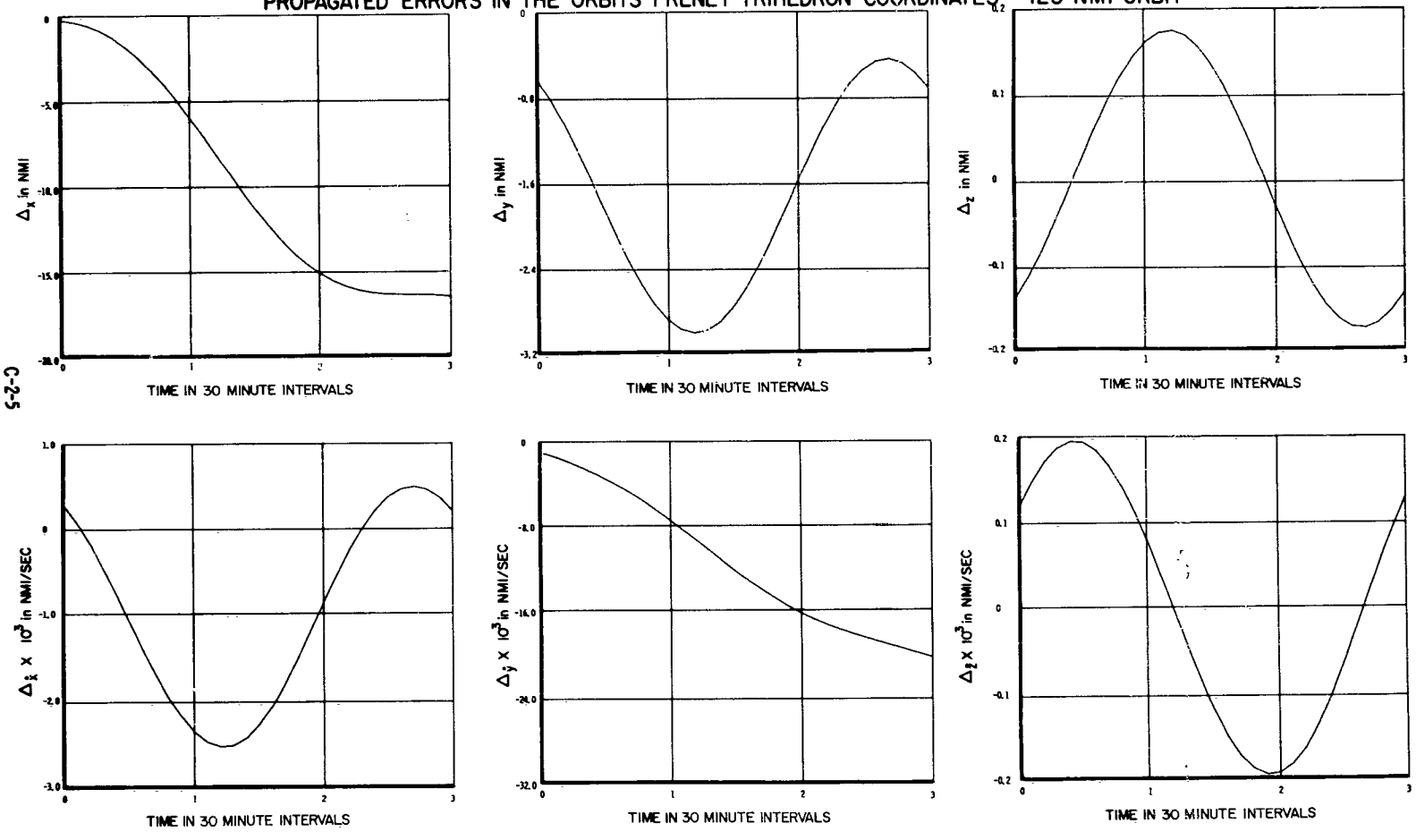
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

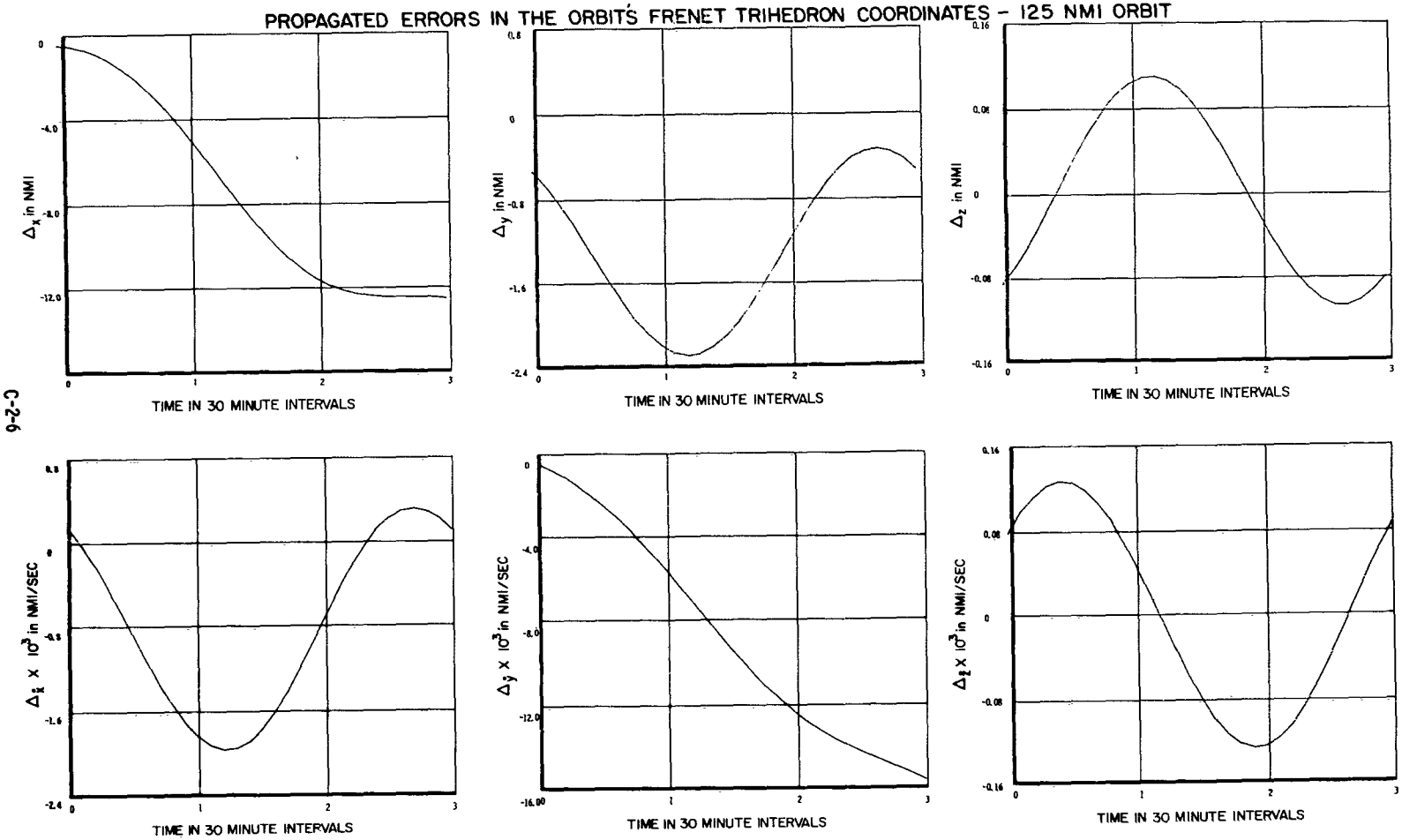
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

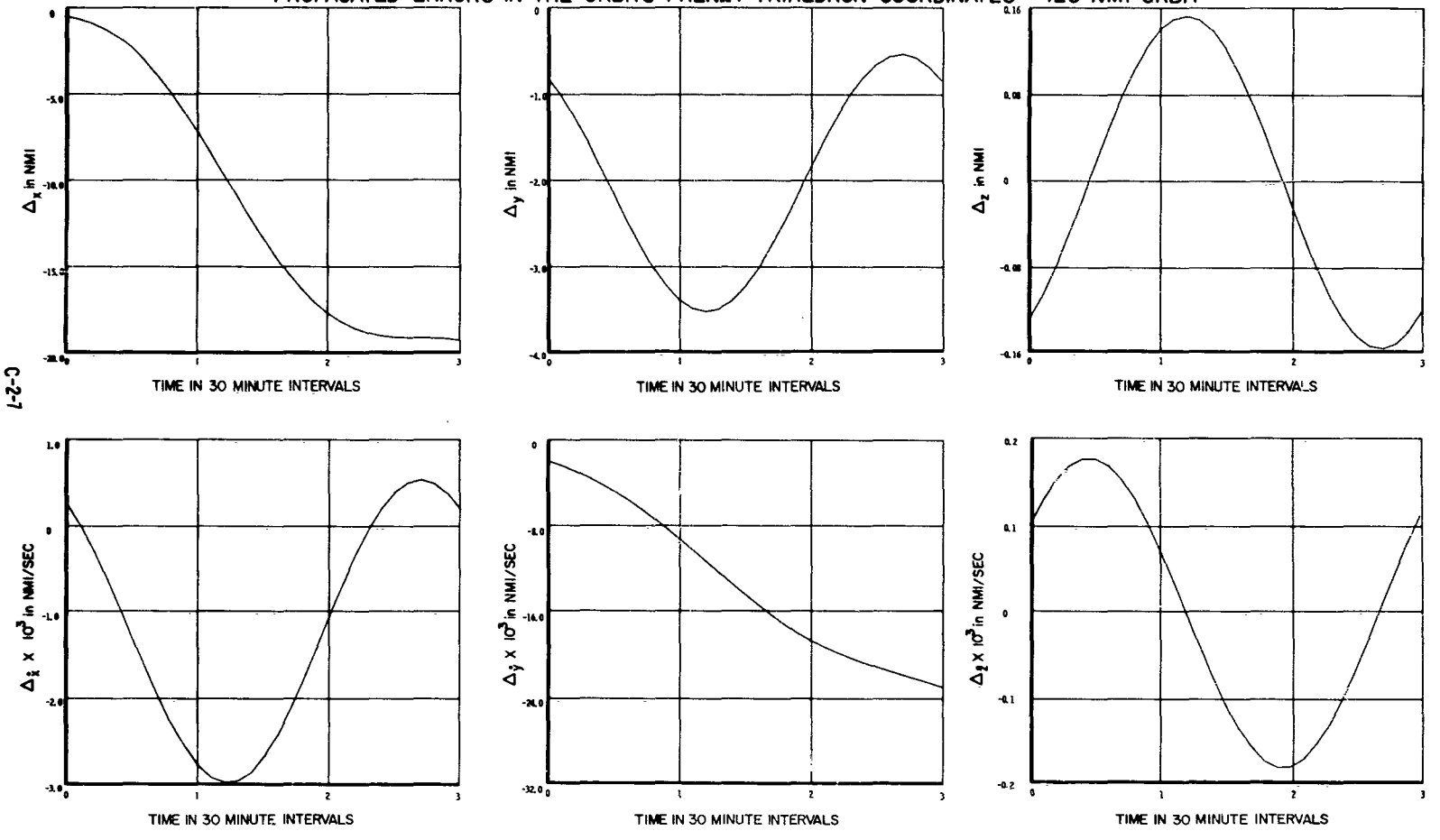
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

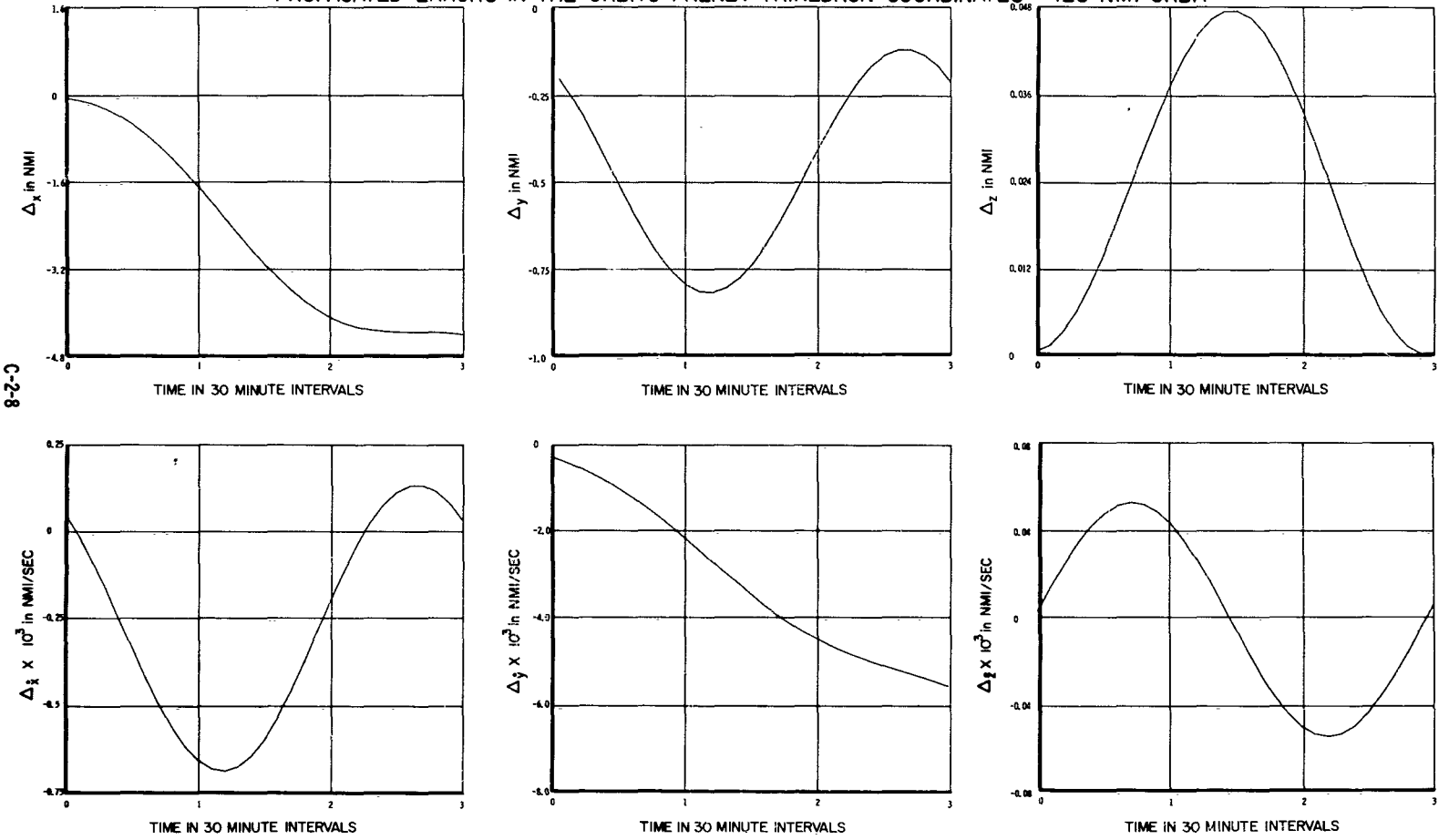


C-2-7

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

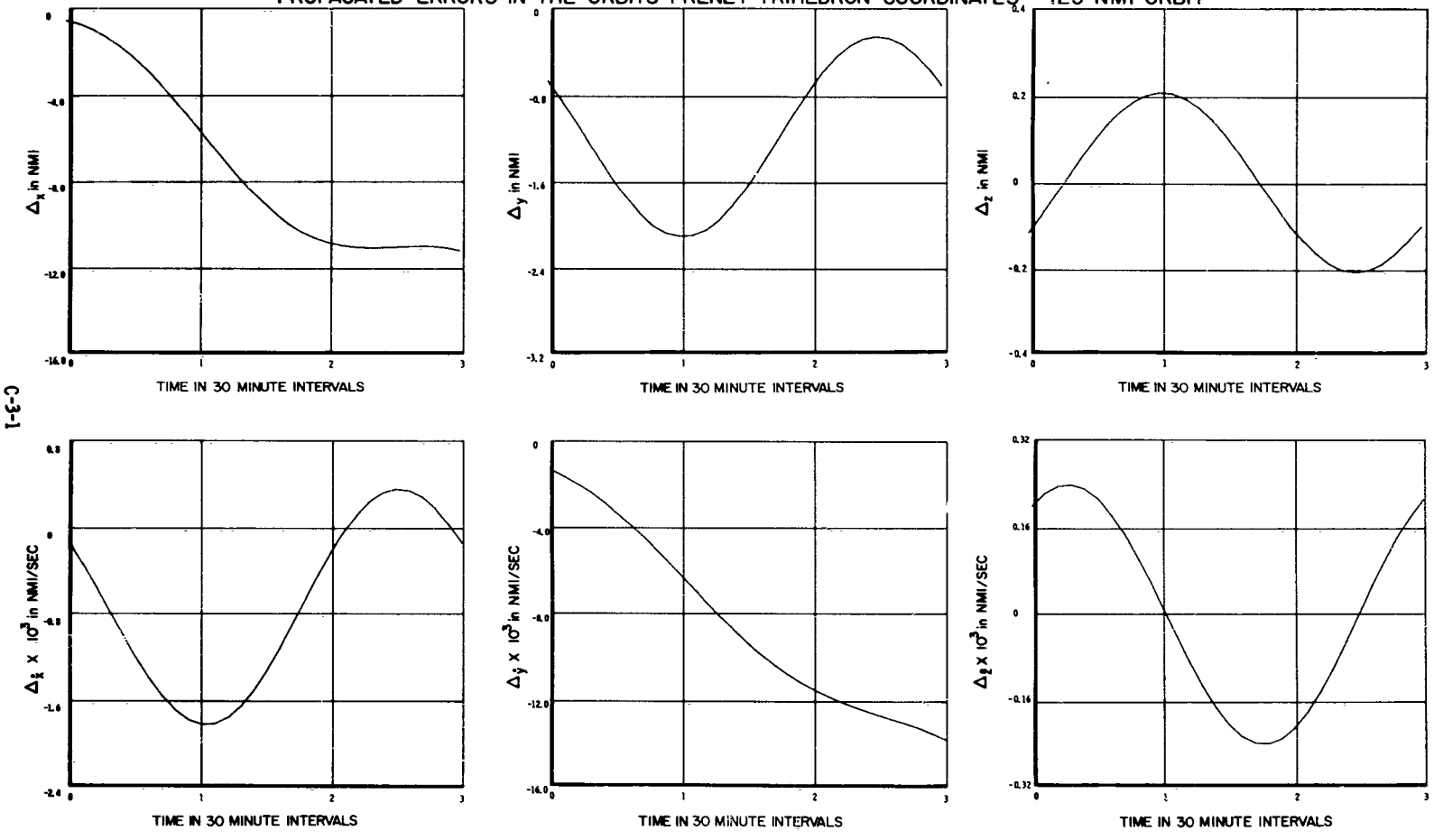
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, .25 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

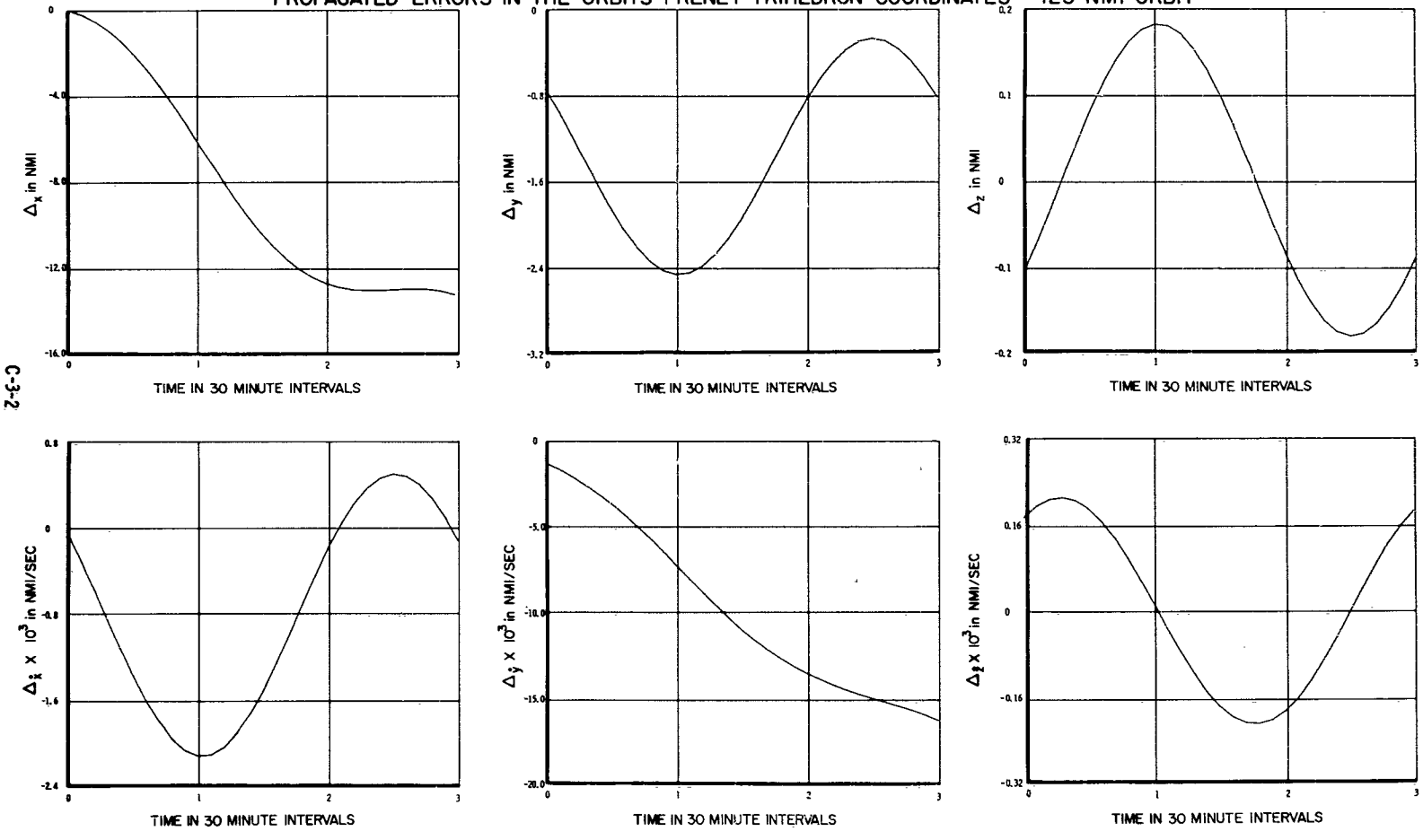
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

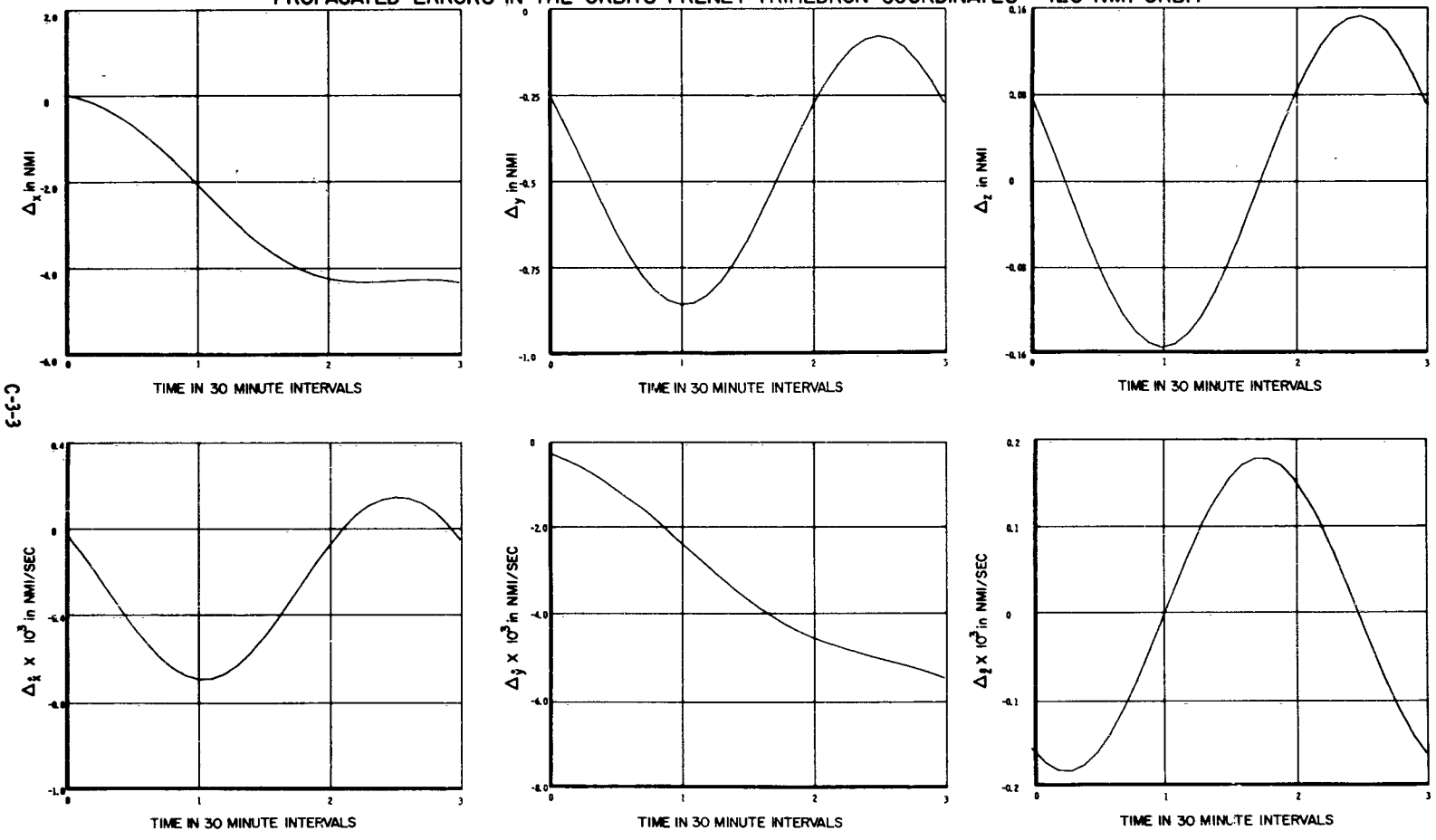
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

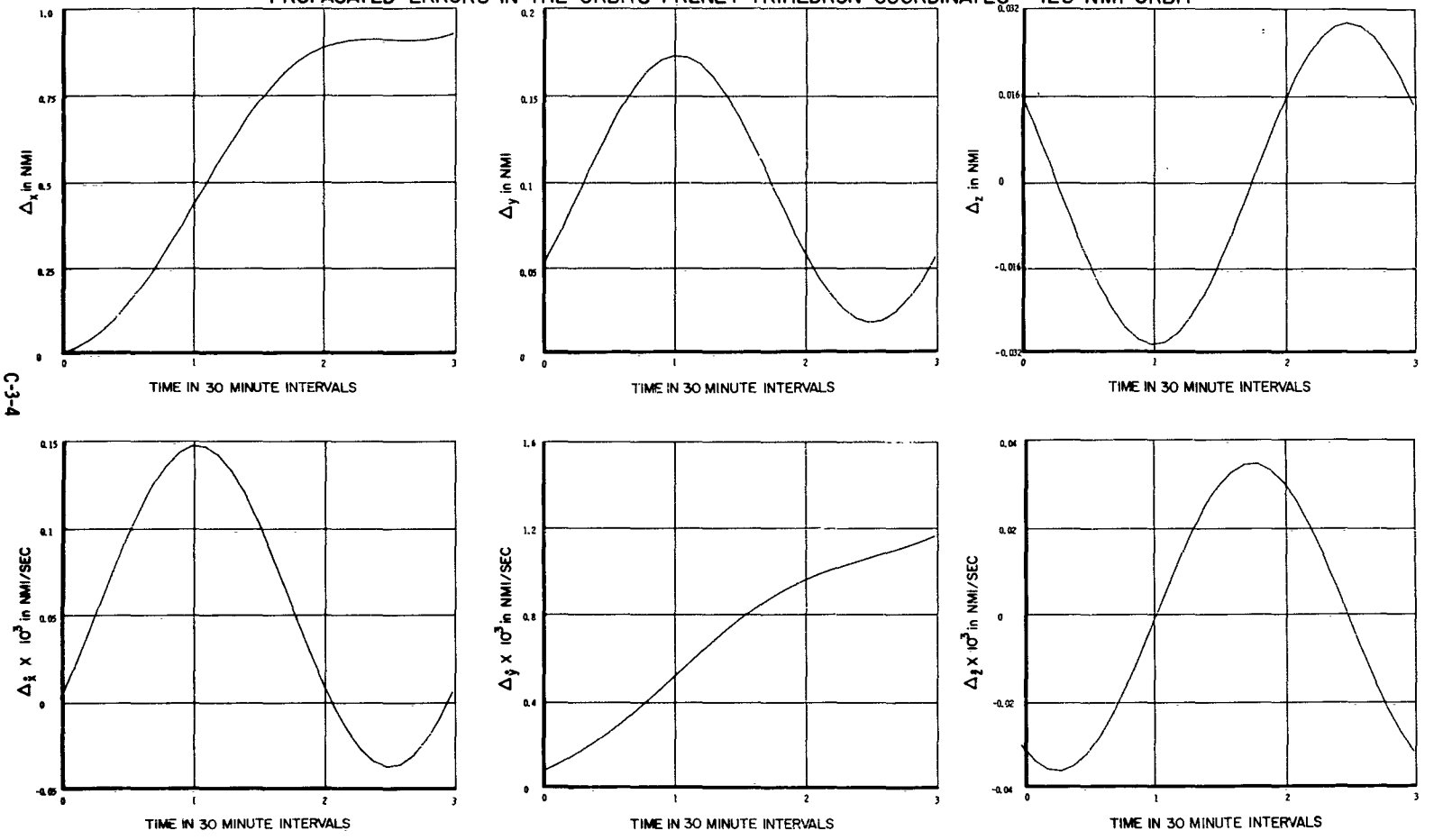
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 1000 ft, .25 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

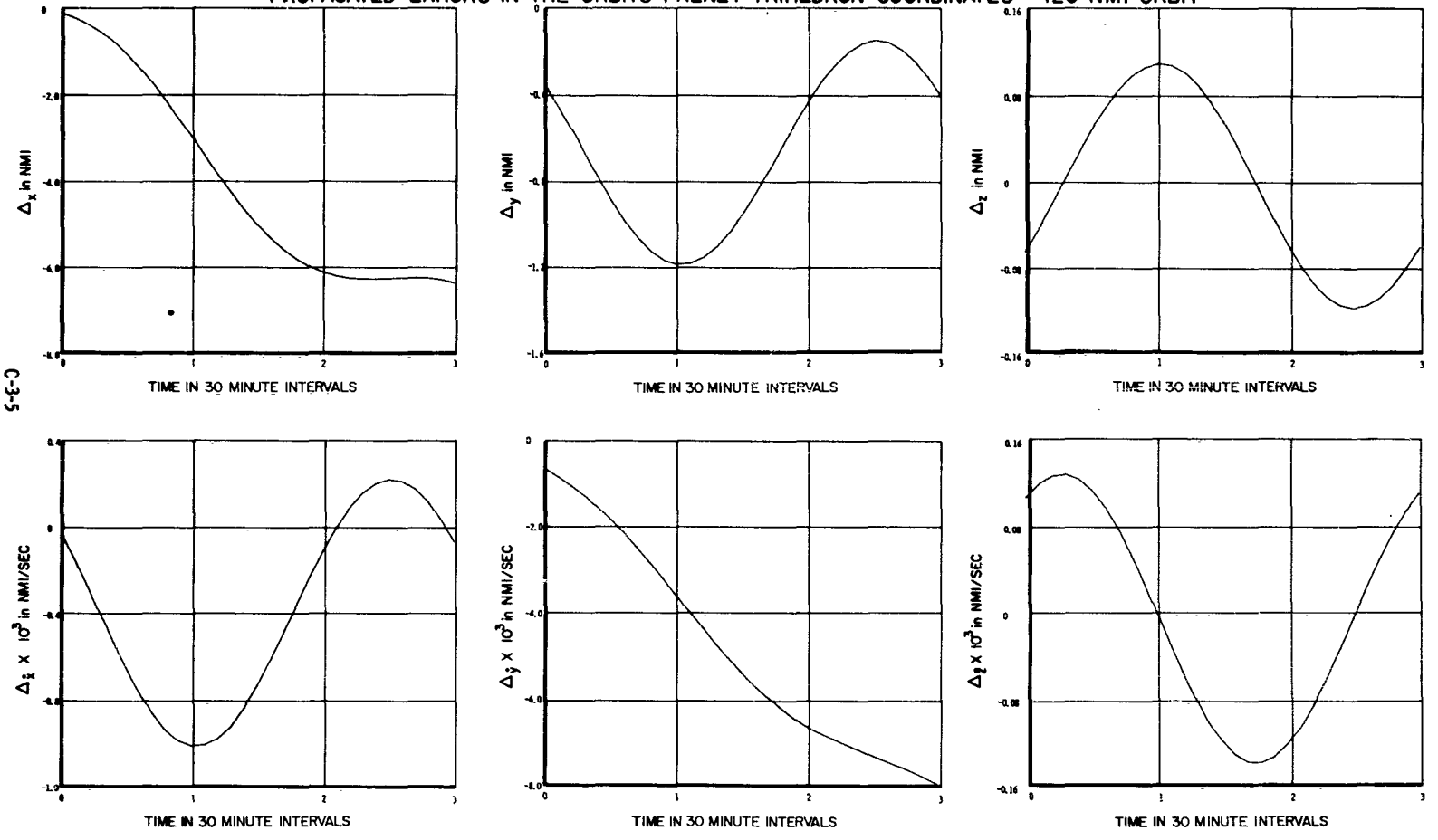
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

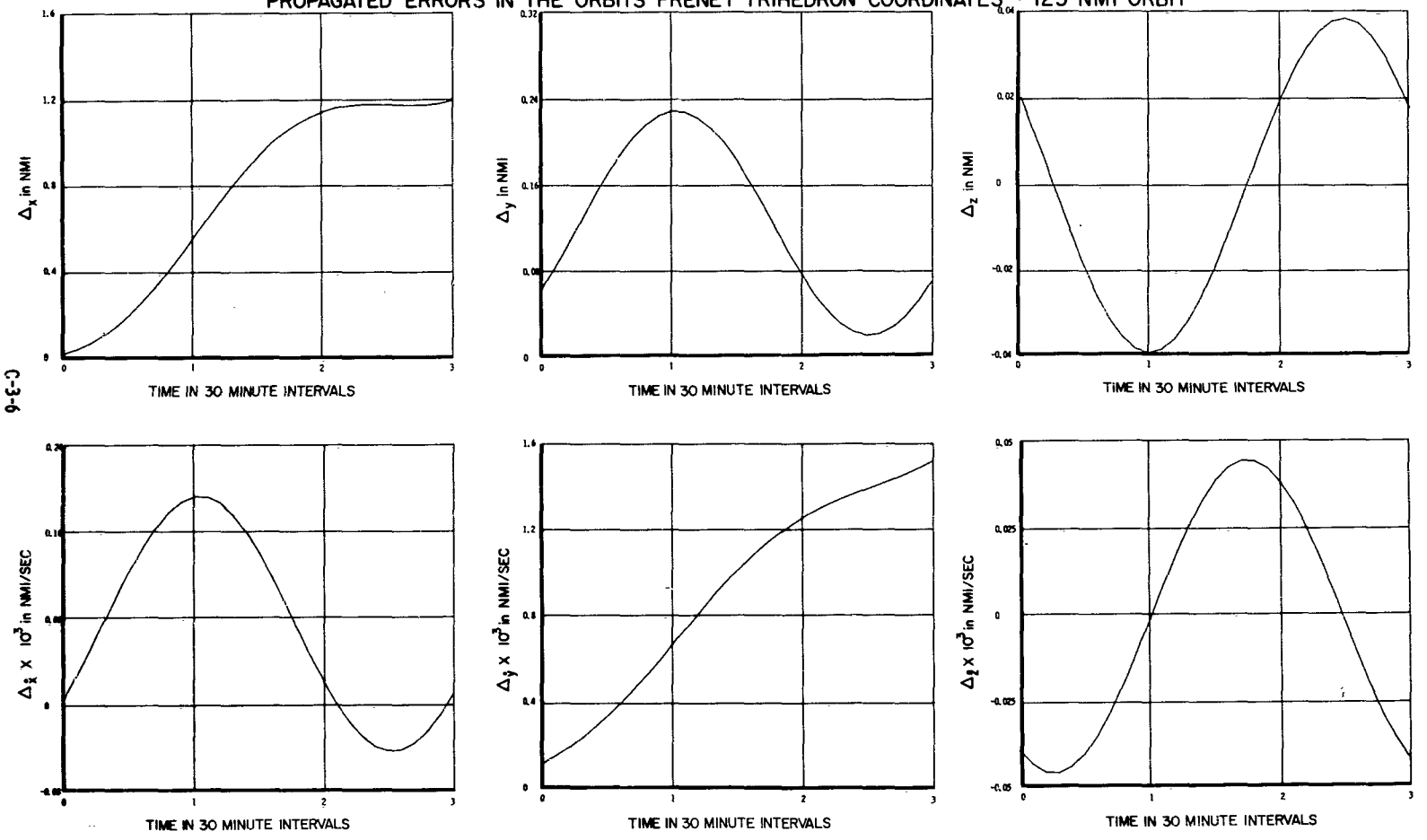
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

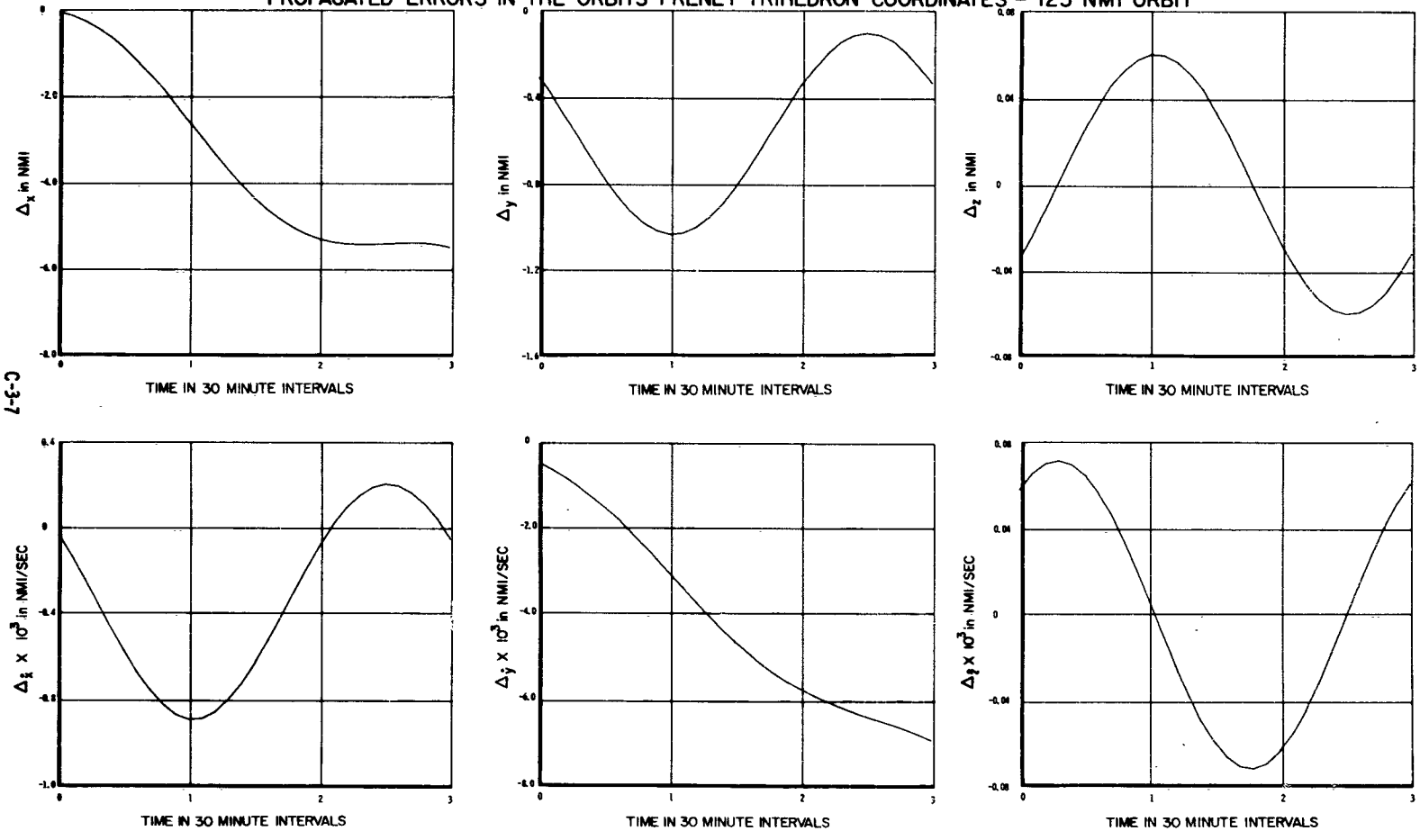
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 fo Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

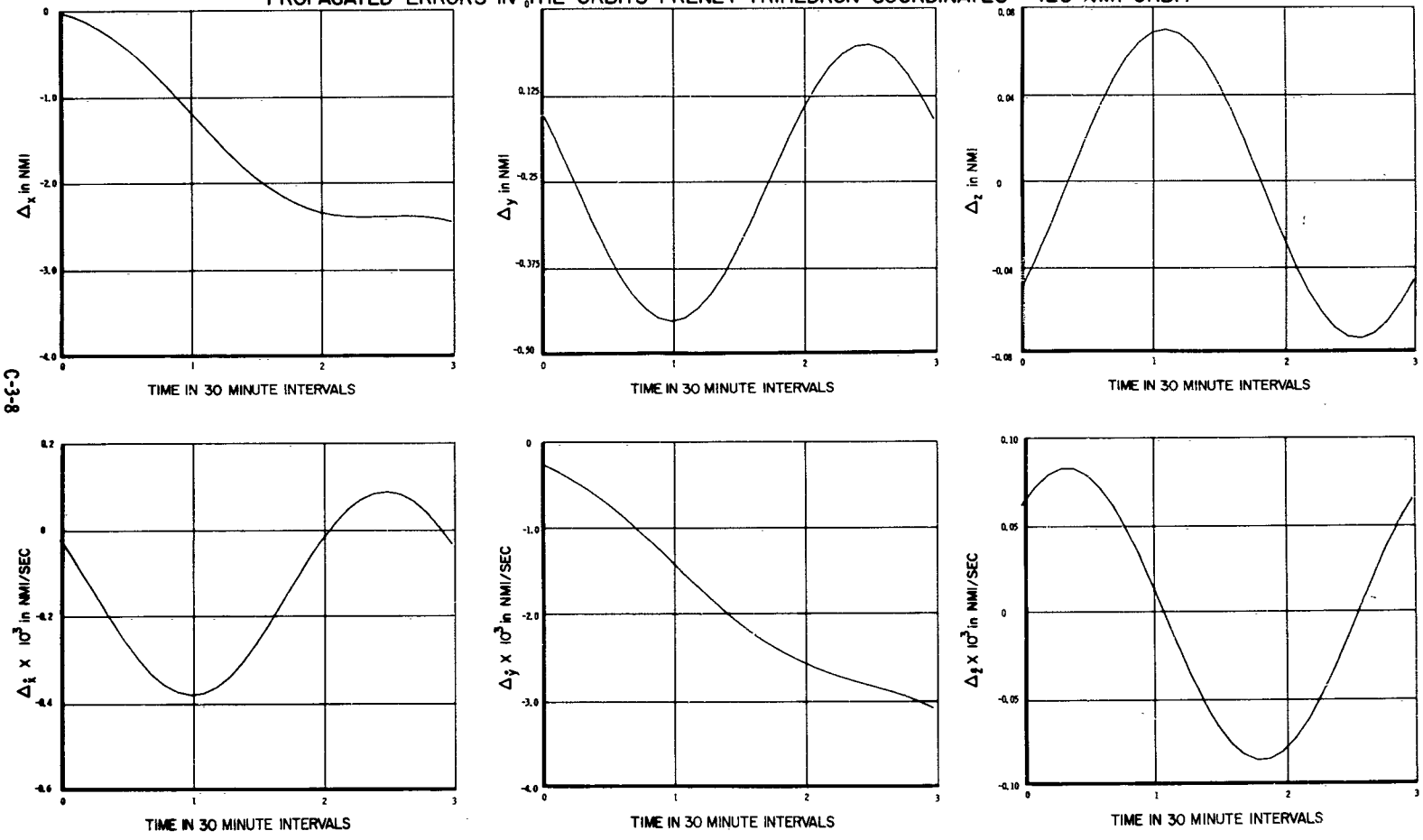
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 1000 ft, .1 ft/sec, 1 Milliradian (Fixed Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

APPENDIX SECTION II
RANDOM ERROR

SECTION II

RANDOM ERROR

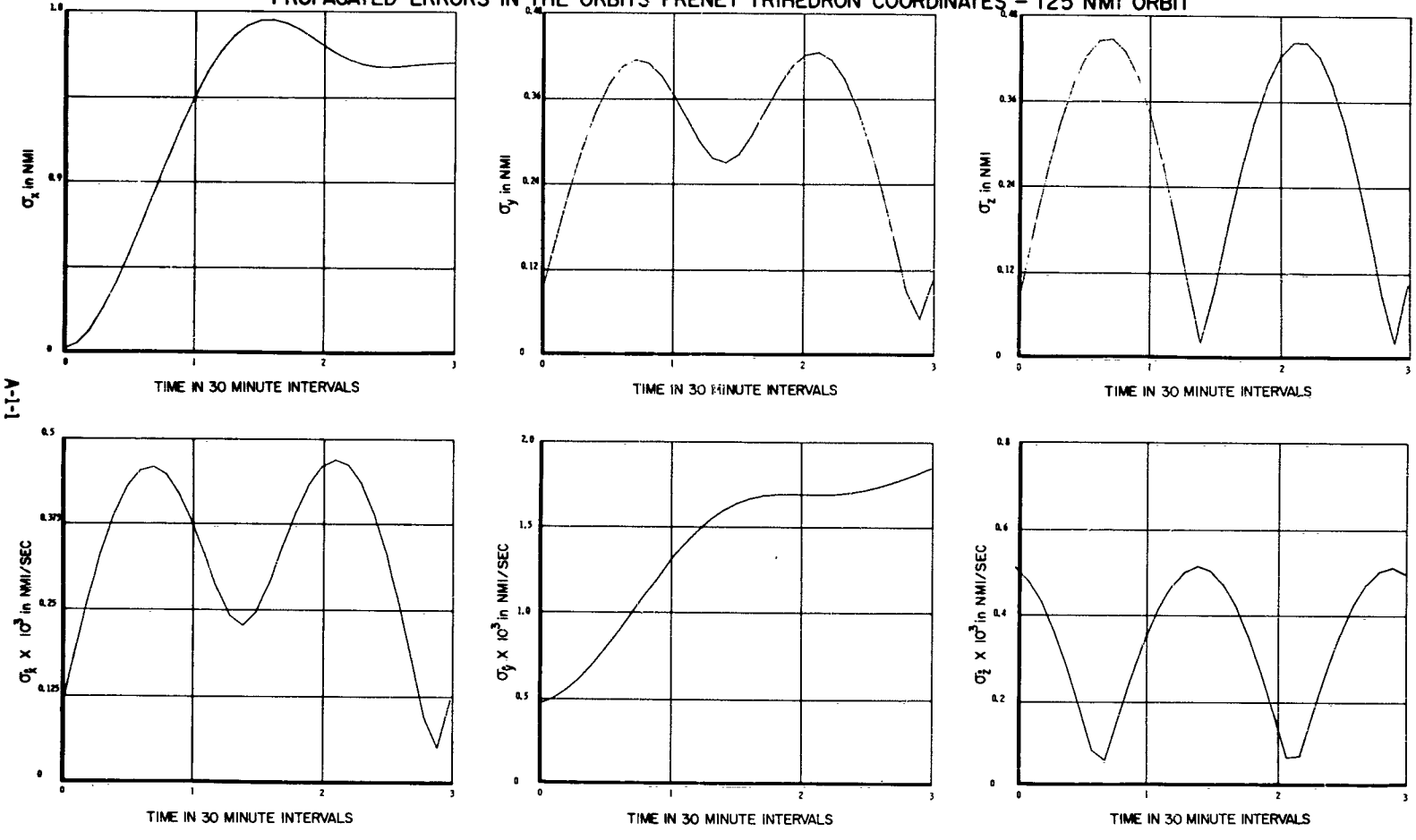
TABLE III. SENSOR ERRORS FOR RANDOM ERROR

CASE NUMBER	RANGE AND ANGLE SENSORS	
	RANGE S.D.* (ft.)	AZ. AND EL. S.D.* (mr)
1	50	1
2	300	1

CASE NUMBER	RANGE, RANGE-RATE, AND ANGLE SENSORS		
	RANGE S.D.* (ft.)	RANGE-RATE S.D.* (ft./sec.)	ANGLE S.D.* (mr)
3	50	0.1	1
4	50	1	1
5	300	0.1	1
6	300	1	1

*Standard Deviation

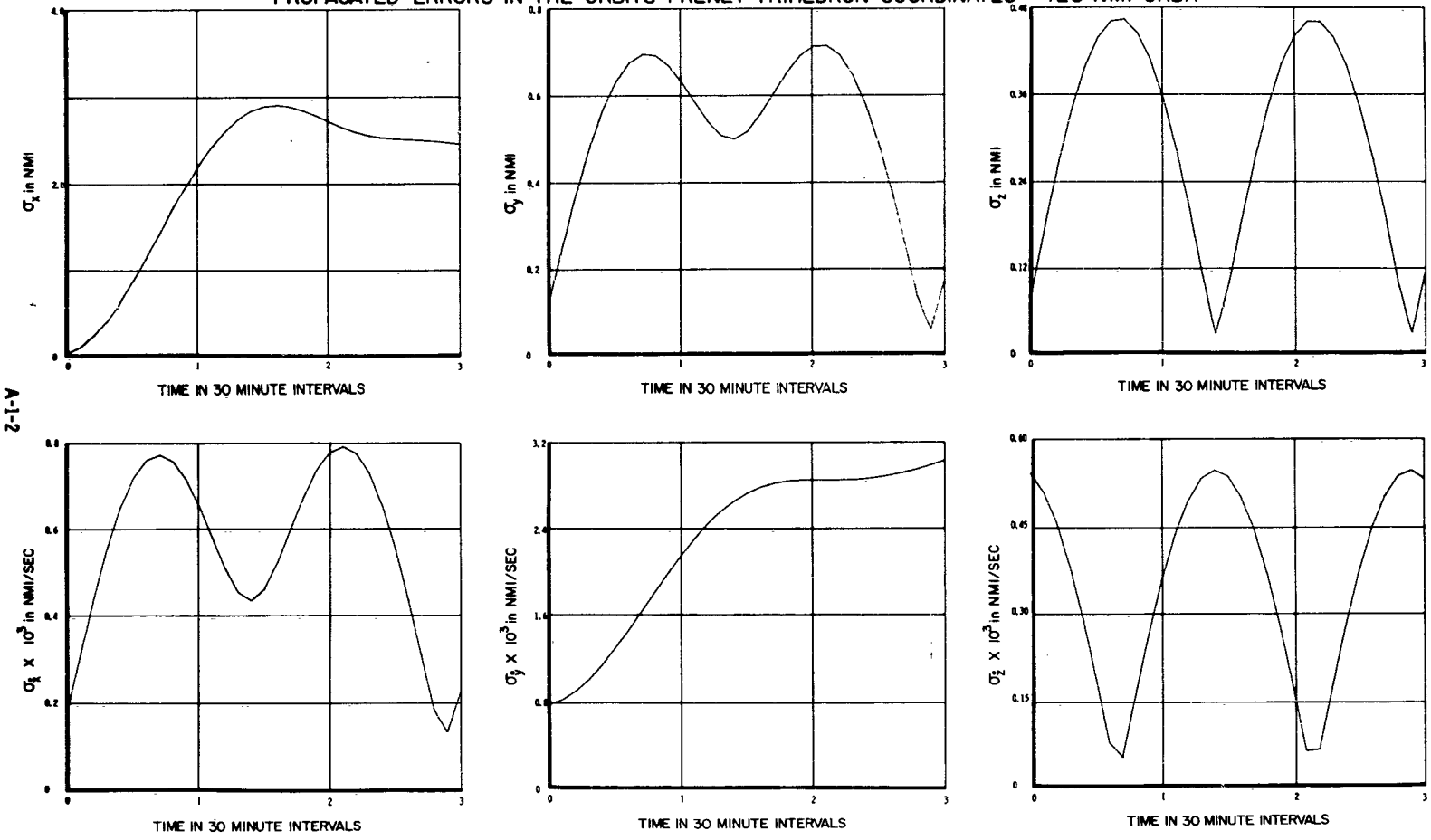
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 120° of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

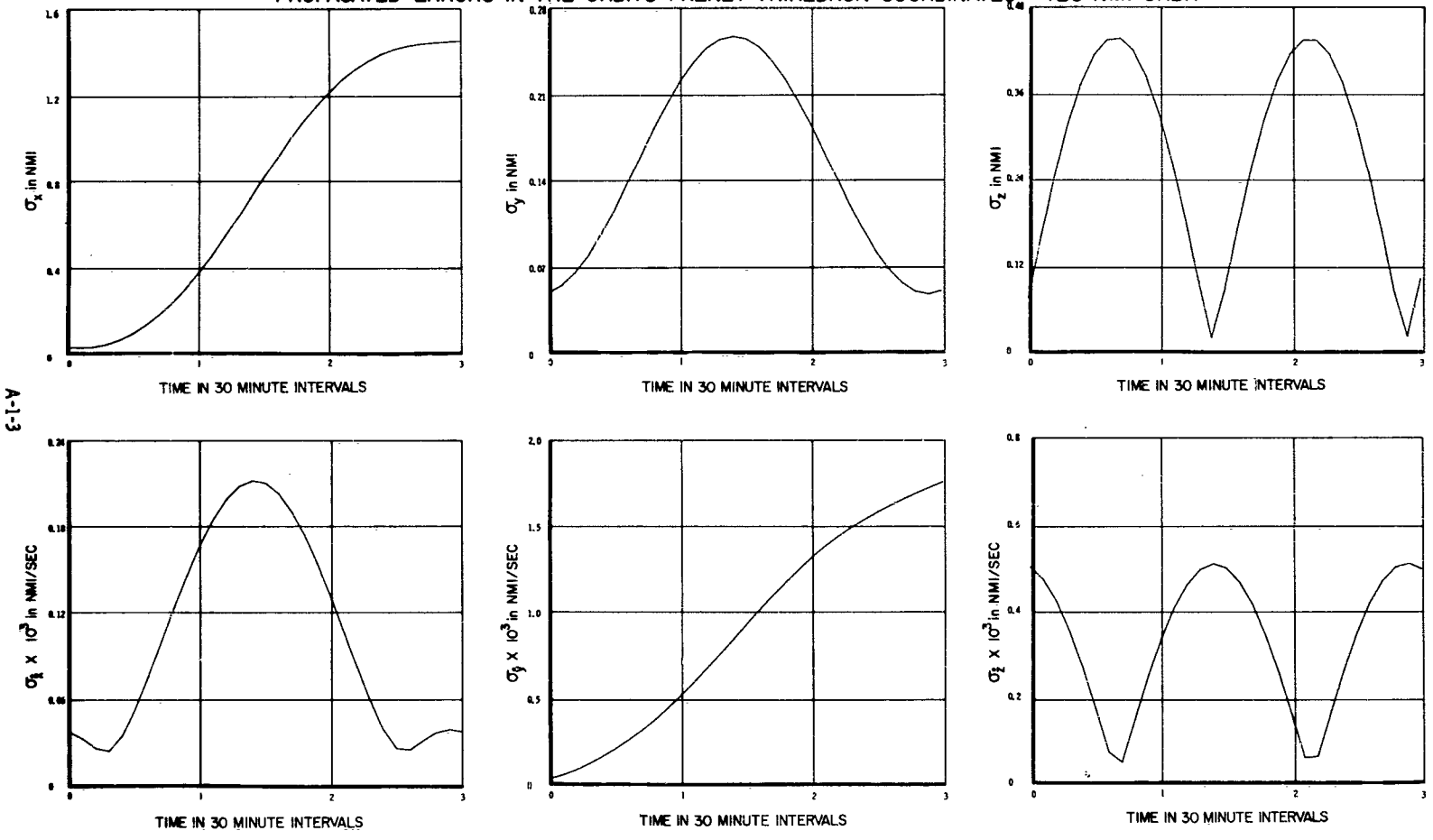


A-1-2

Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

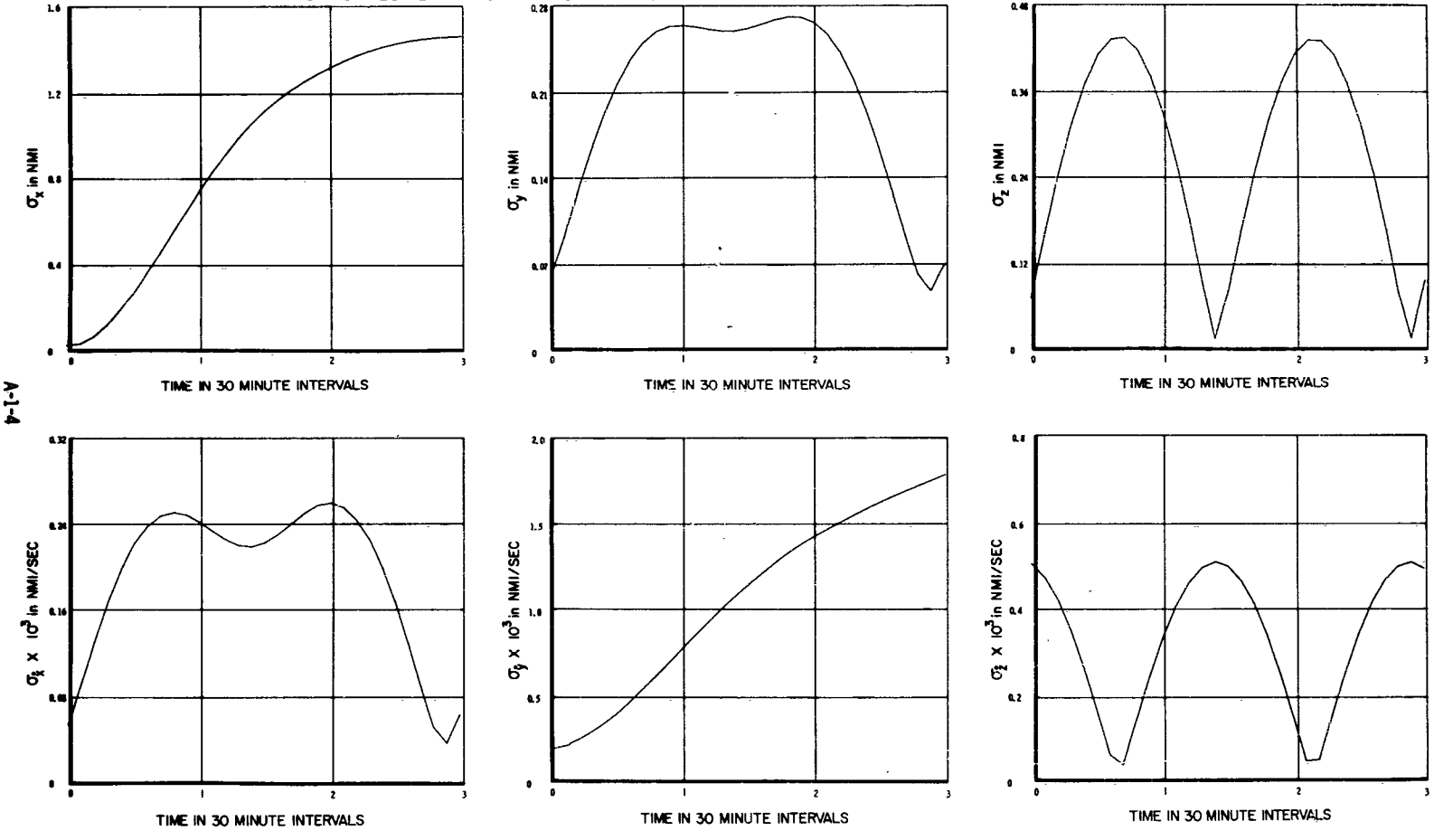
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error,

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

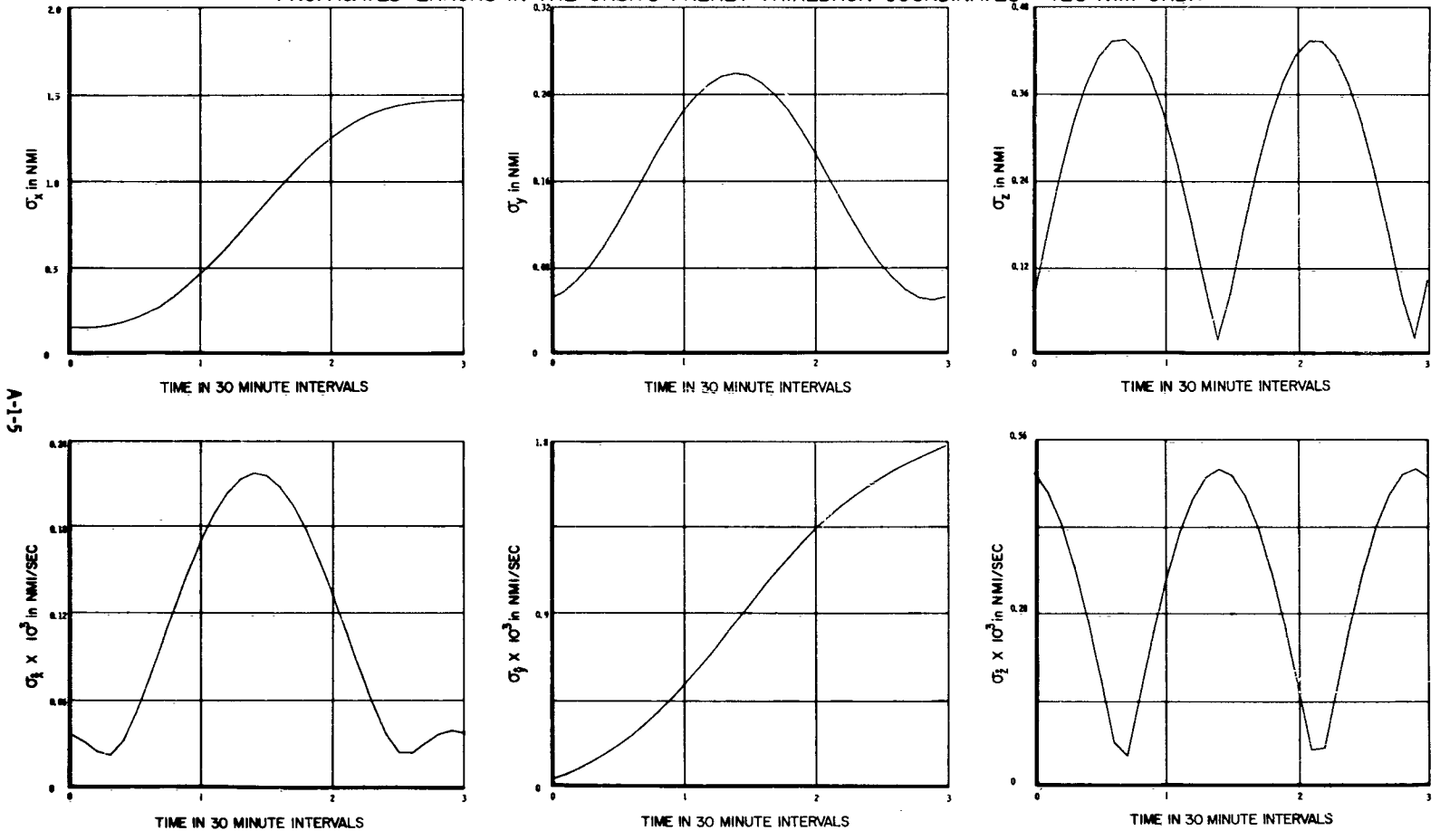
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

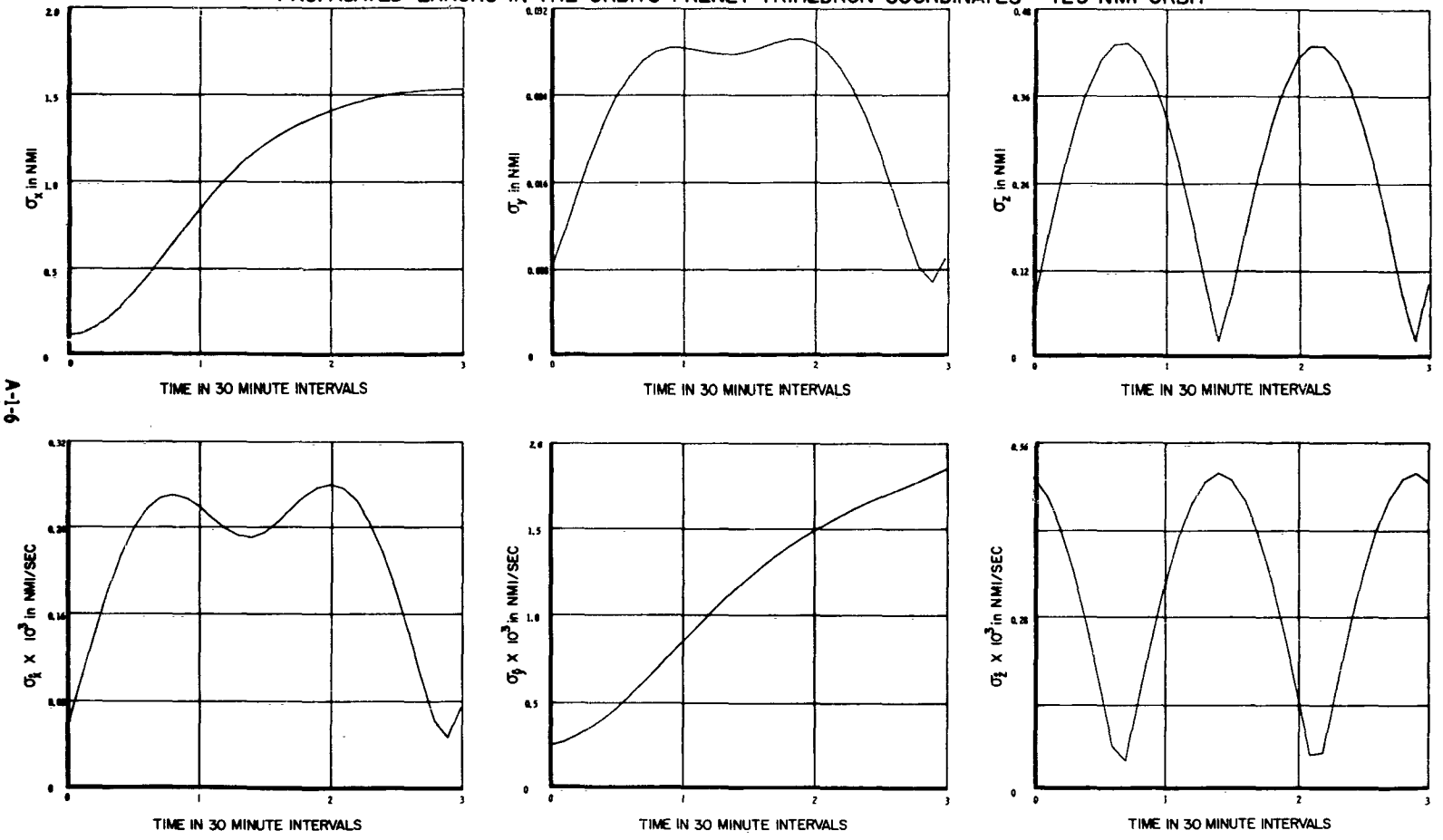
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

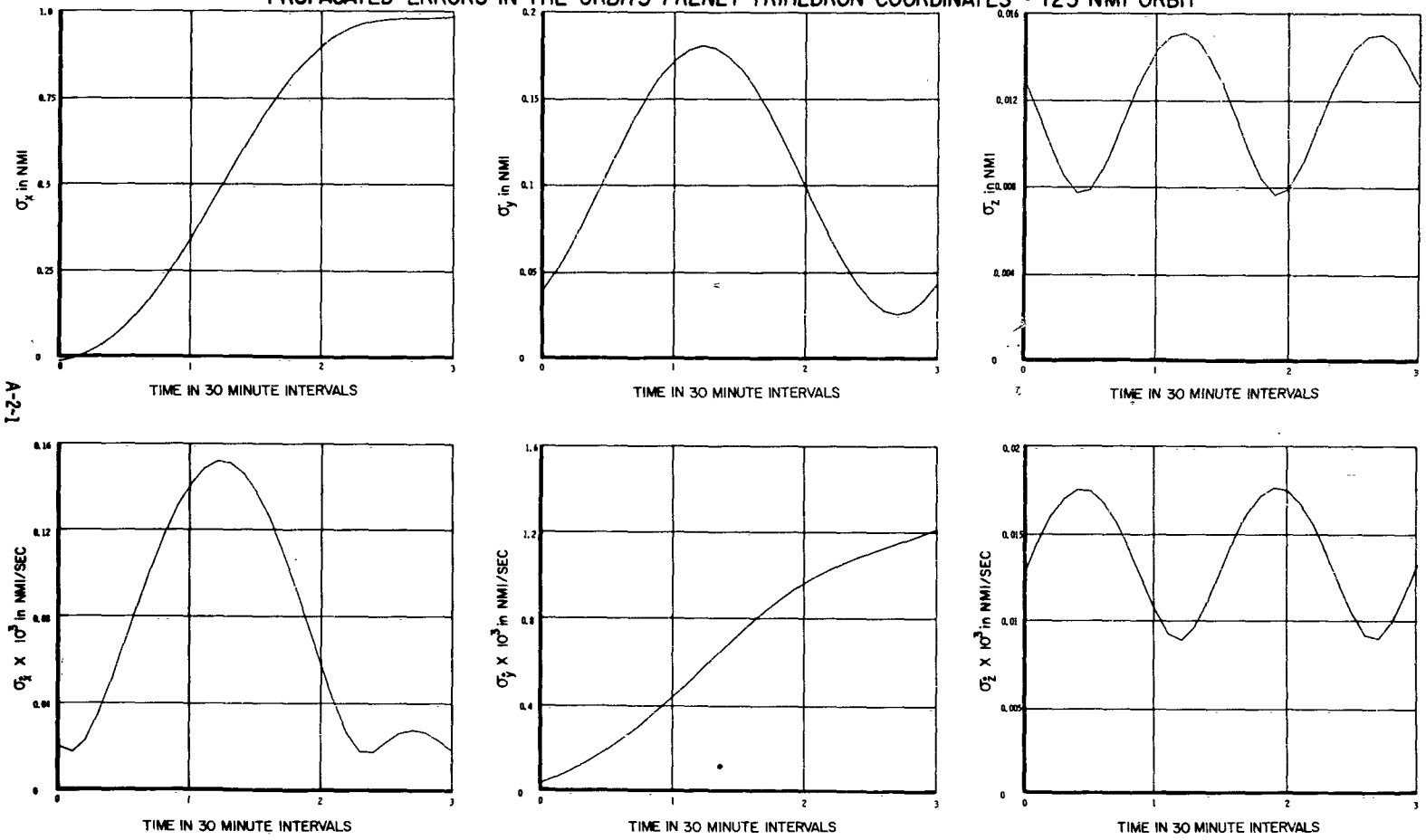


9-1-V

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 1 Station

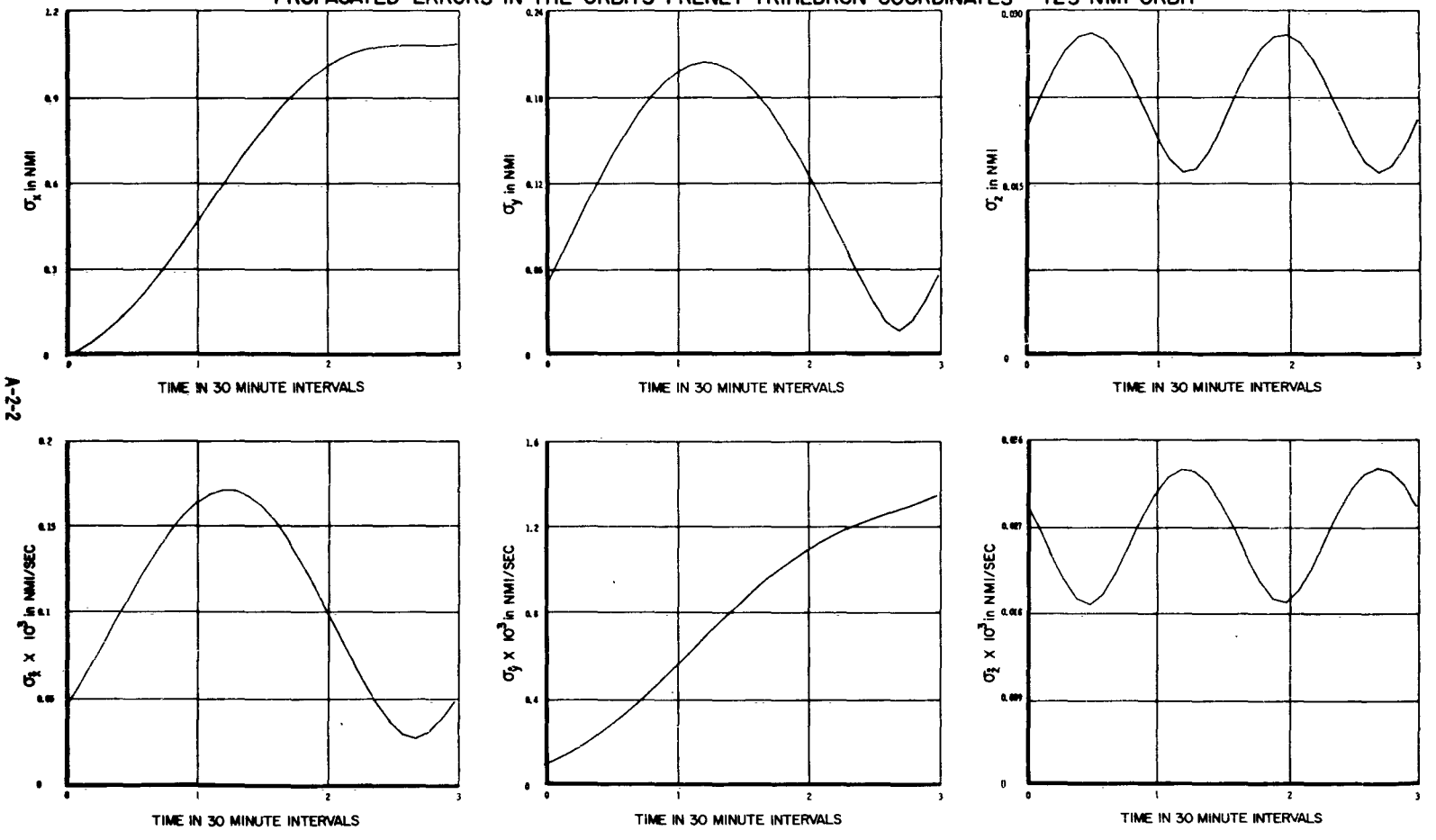
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 120° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

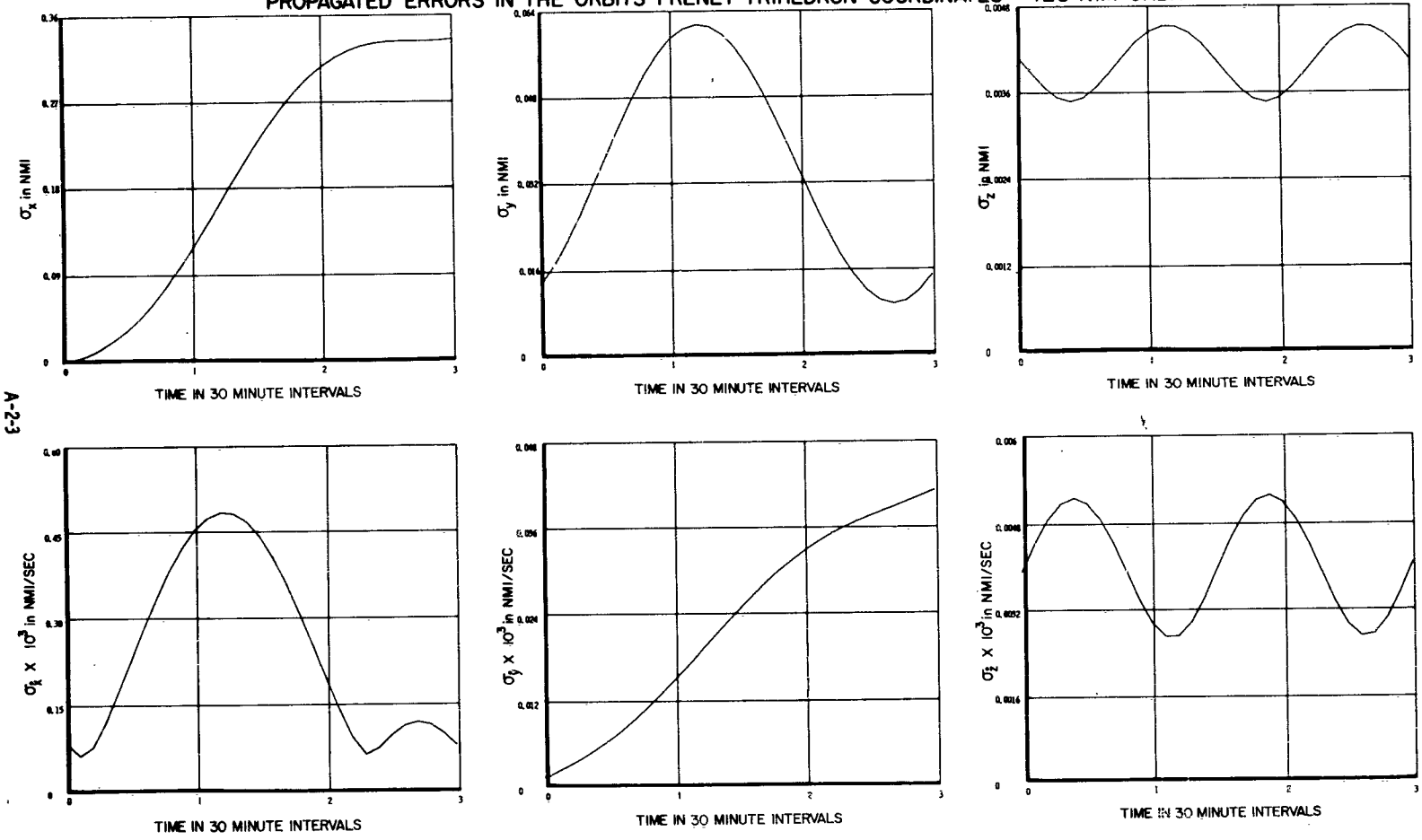


A-2-2

Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

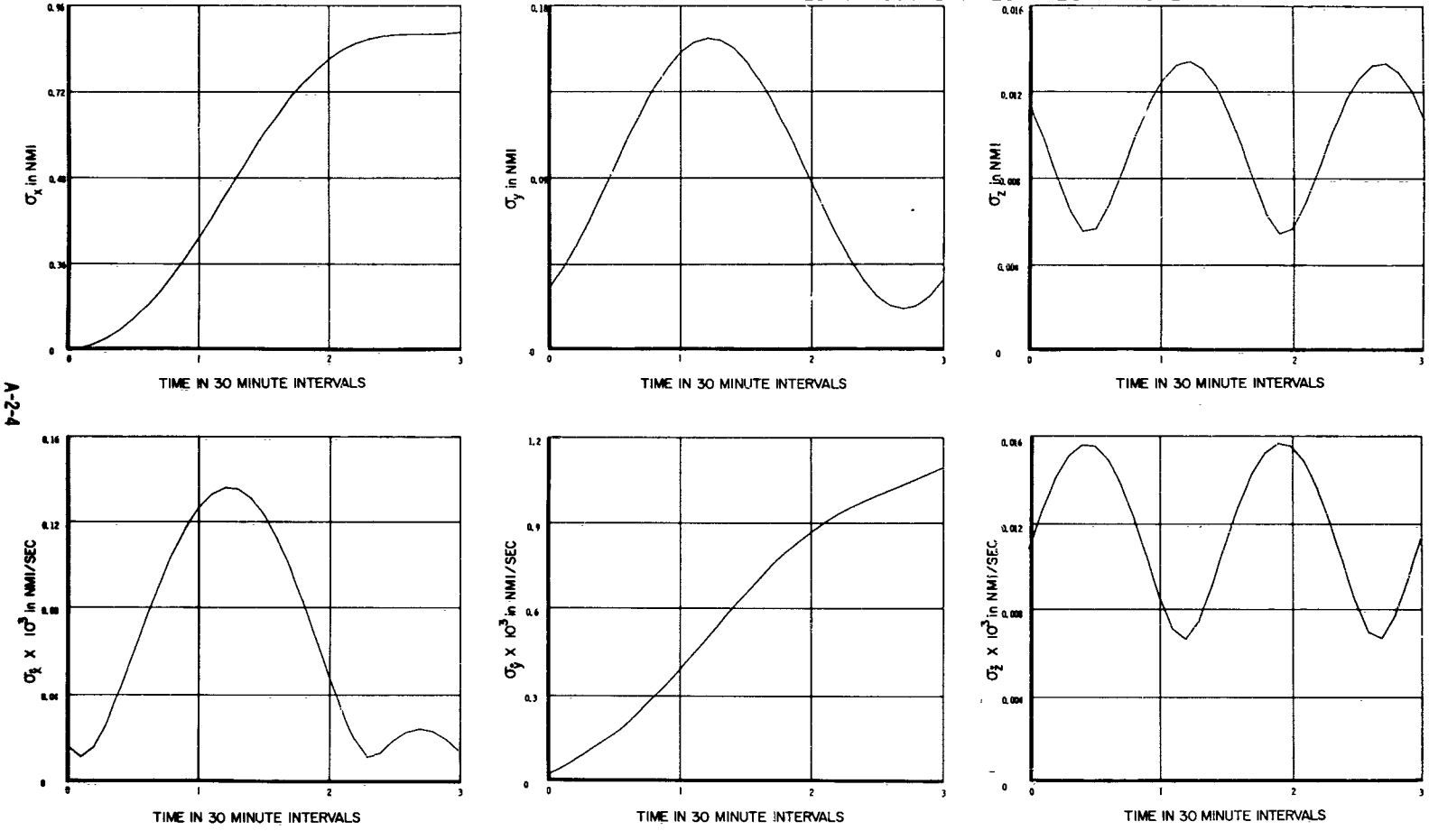


A-2-3

Sensor: Range, Range Rate and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 120° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

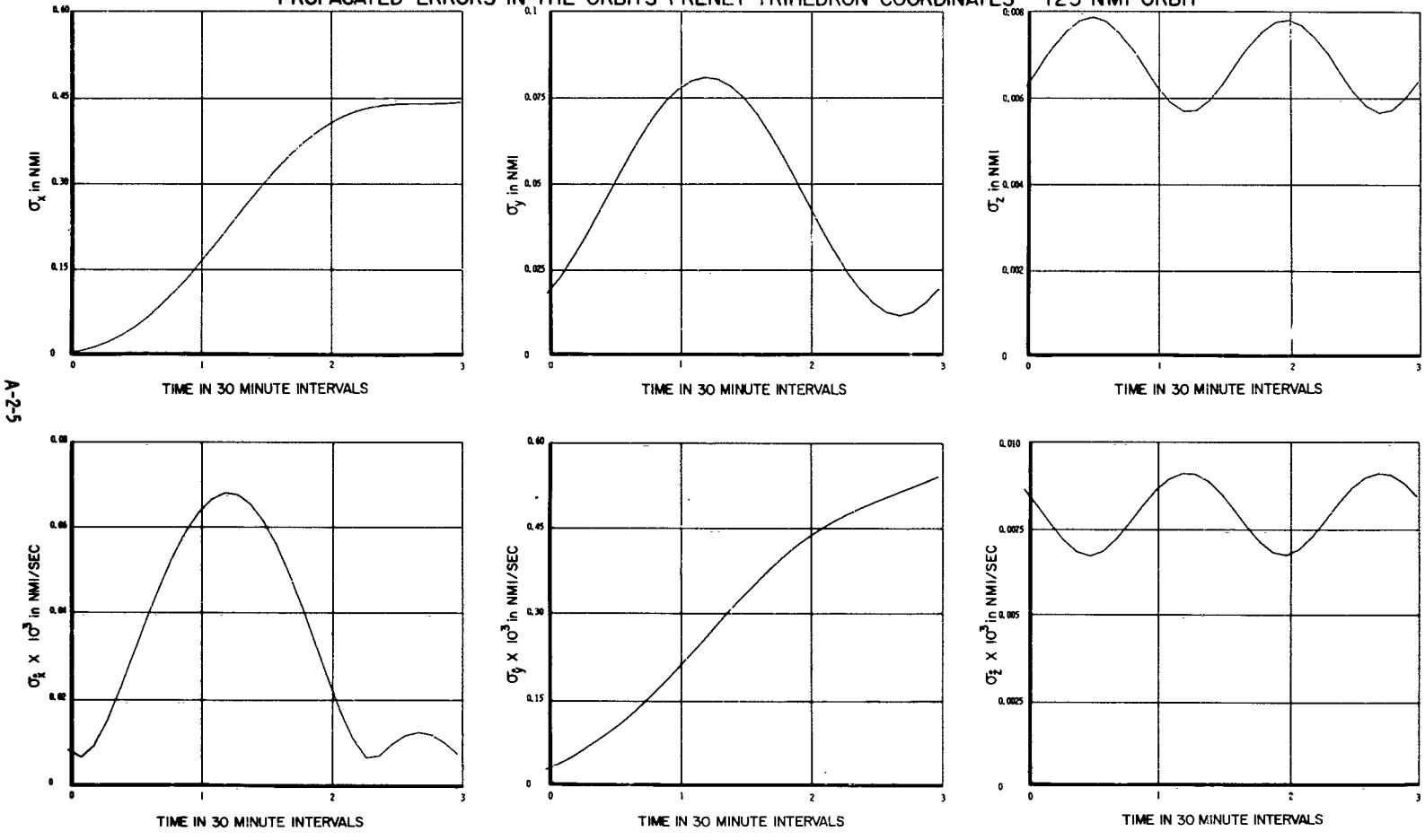
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

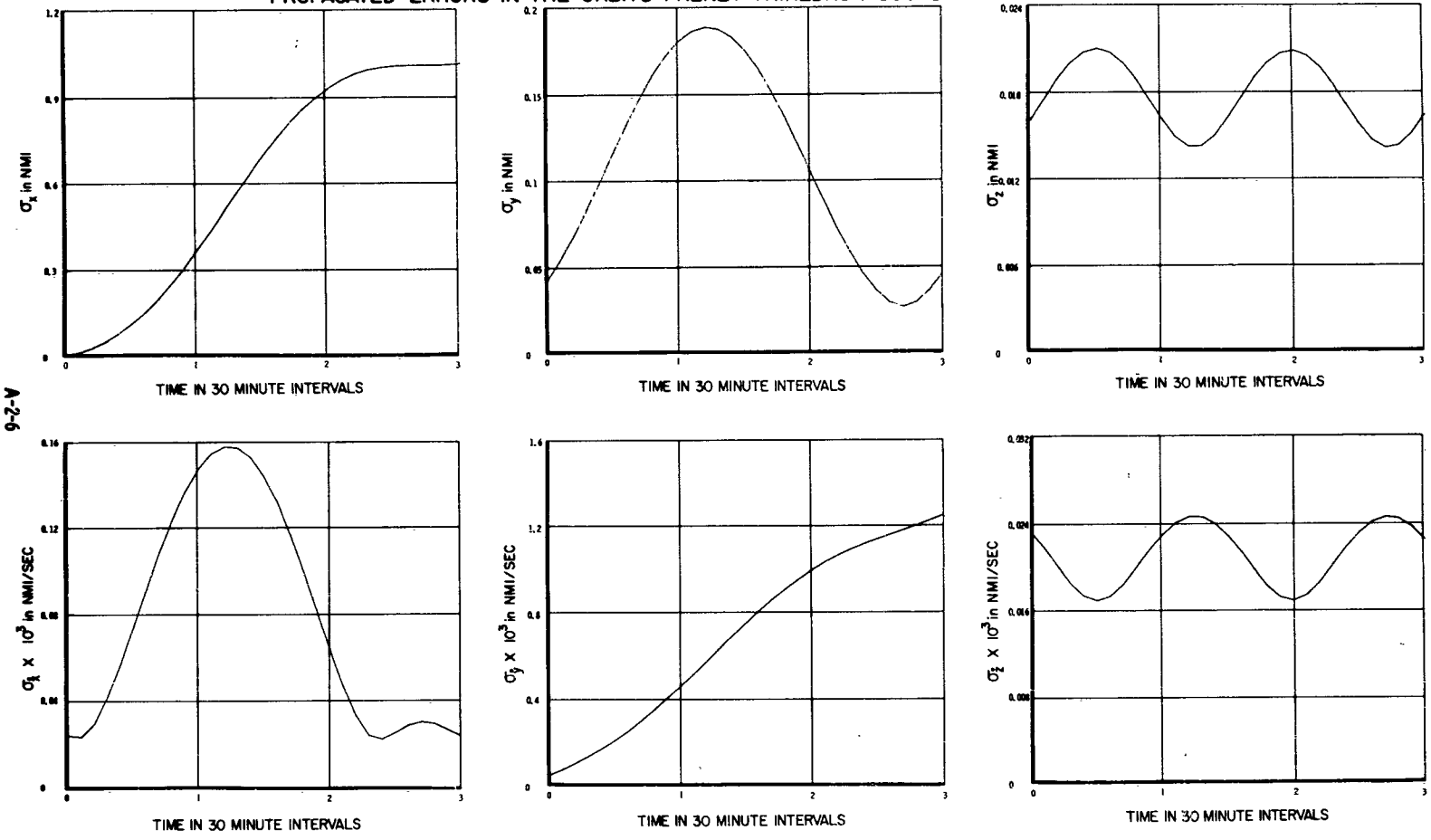
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 120° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

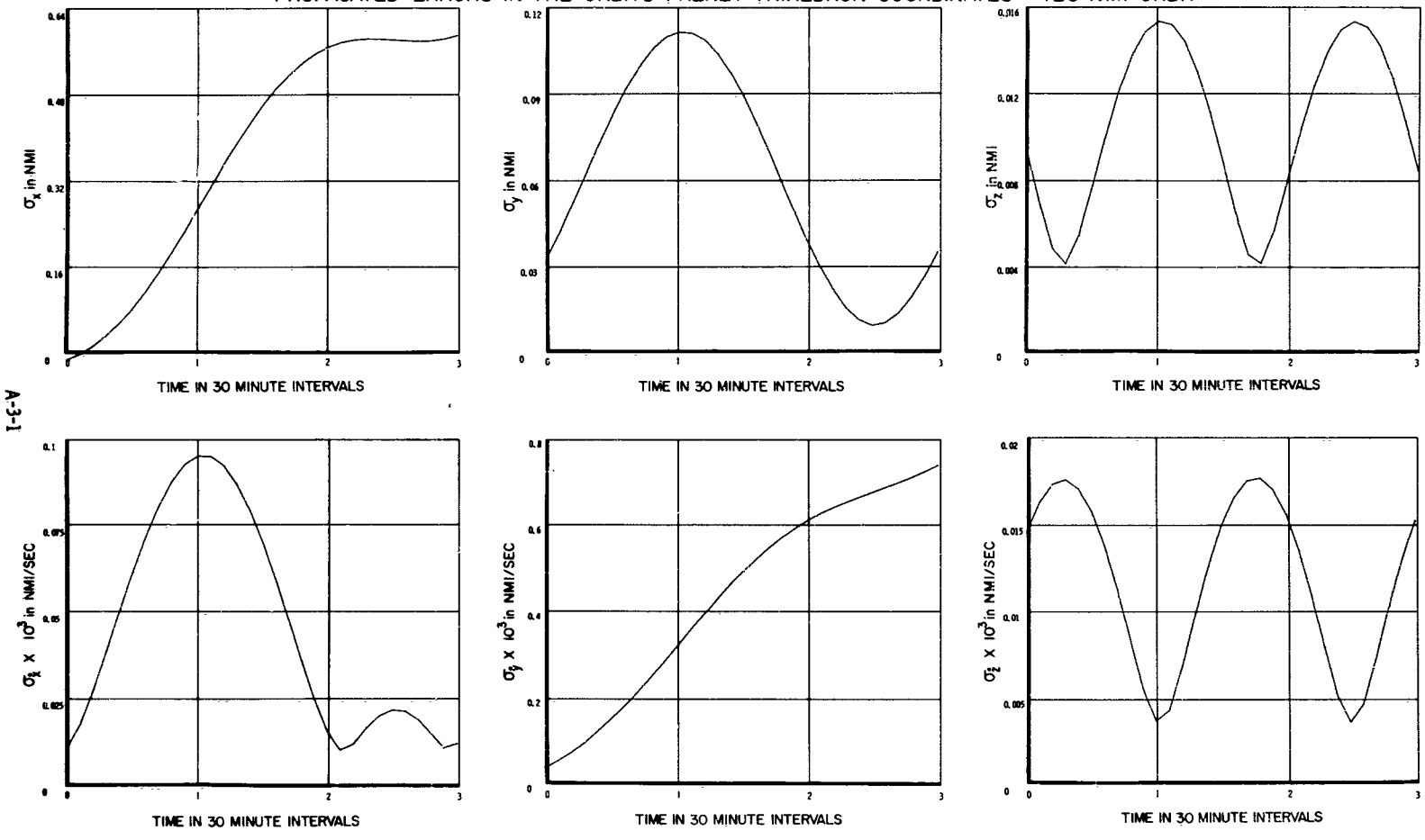


9-2-V

Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

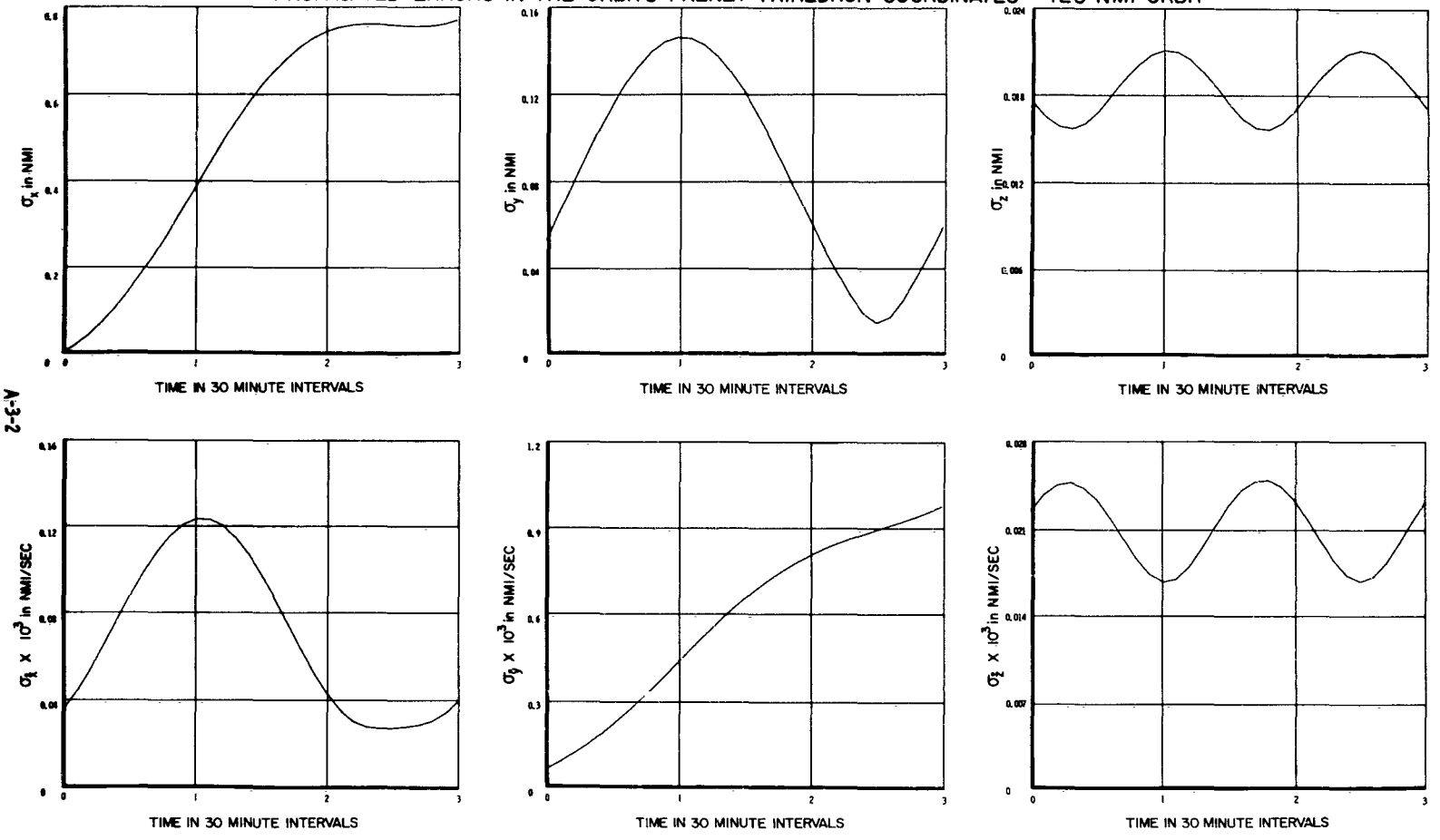
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

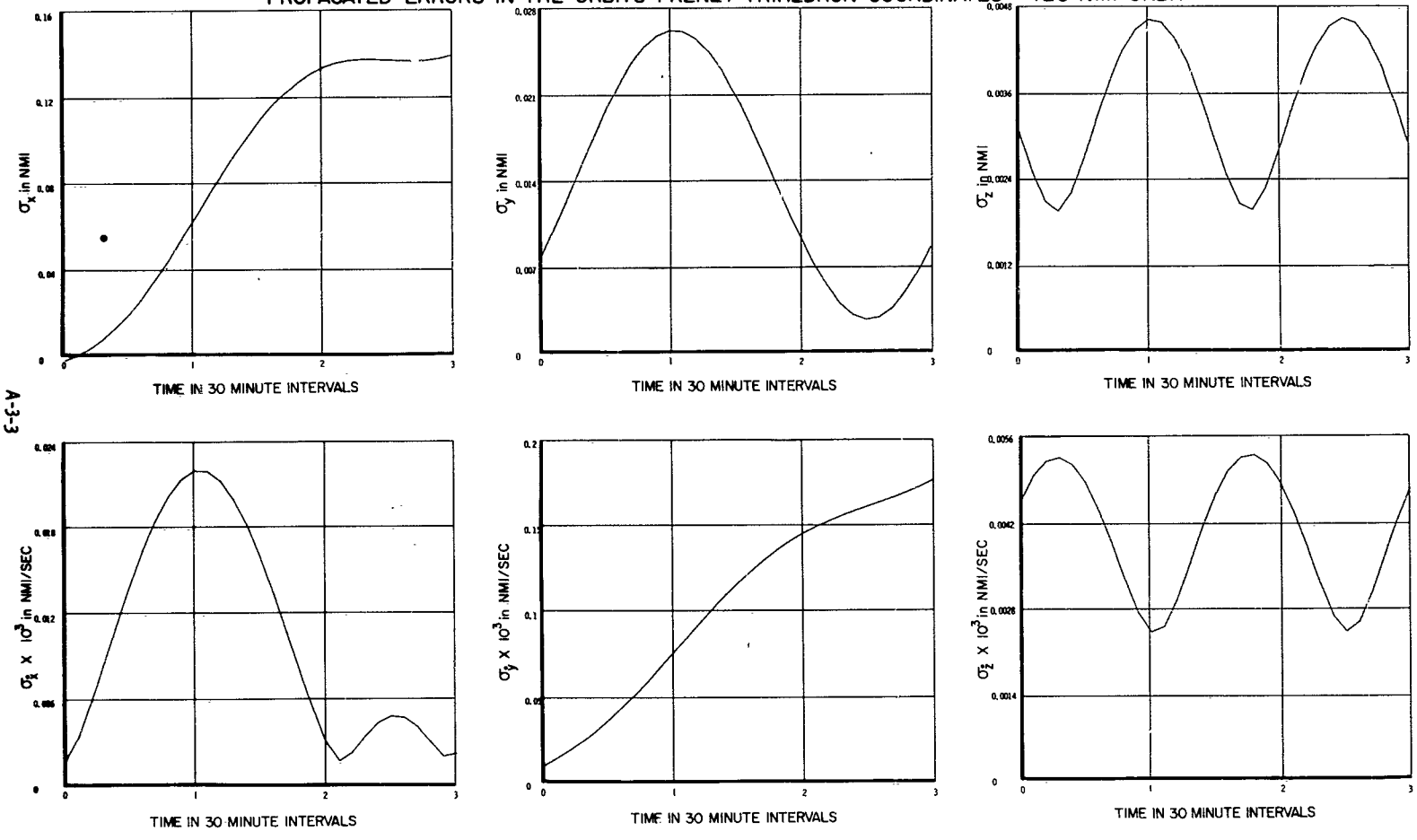
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

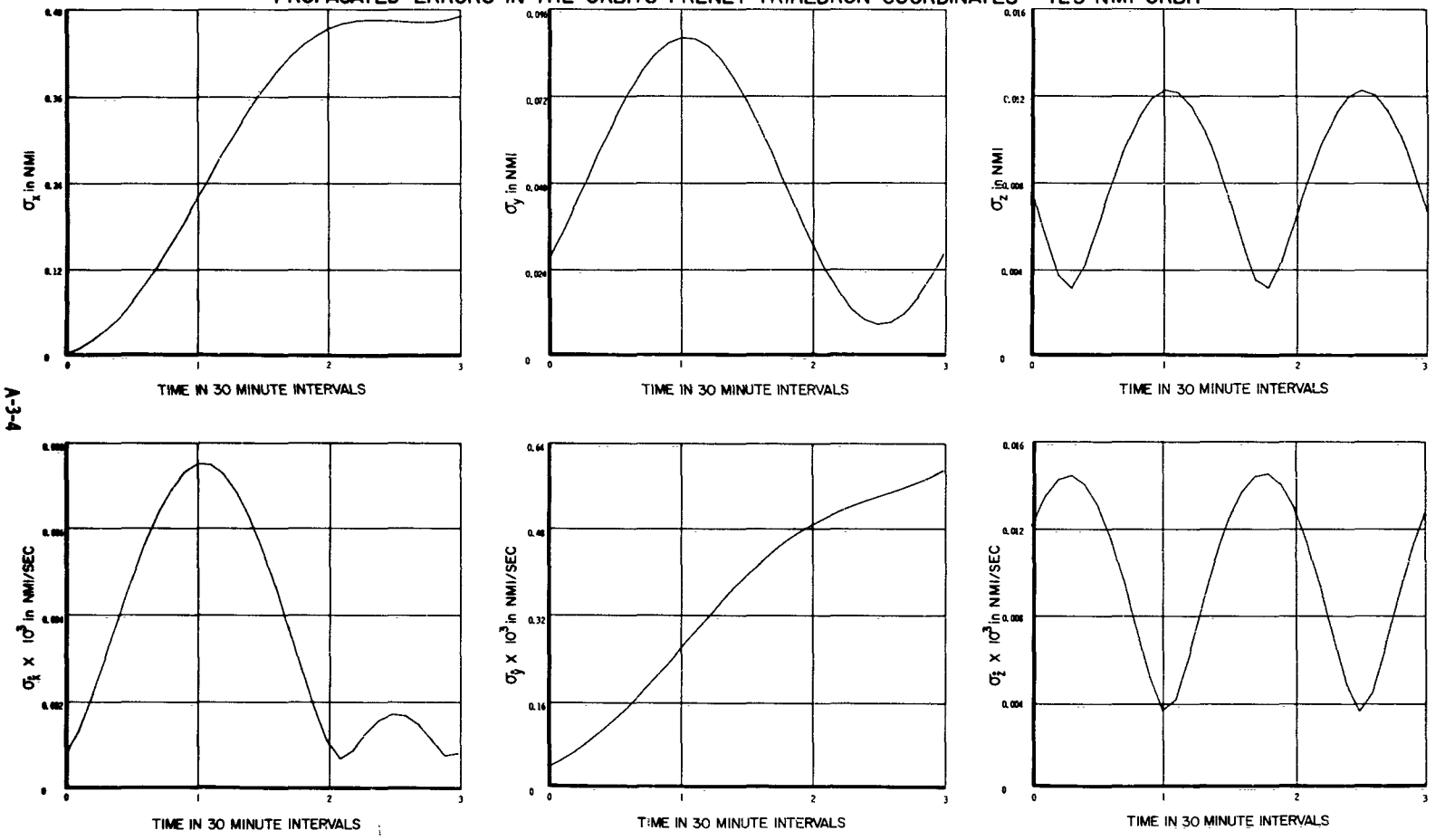
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

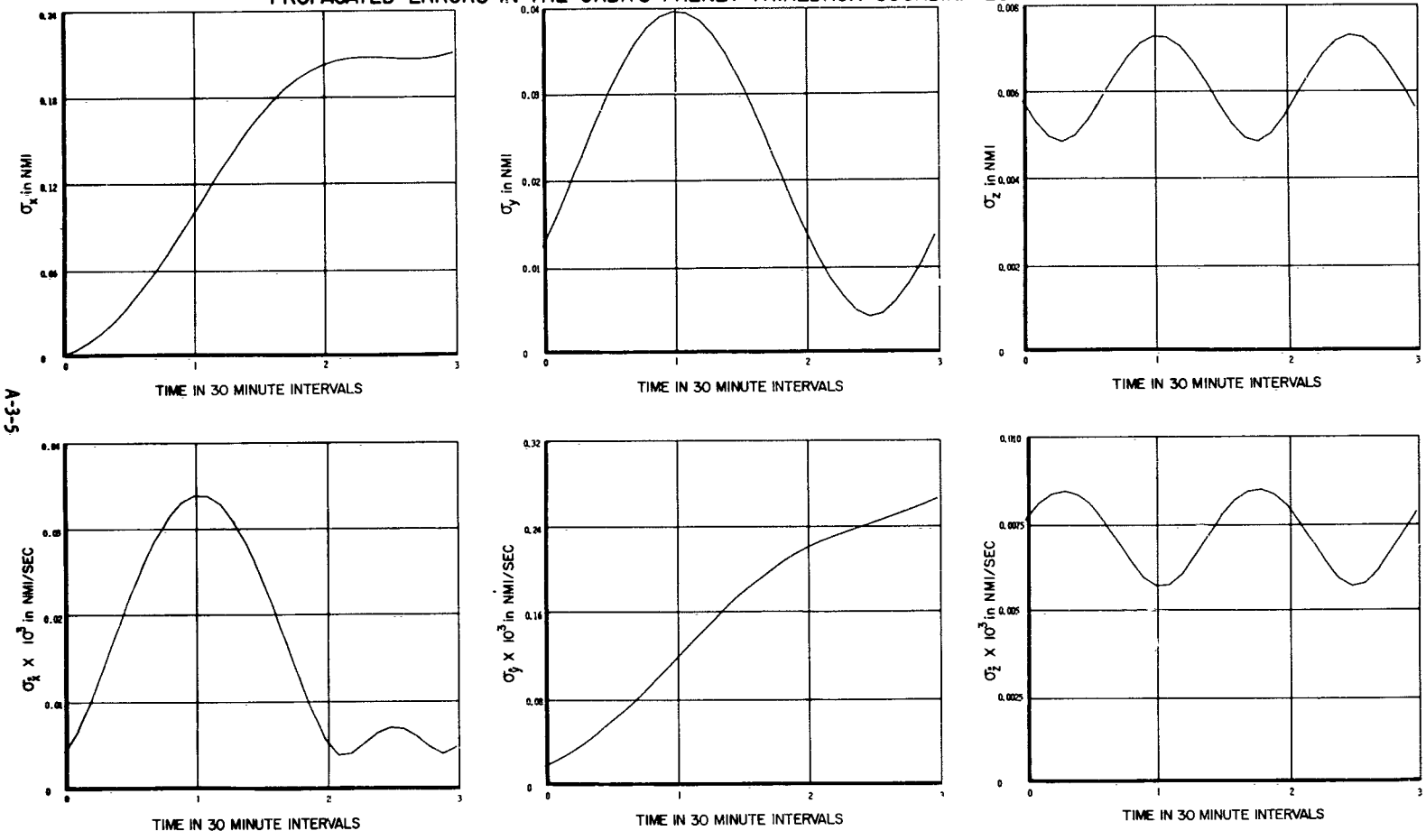
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

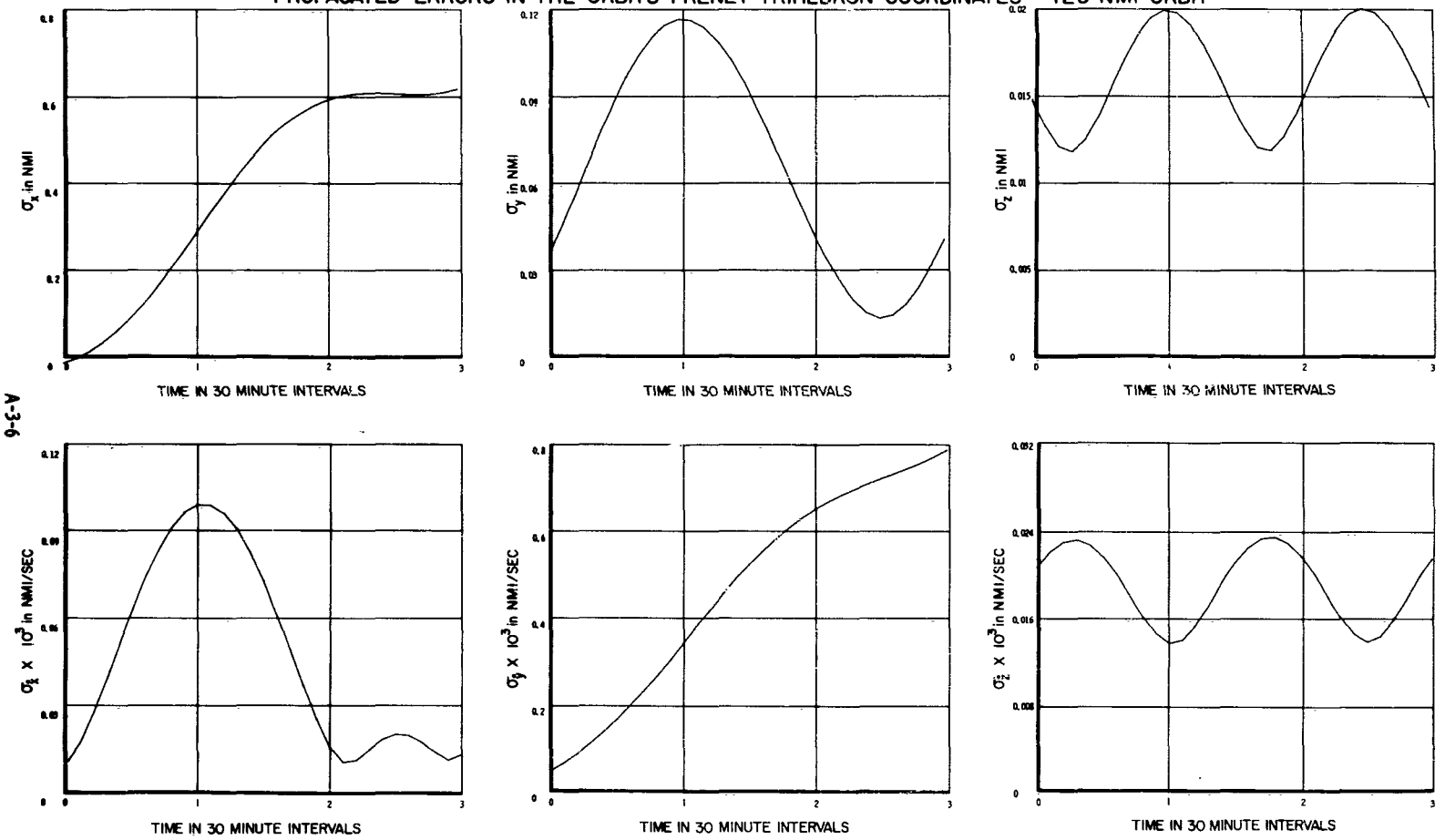
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 120^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

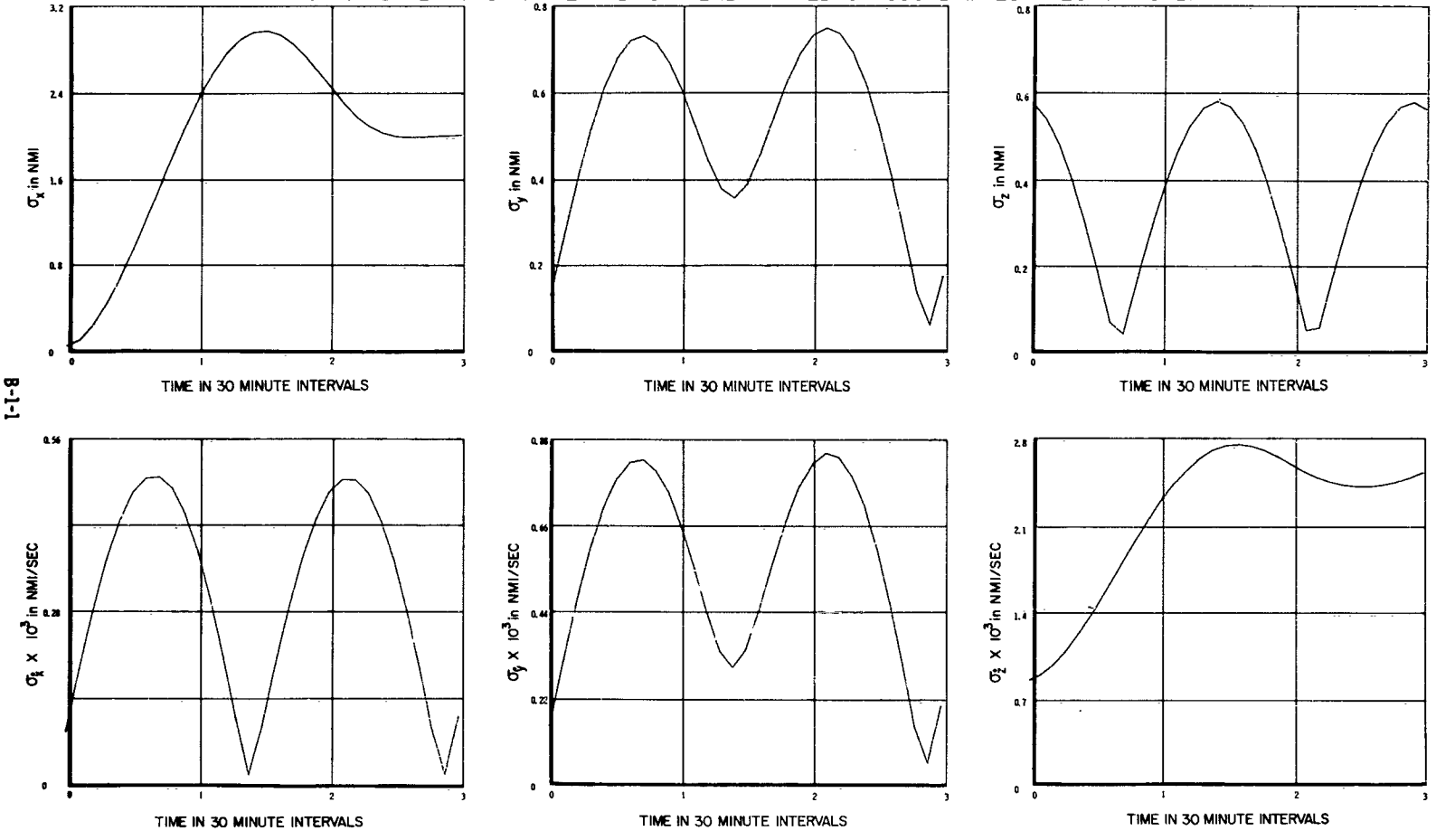
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 120° of Azimuth
Tracking From 2 Stations (90° Latitude Separation)

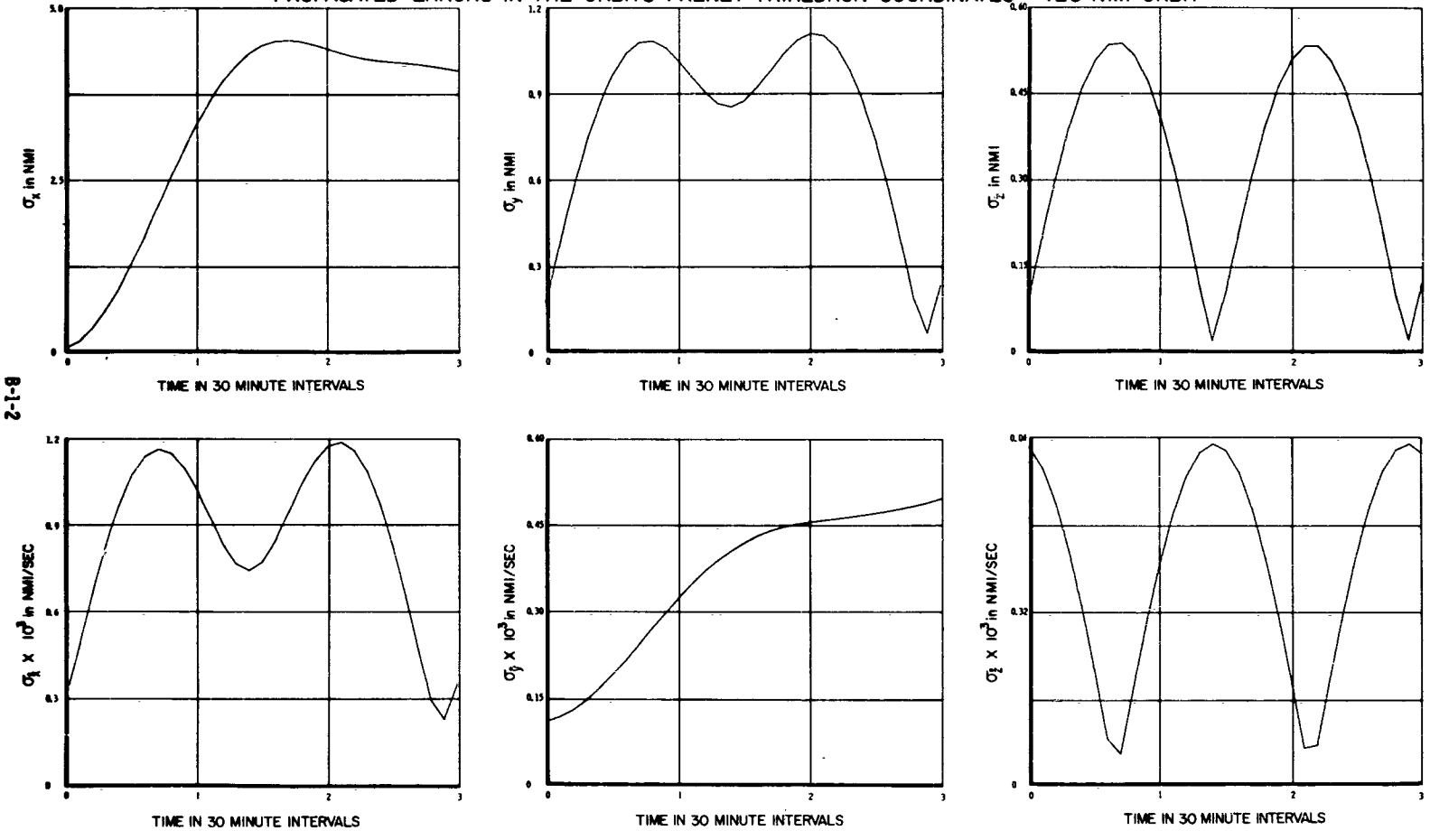
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 1 Station

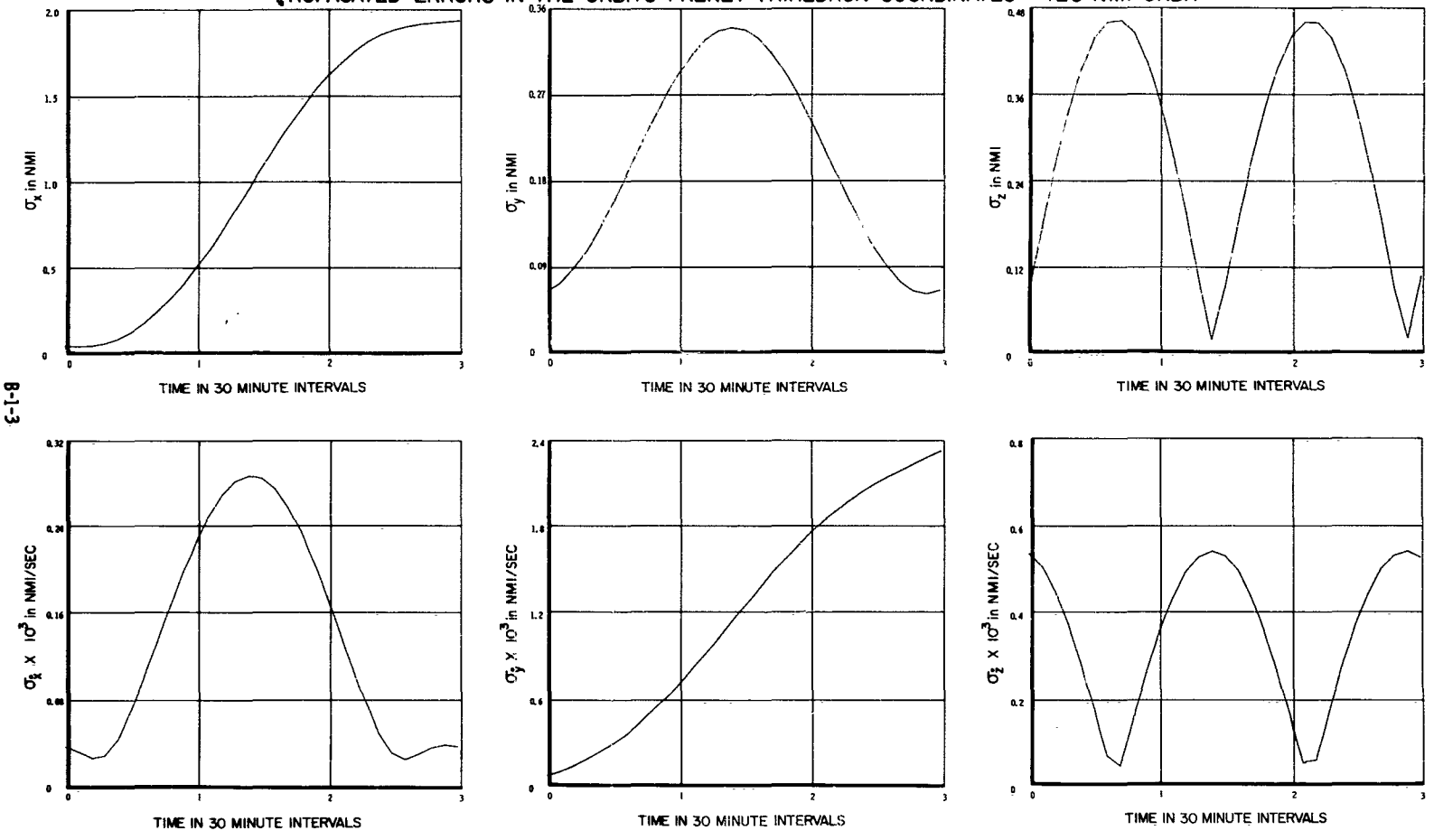
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 90° of Azimuth
Tracking From 1 Station

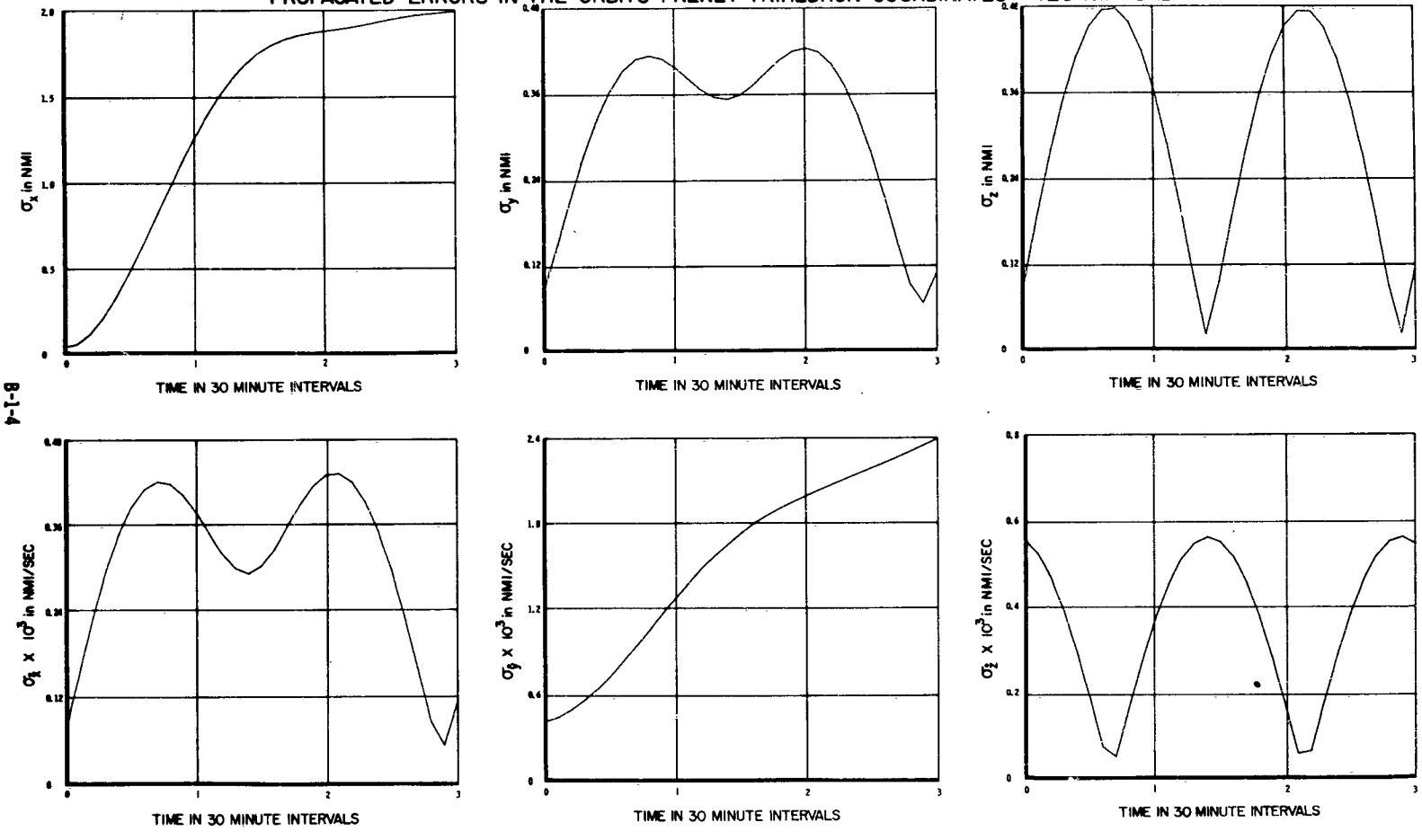
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)

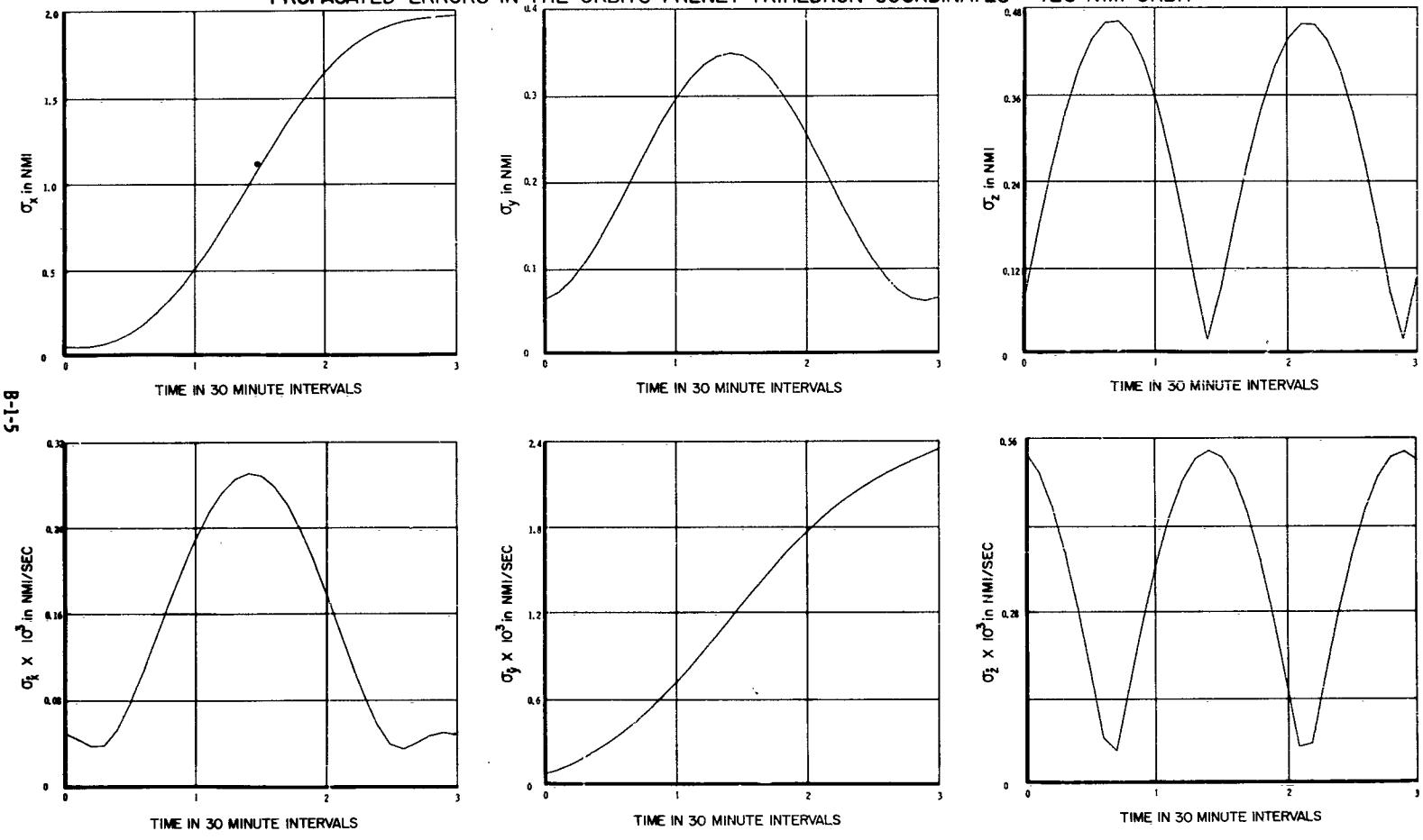
Tracking Through 90^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



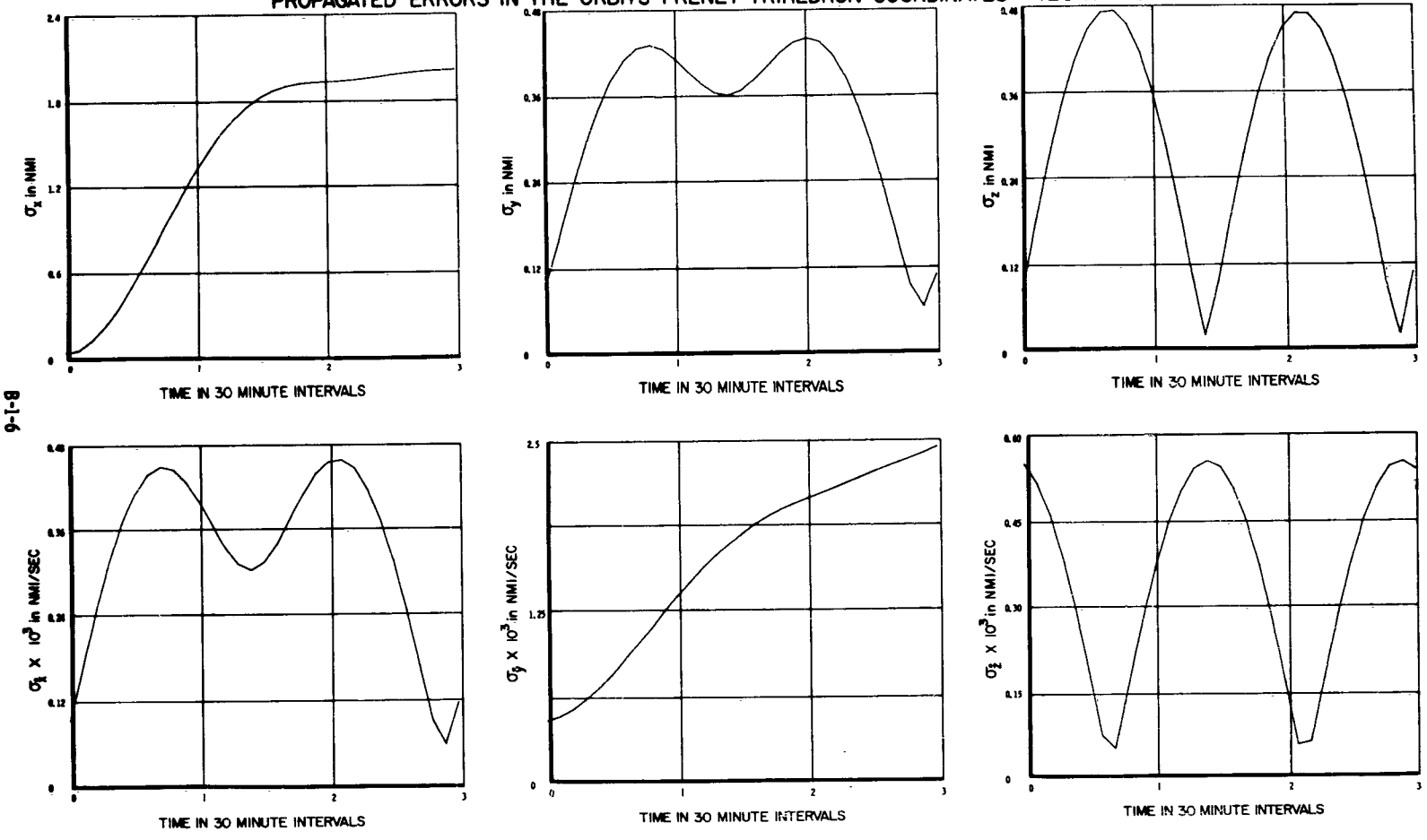
Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)
Tracking Through 90° of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)
Tracking Through 90° of Azimuth
Tracking From 1 Station

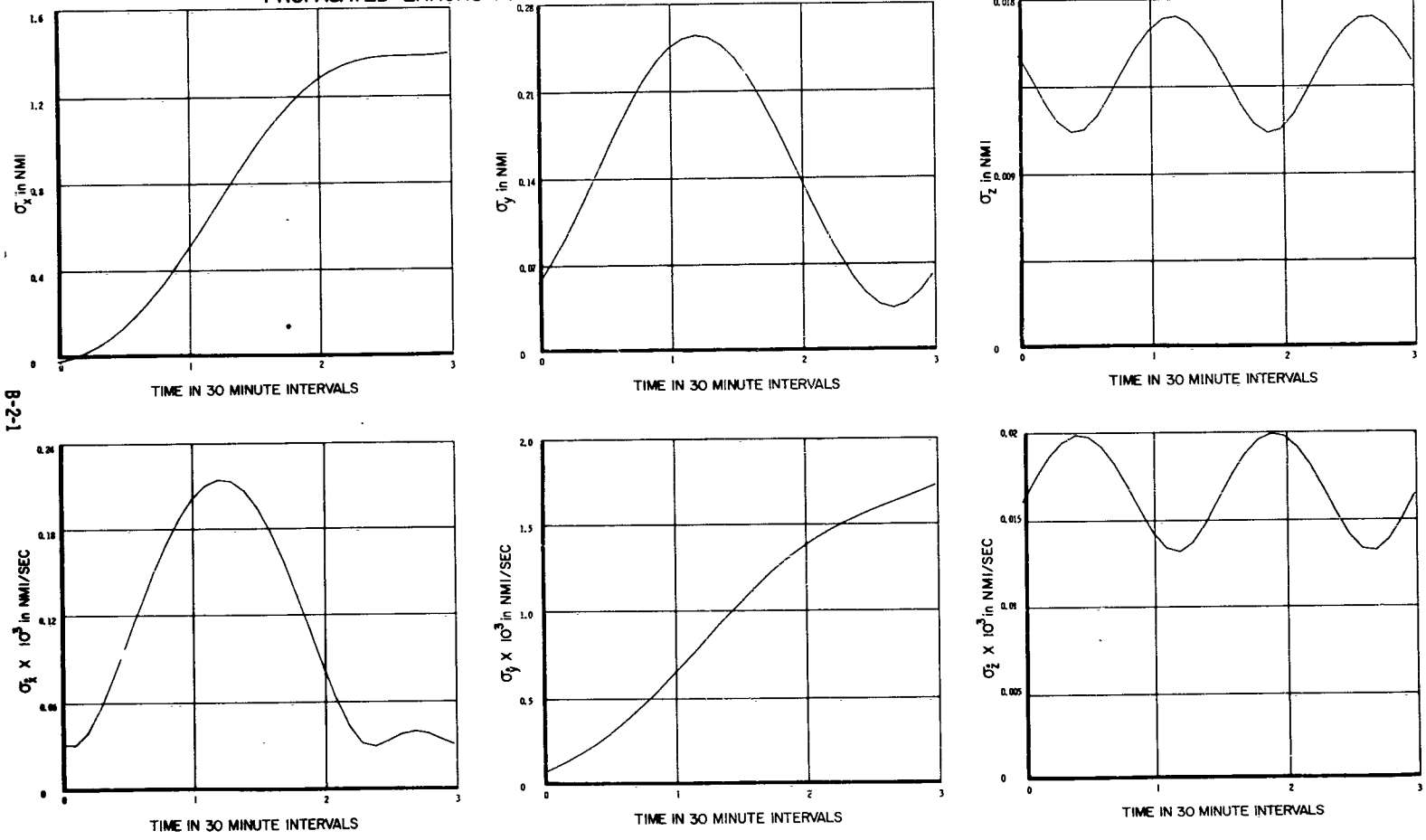
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 1 Station

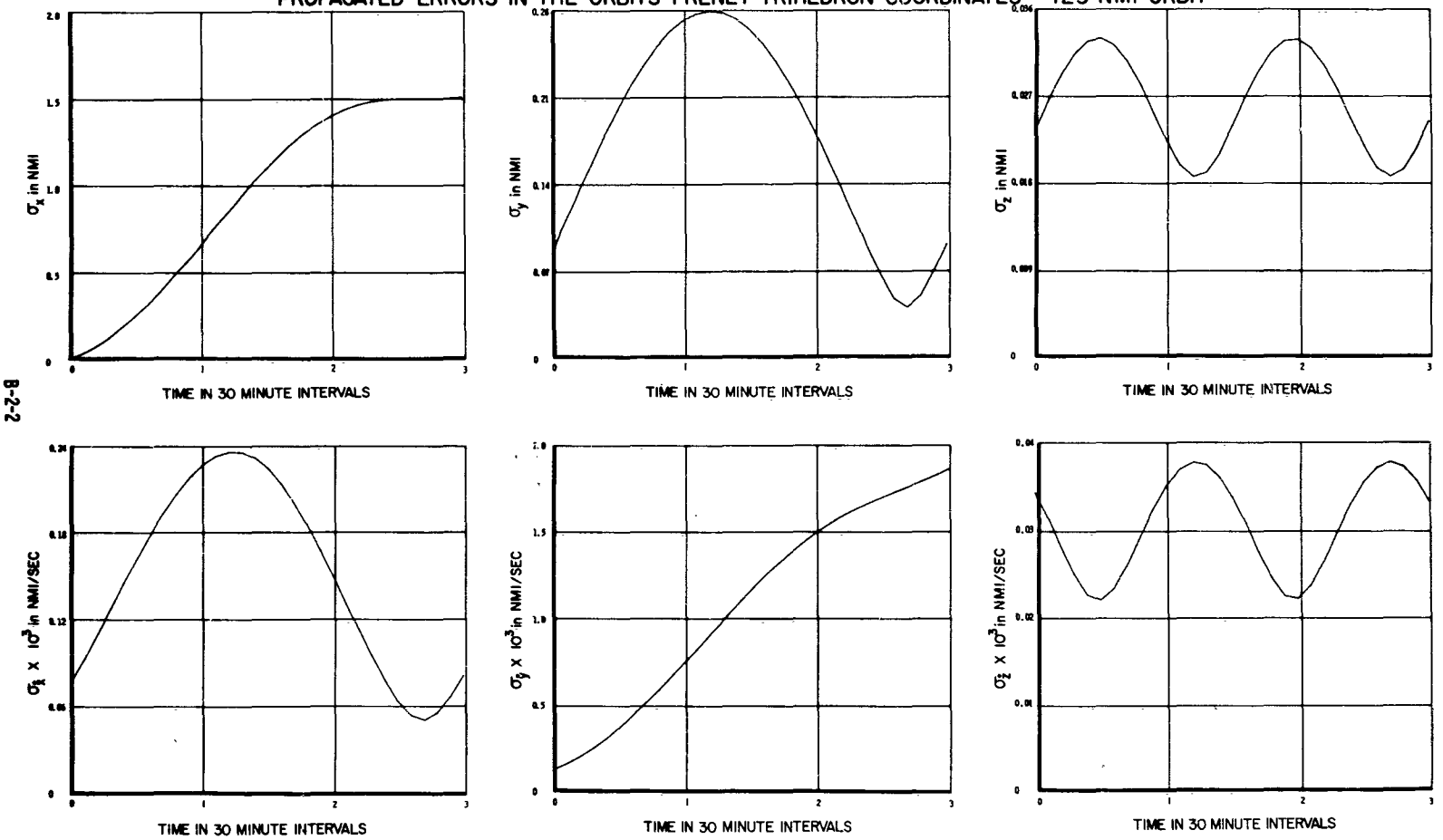
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Error: 50 ft, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

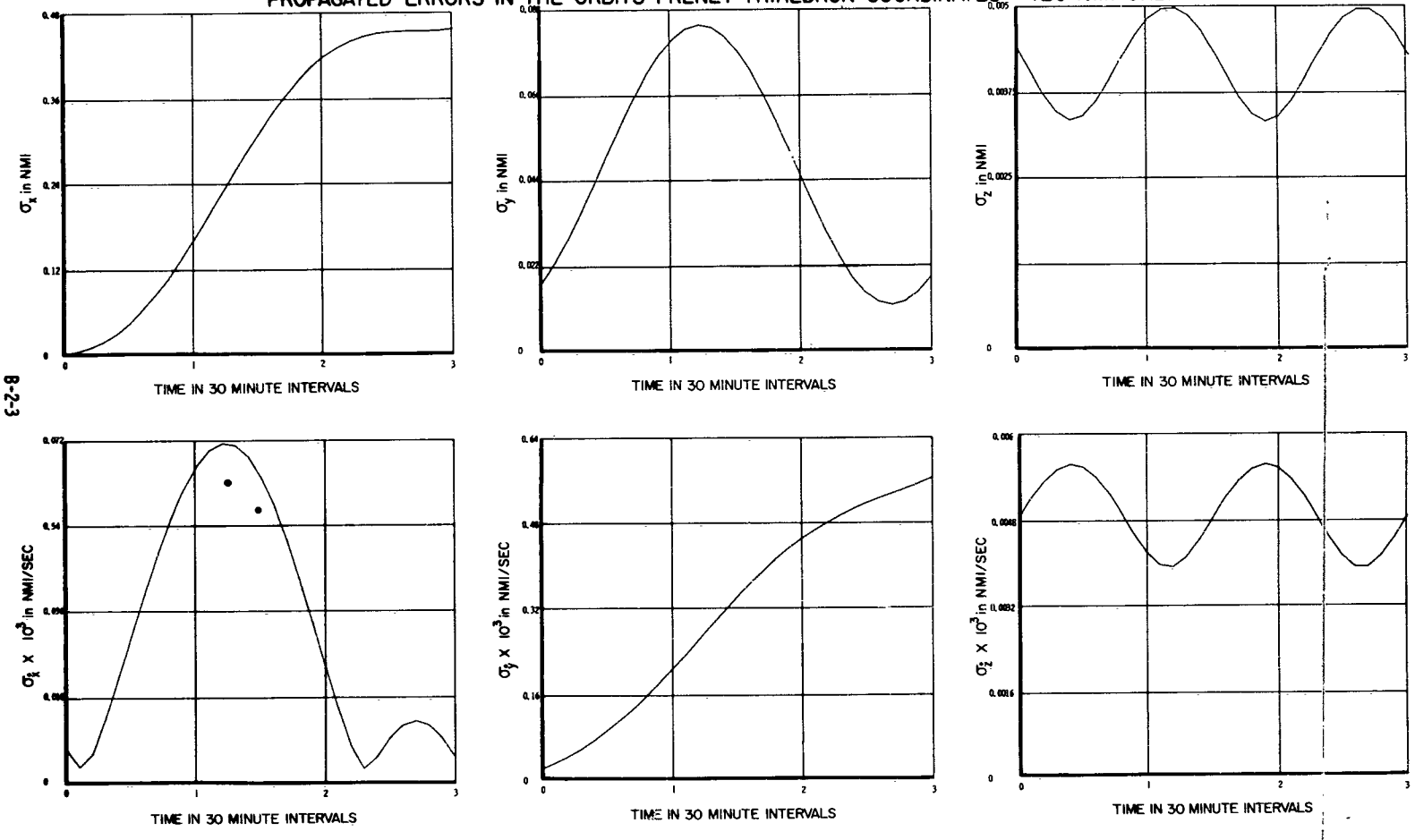
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
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Tracking Through 90^0 of Azimuth
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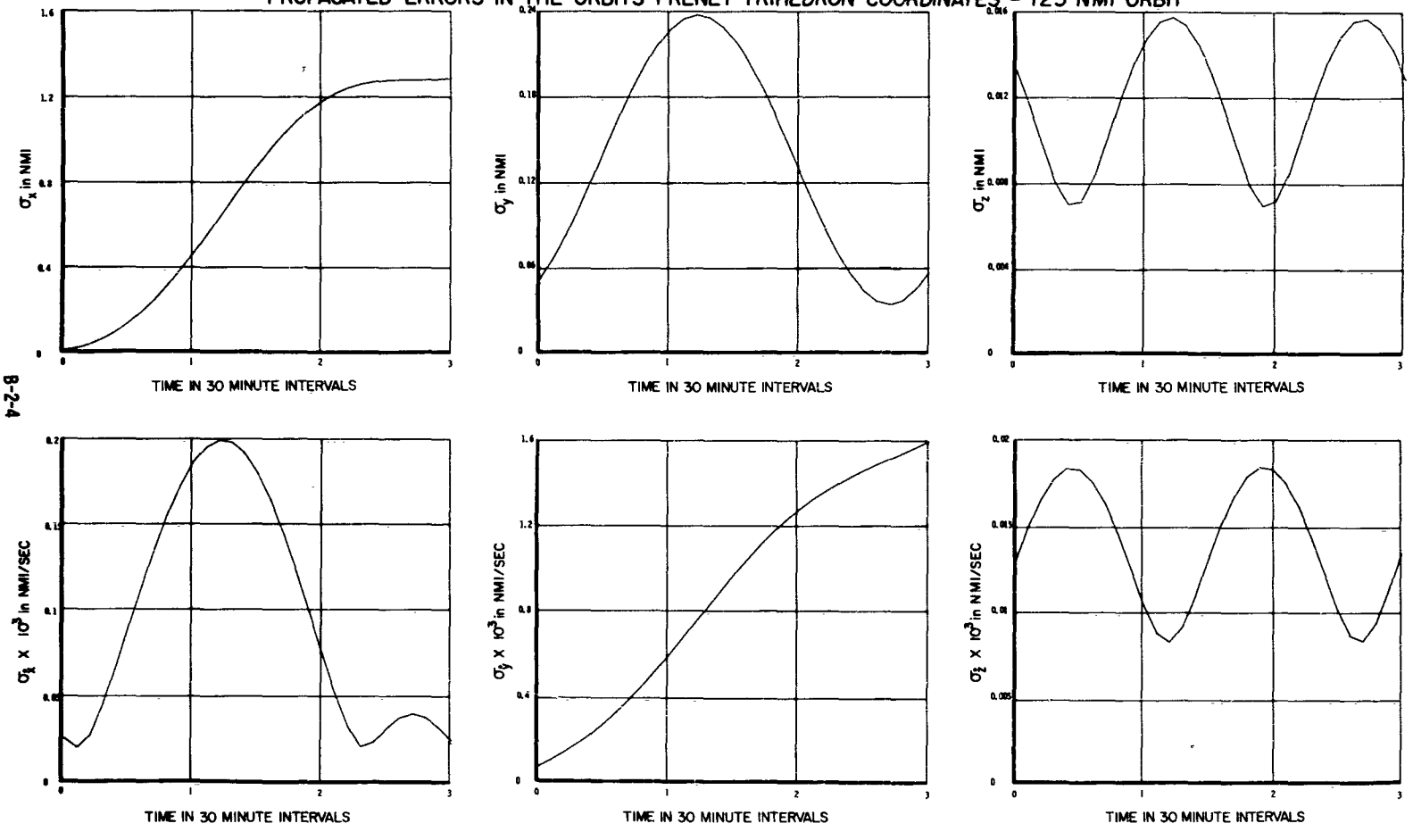

Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

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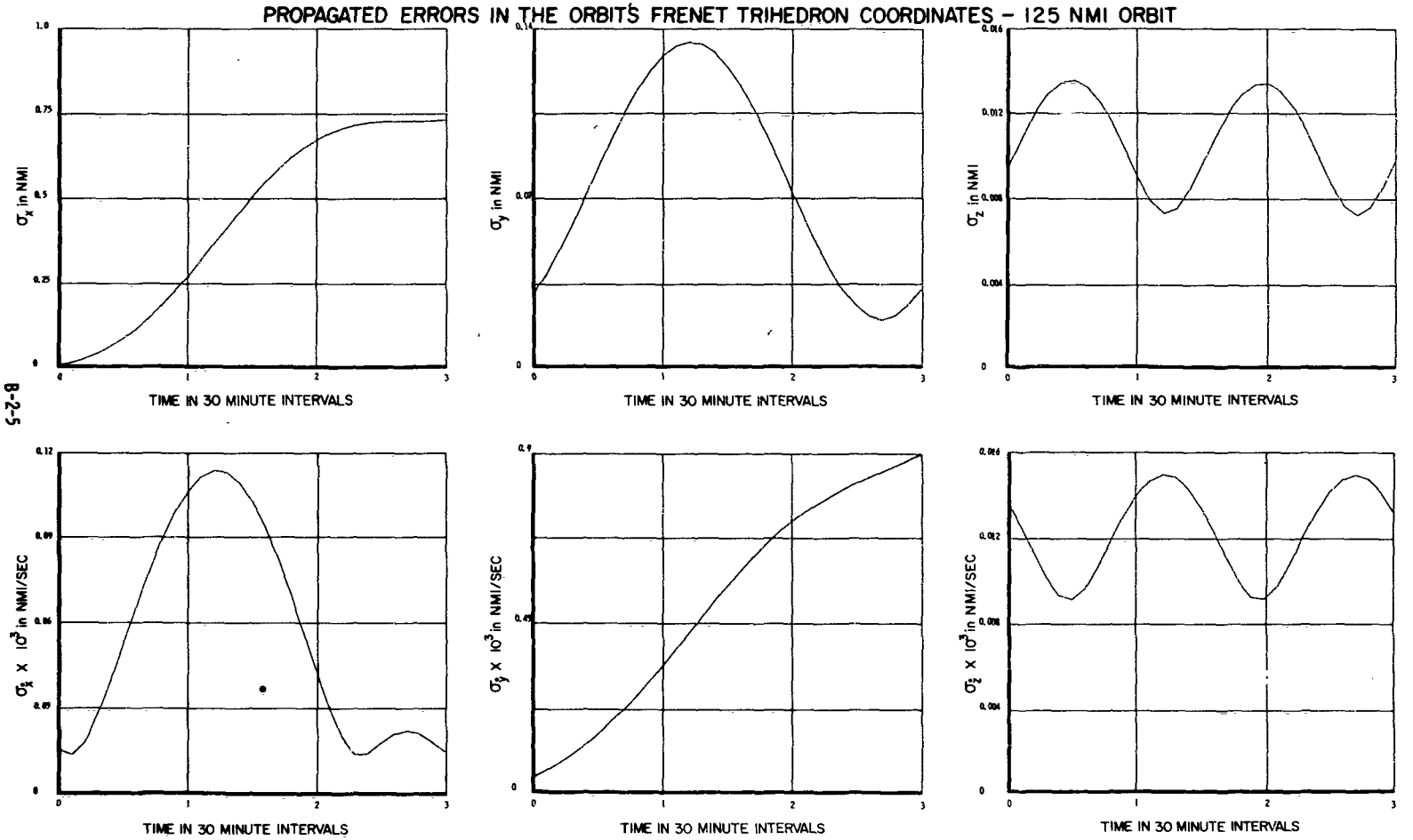

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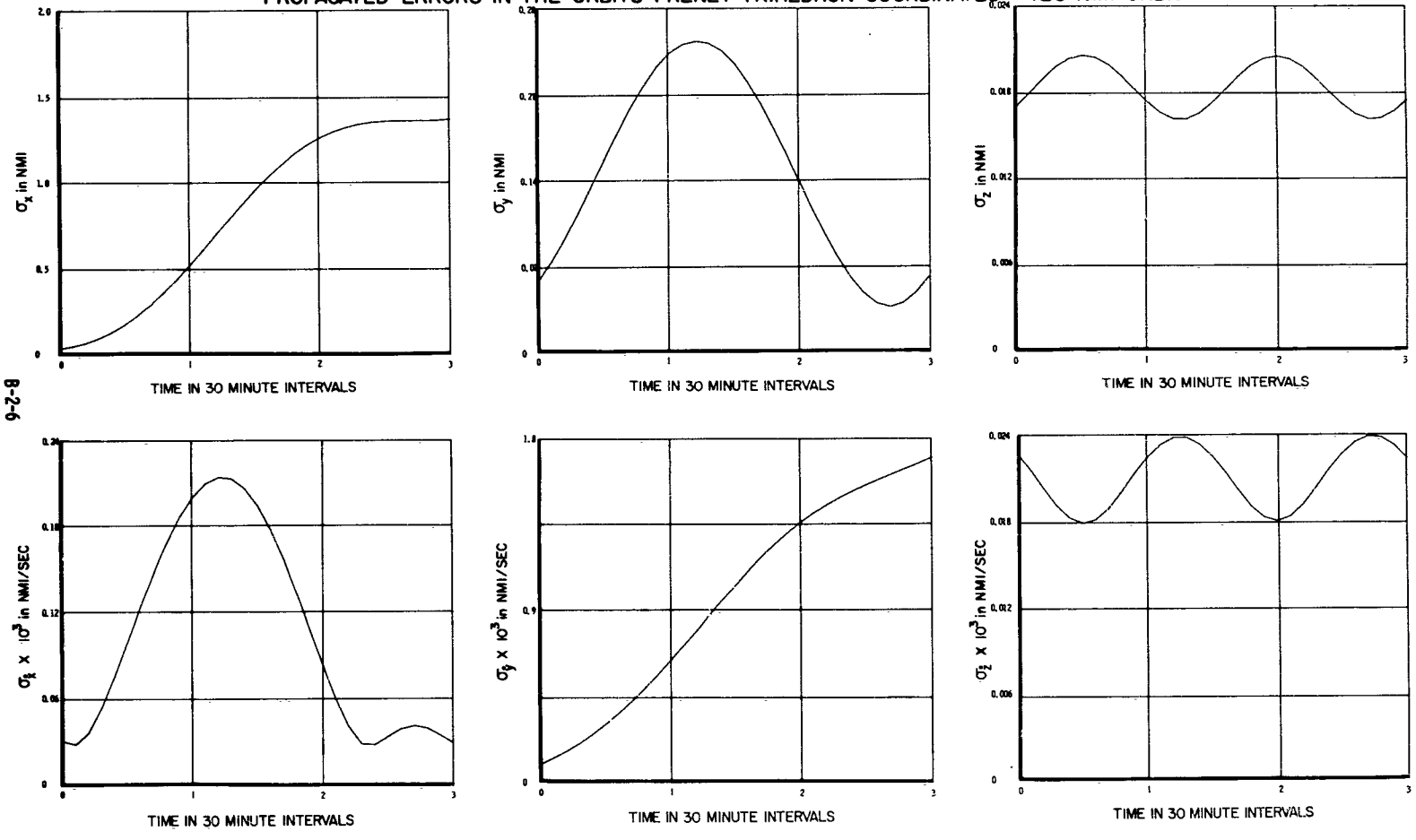
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

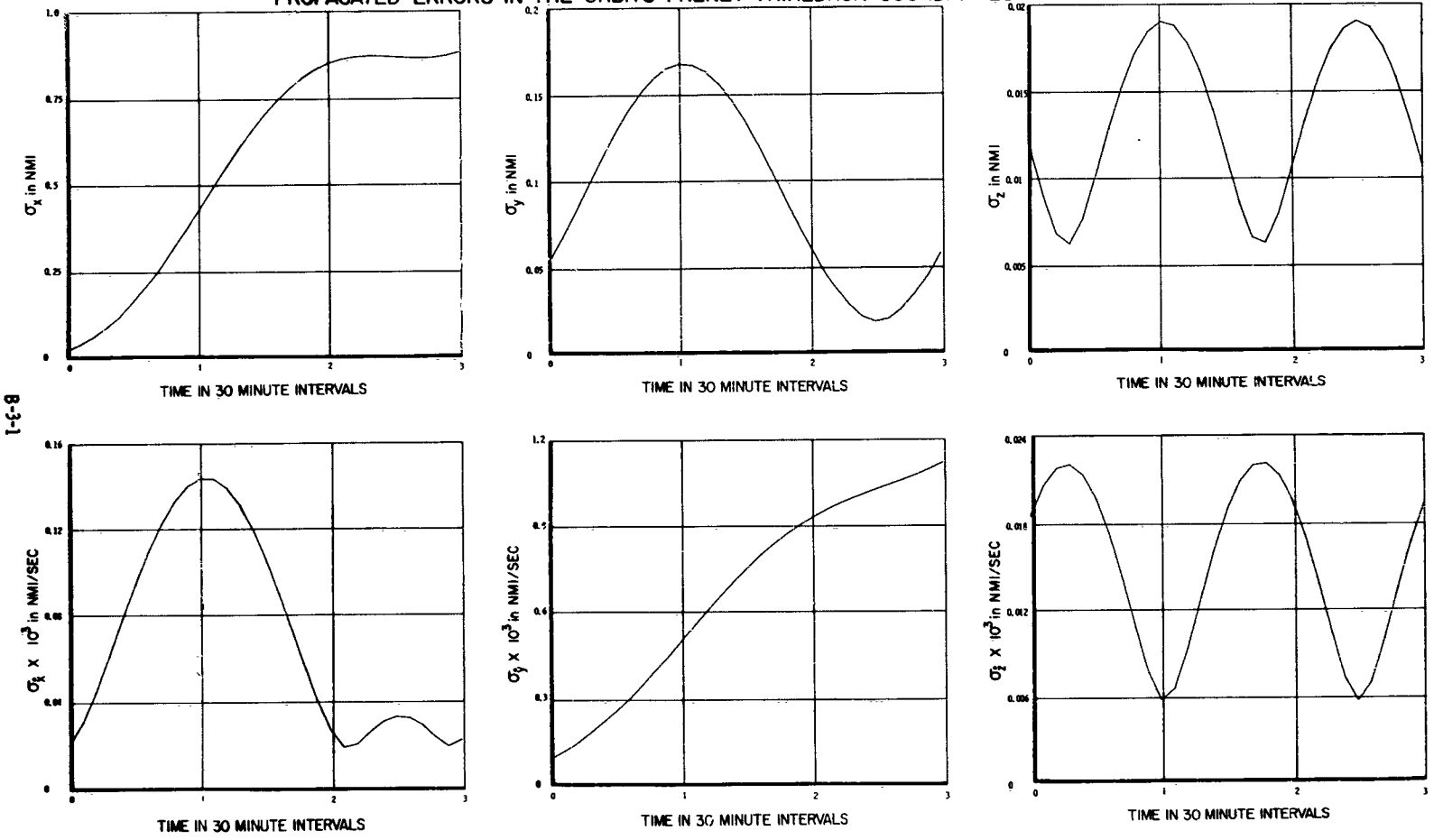
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 90° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

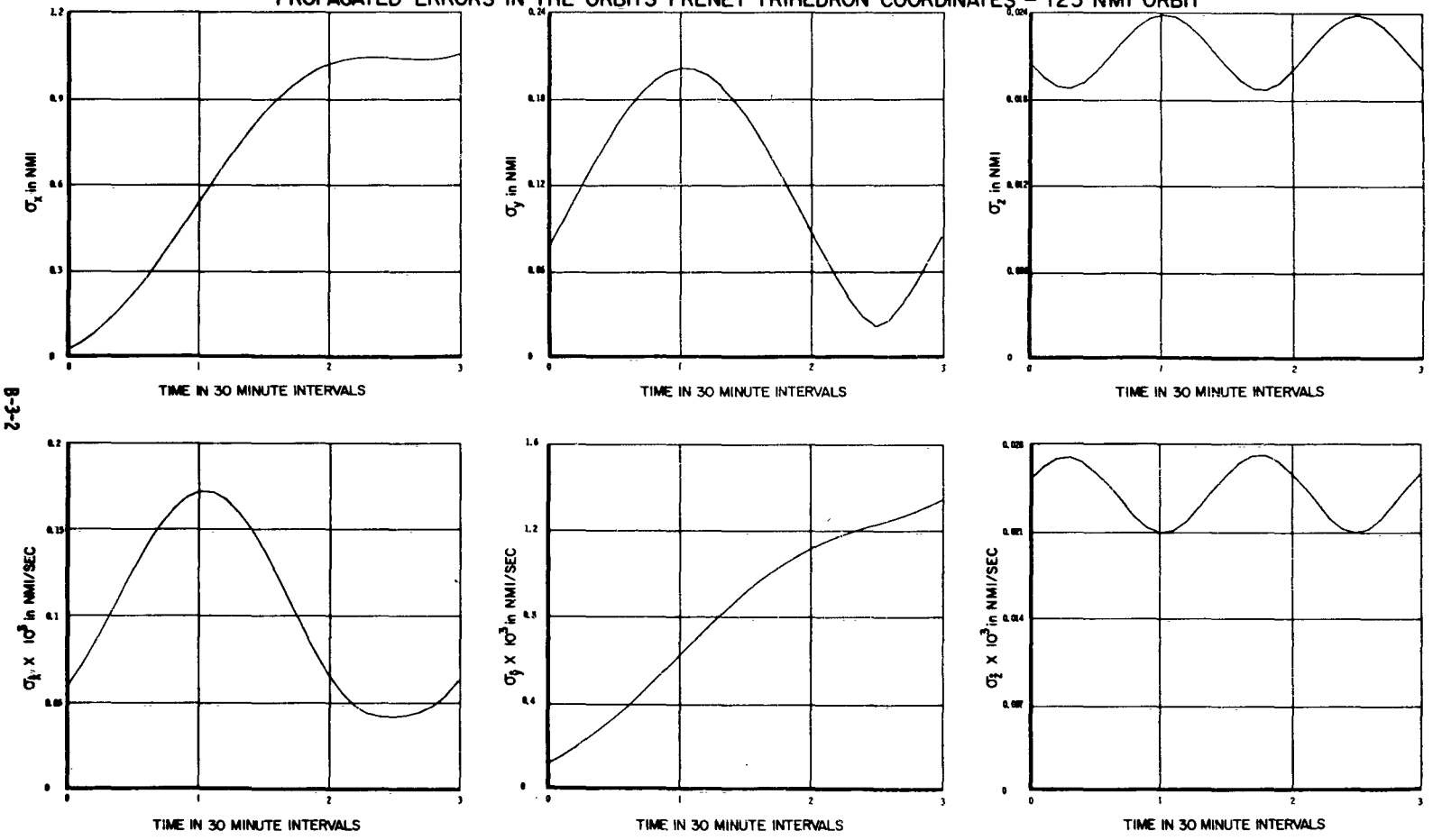
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



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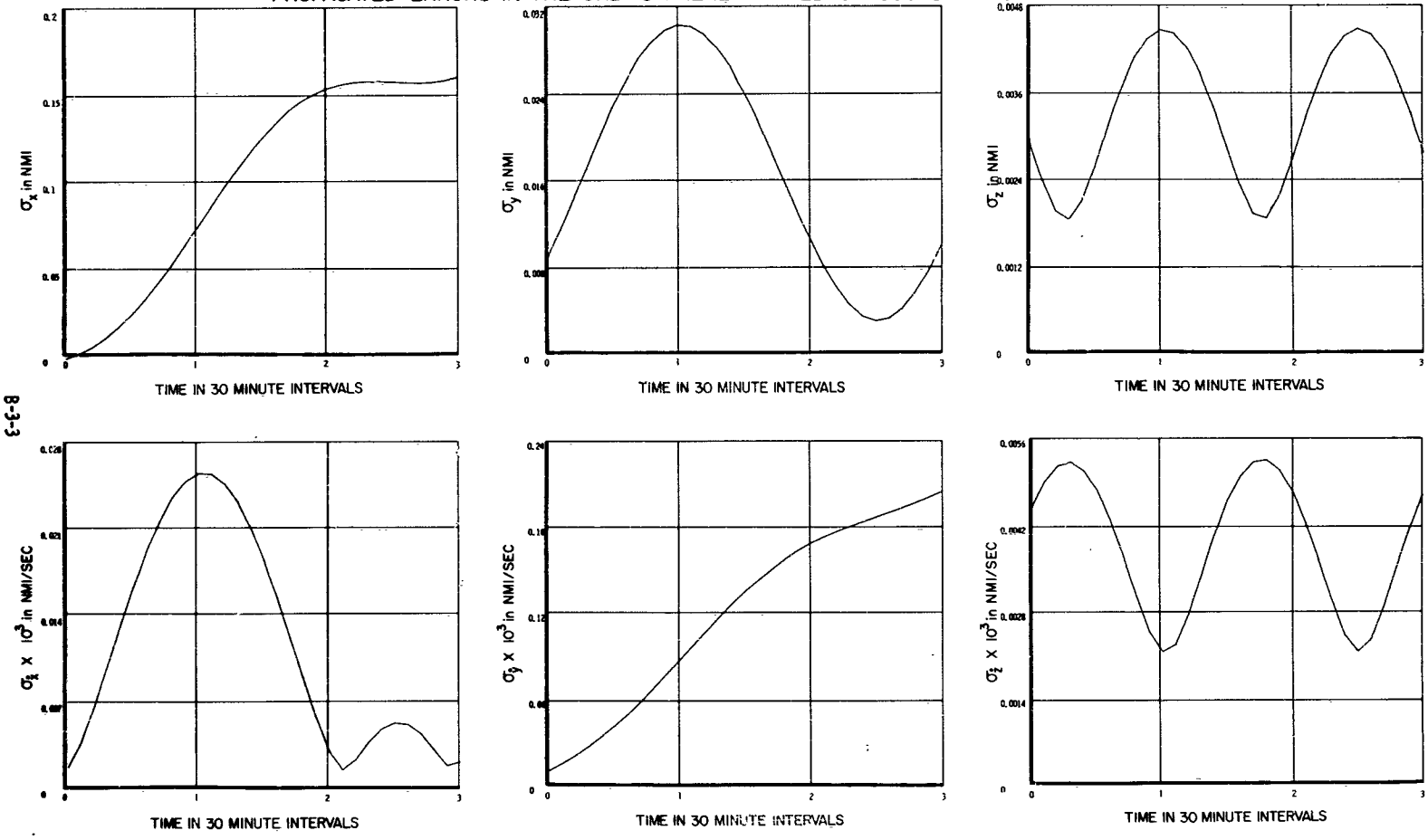
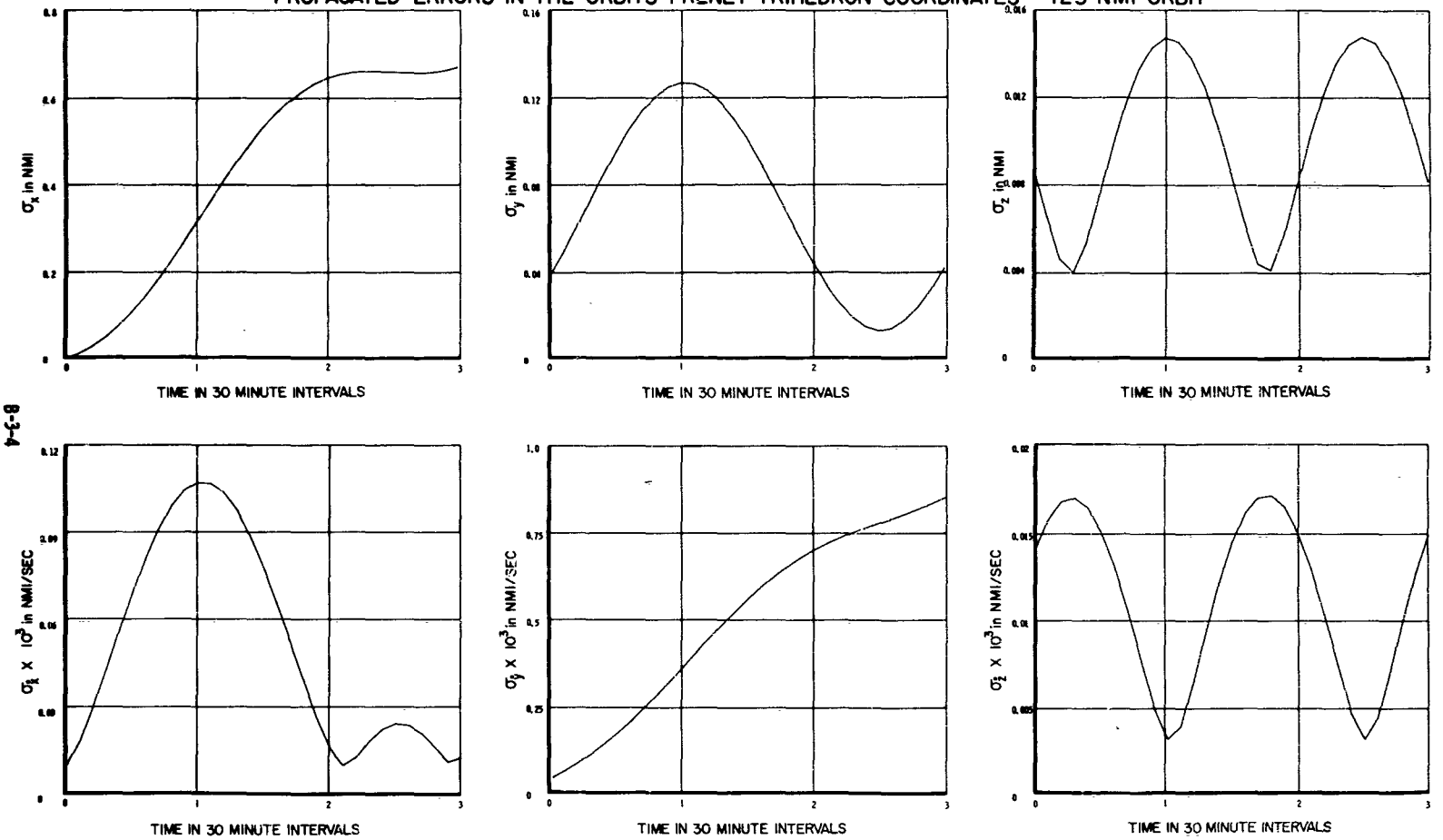
Tracking Through 90° of Azimuth
Tracking From 2 Stations (90° Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)
Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

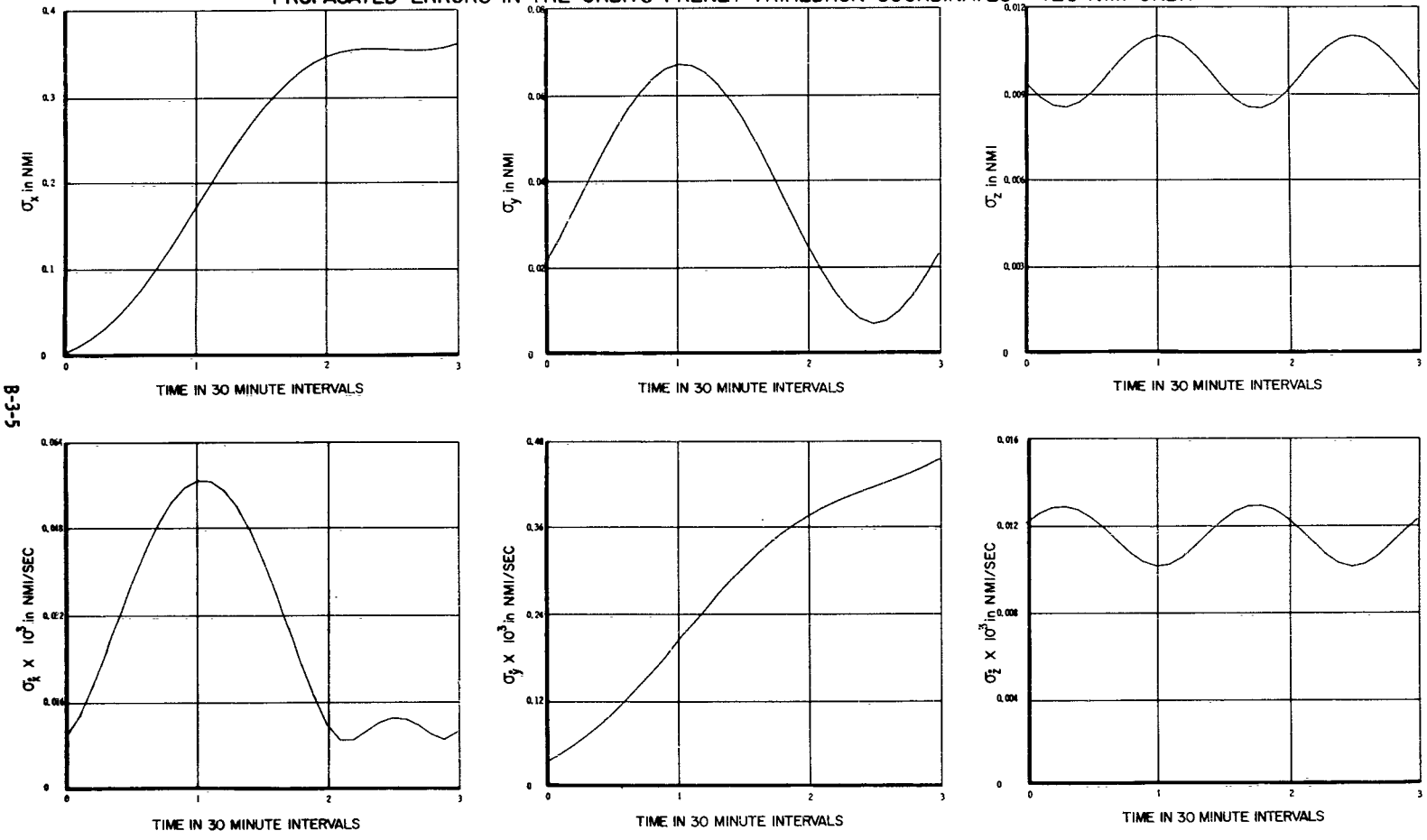
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

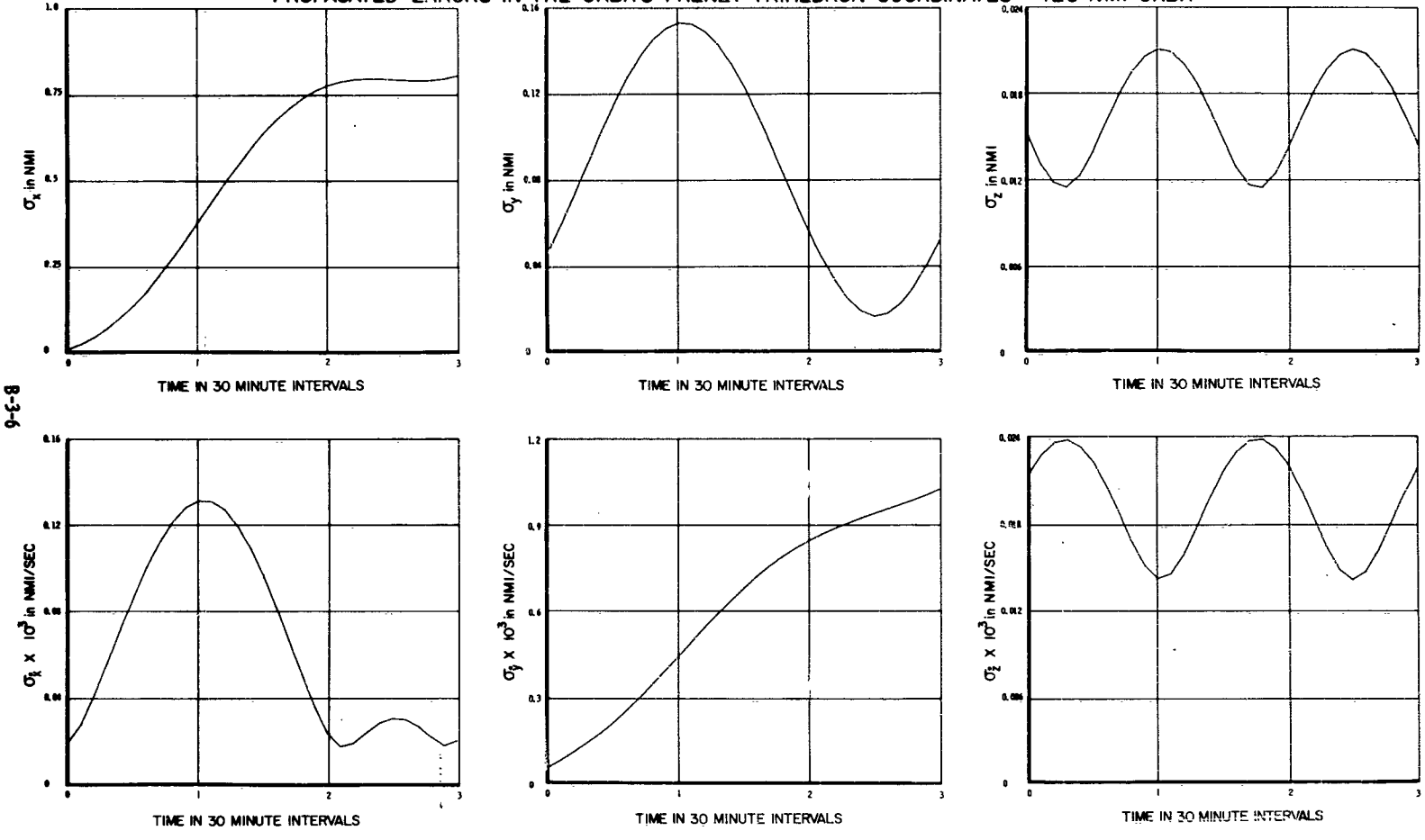
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 90^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

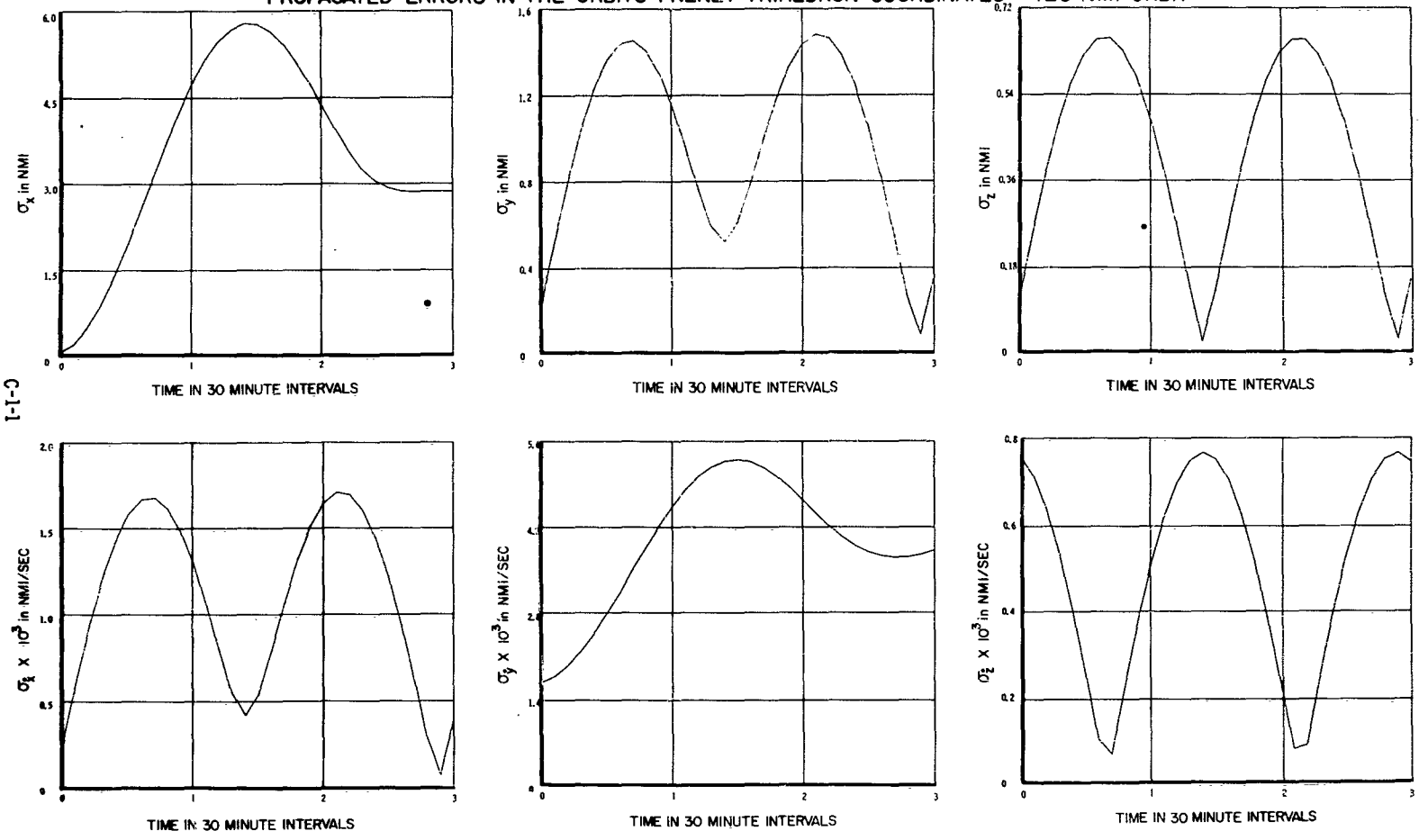
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 90° of Azimuth
Tracking From 2 Stations (90° Latitude Separation)

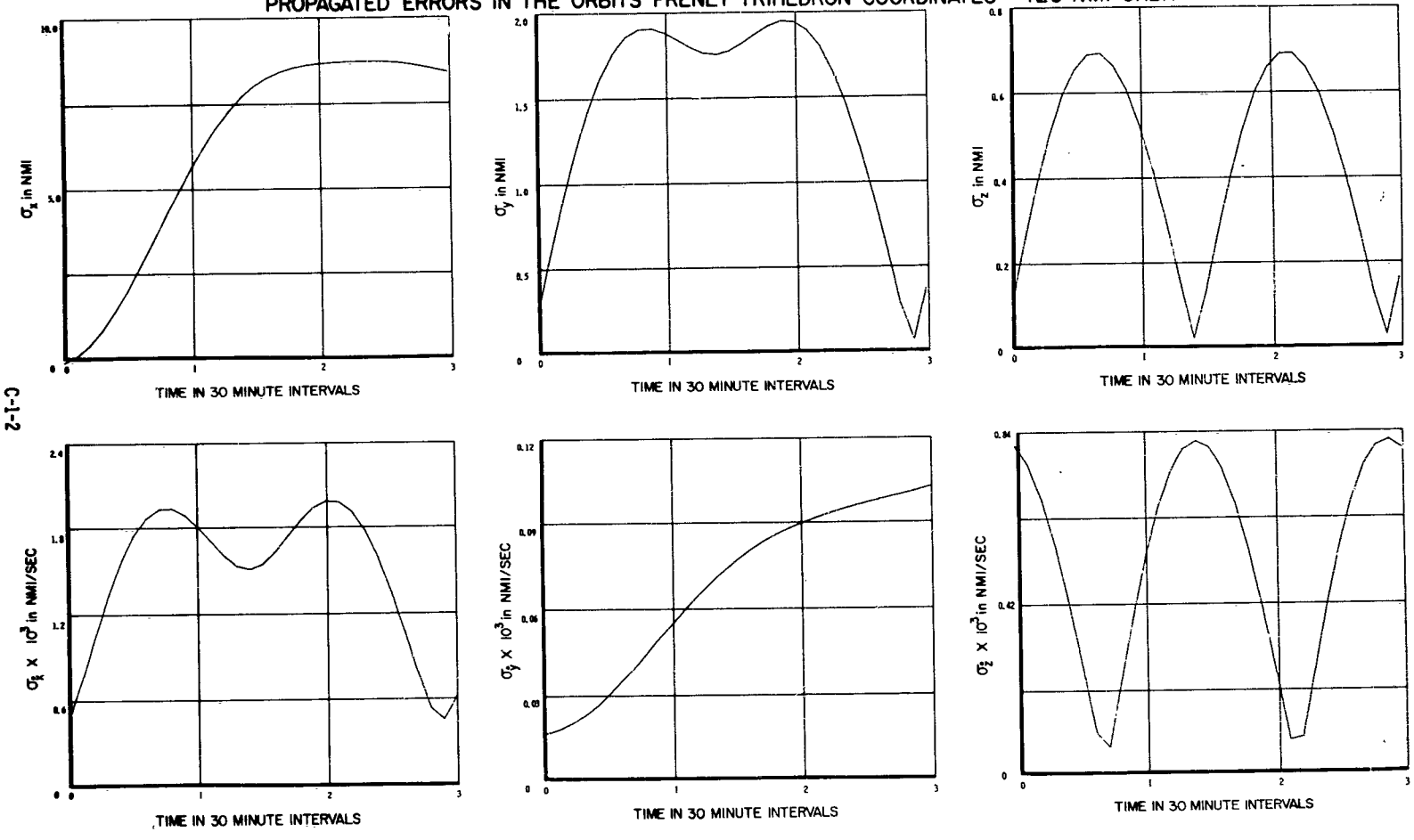
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

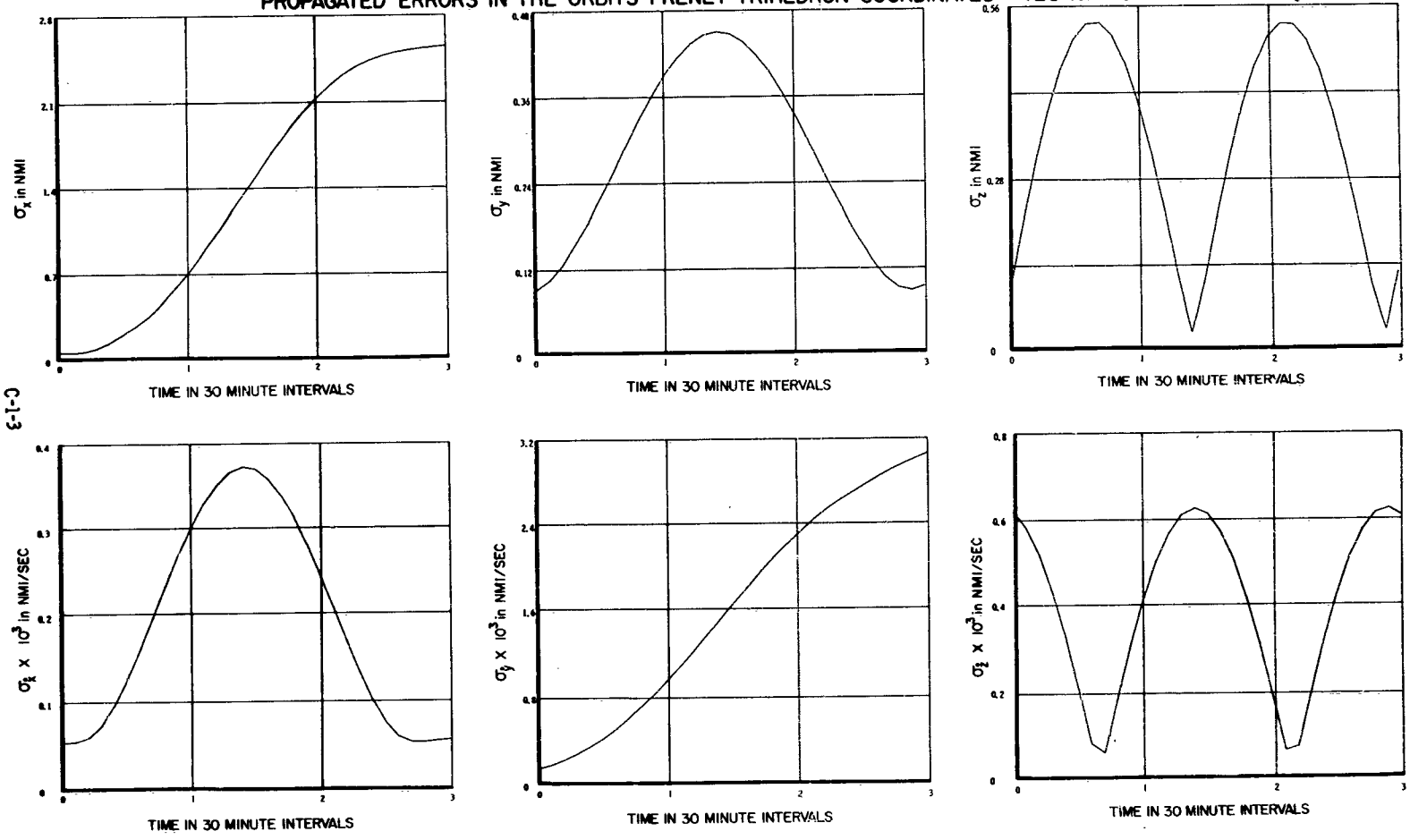
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

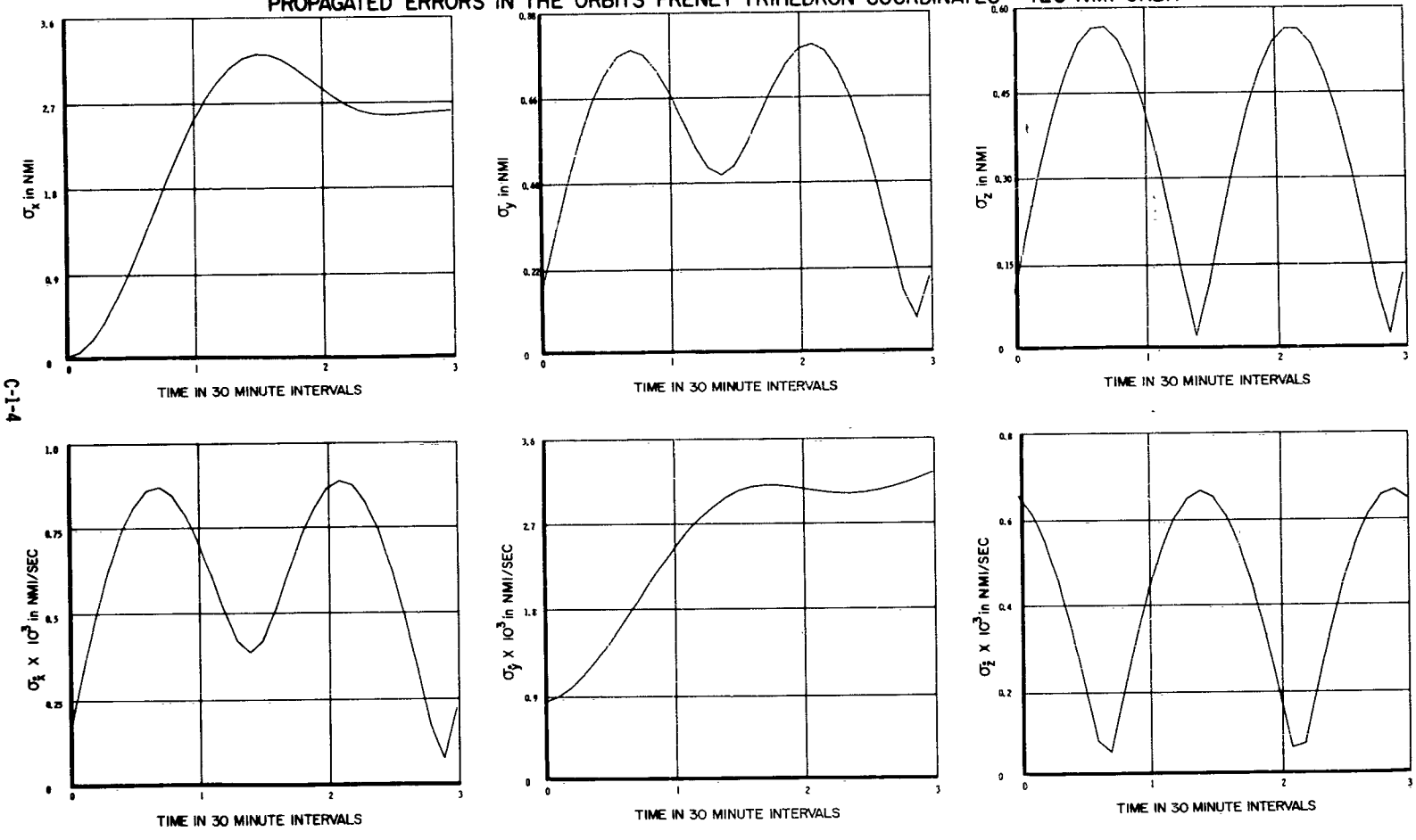
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



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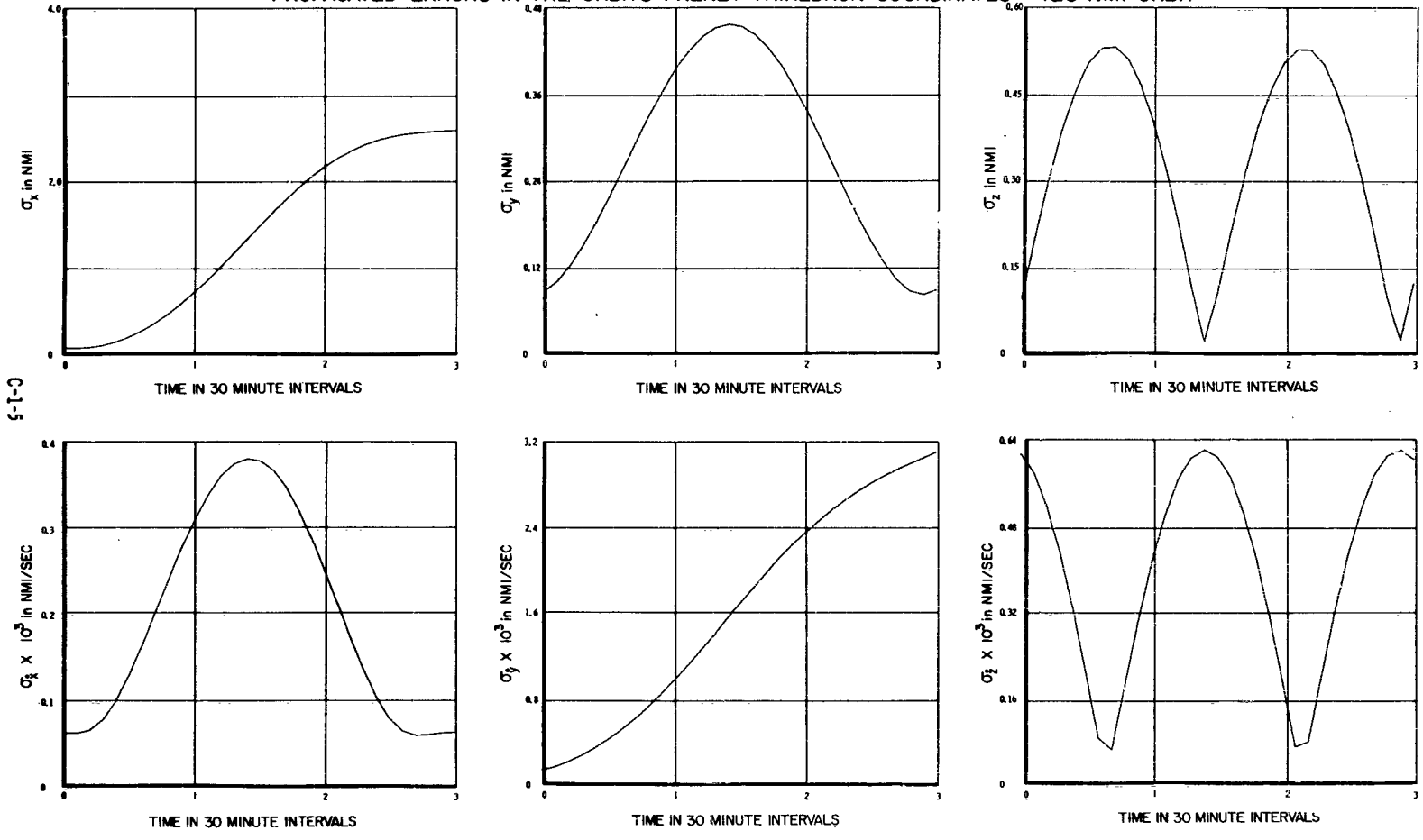
Tracking Through 60^0 of Azimuth
Tracking From 1 Station

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

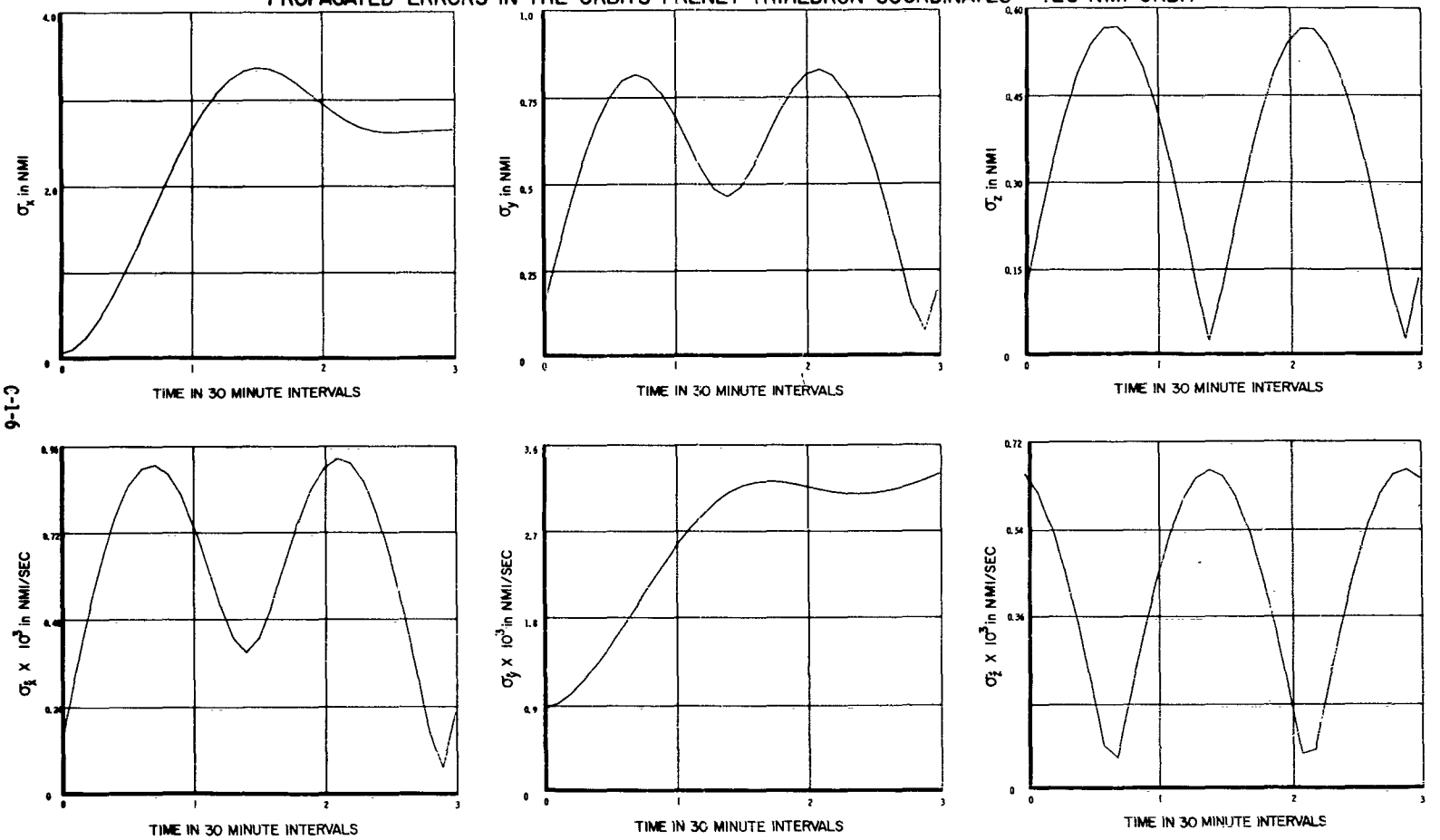


C-1-5

Sensor: Range, Range Rate and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

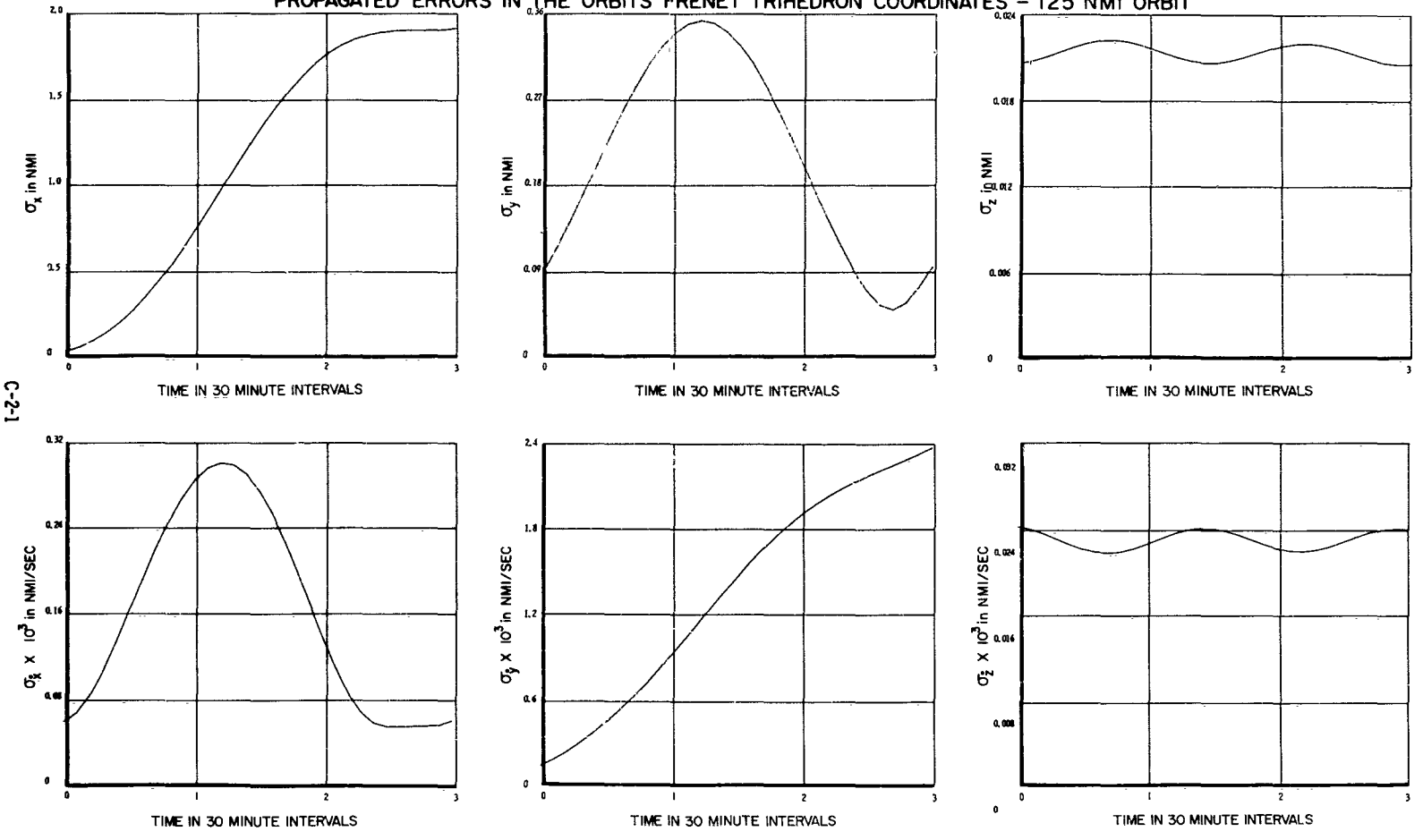
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 1 Station

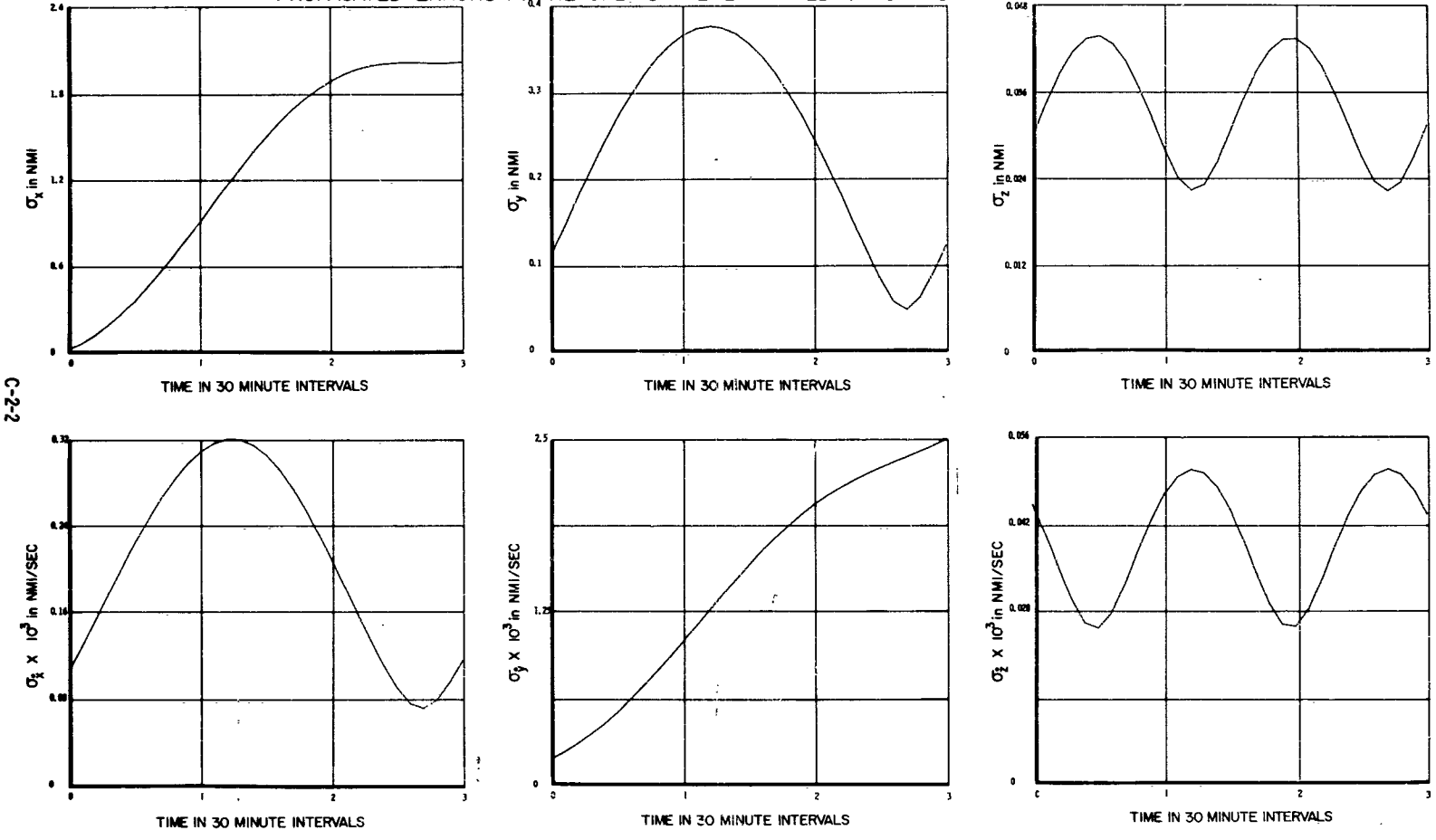
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 60° of Azimuth
Tracking From 2 Stations (45° Latitude Separation

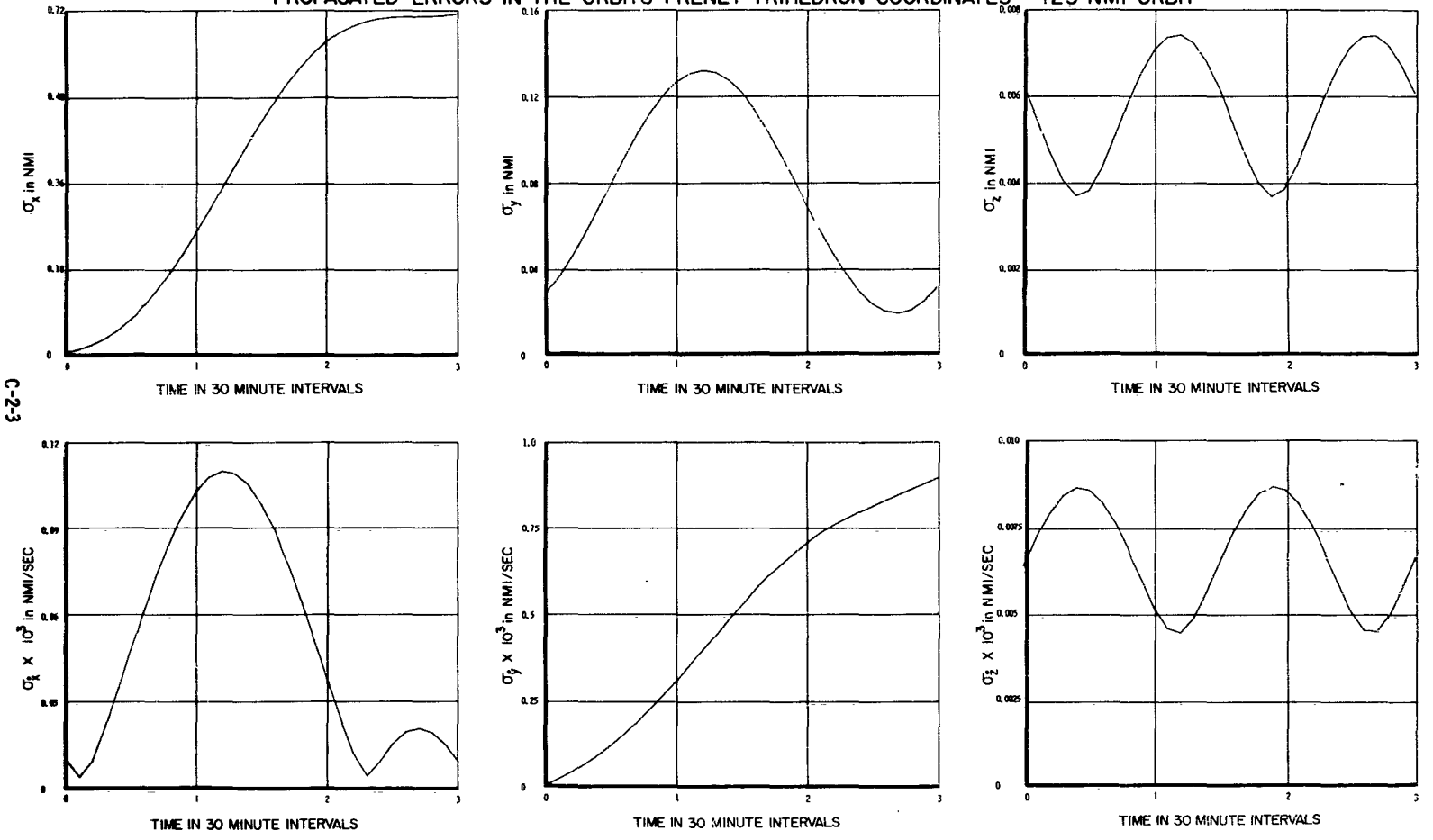
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

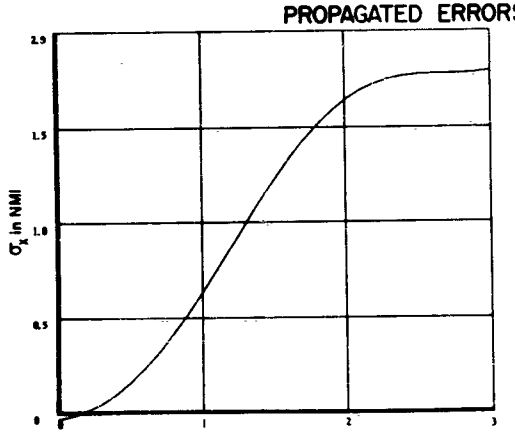
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

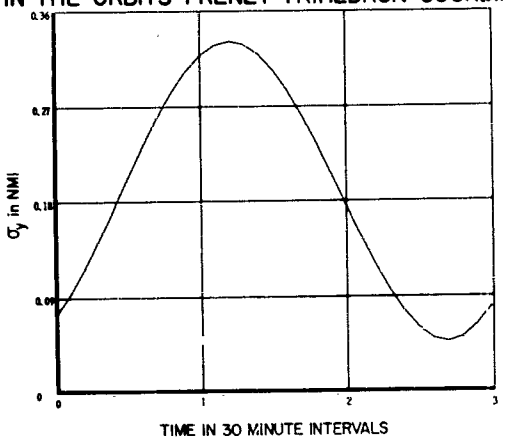


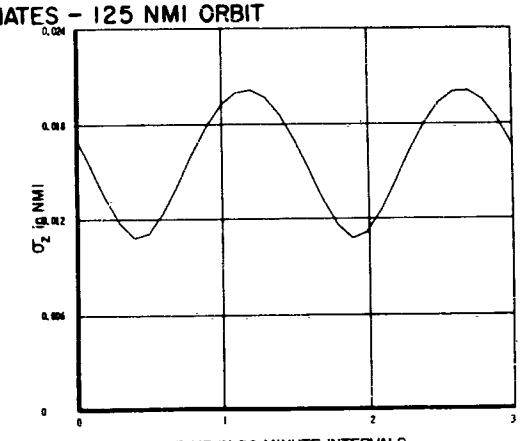
Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)

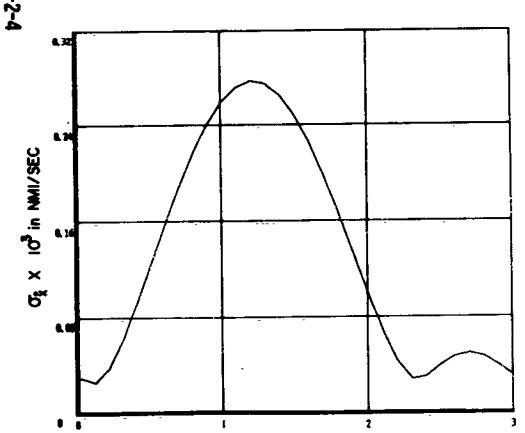
Tracking Through 60^{0} of Azimuth
Tracking From 2 Stations (45^{0} Latitude Separation)

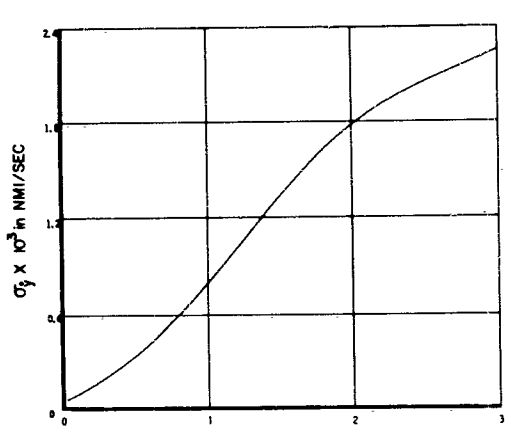
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES - 125 NMI ORBIT

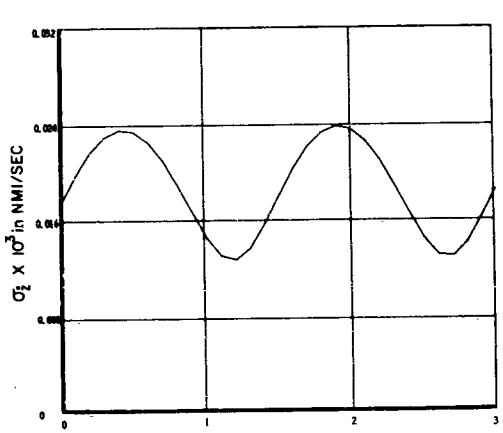










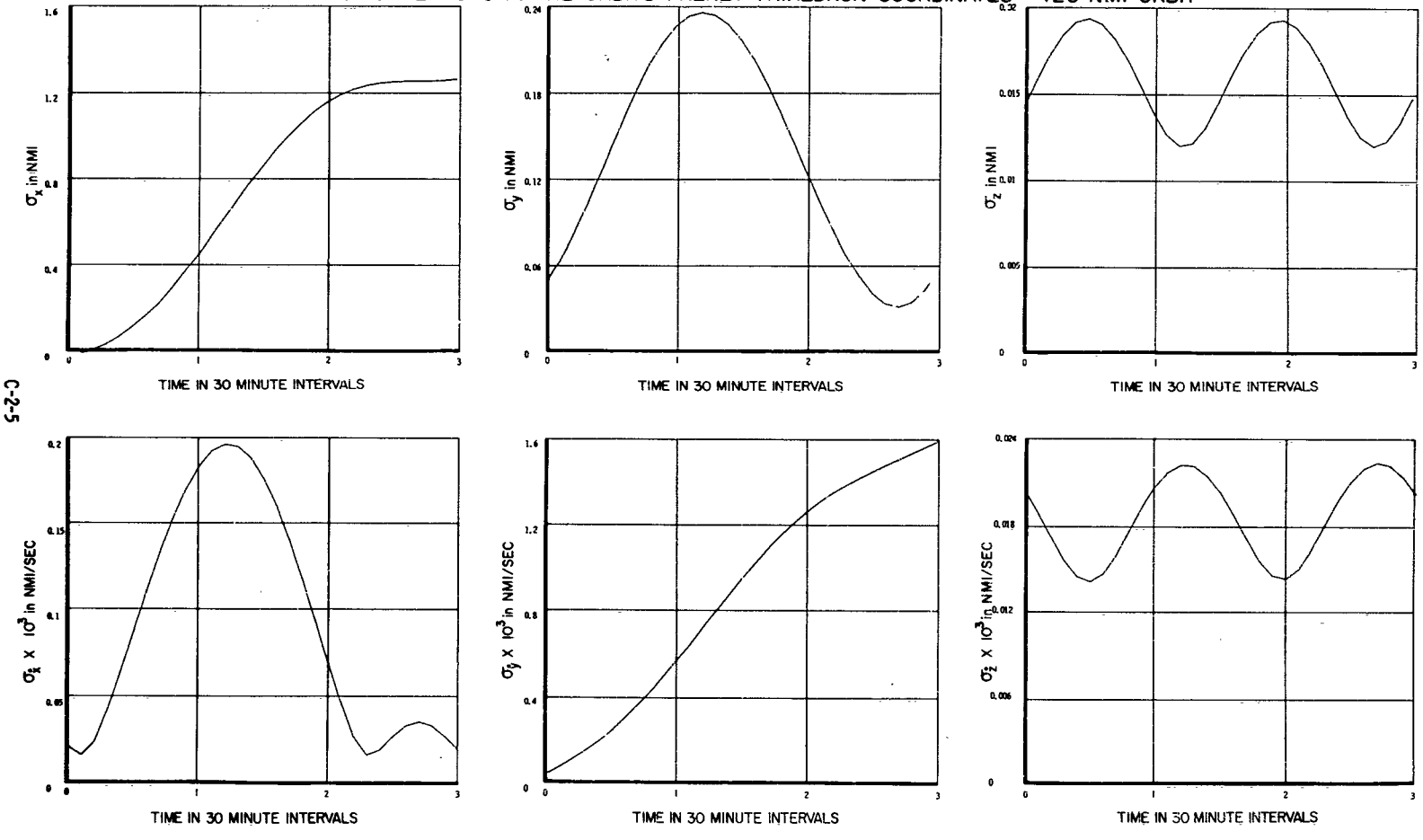


C-2-4

Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT

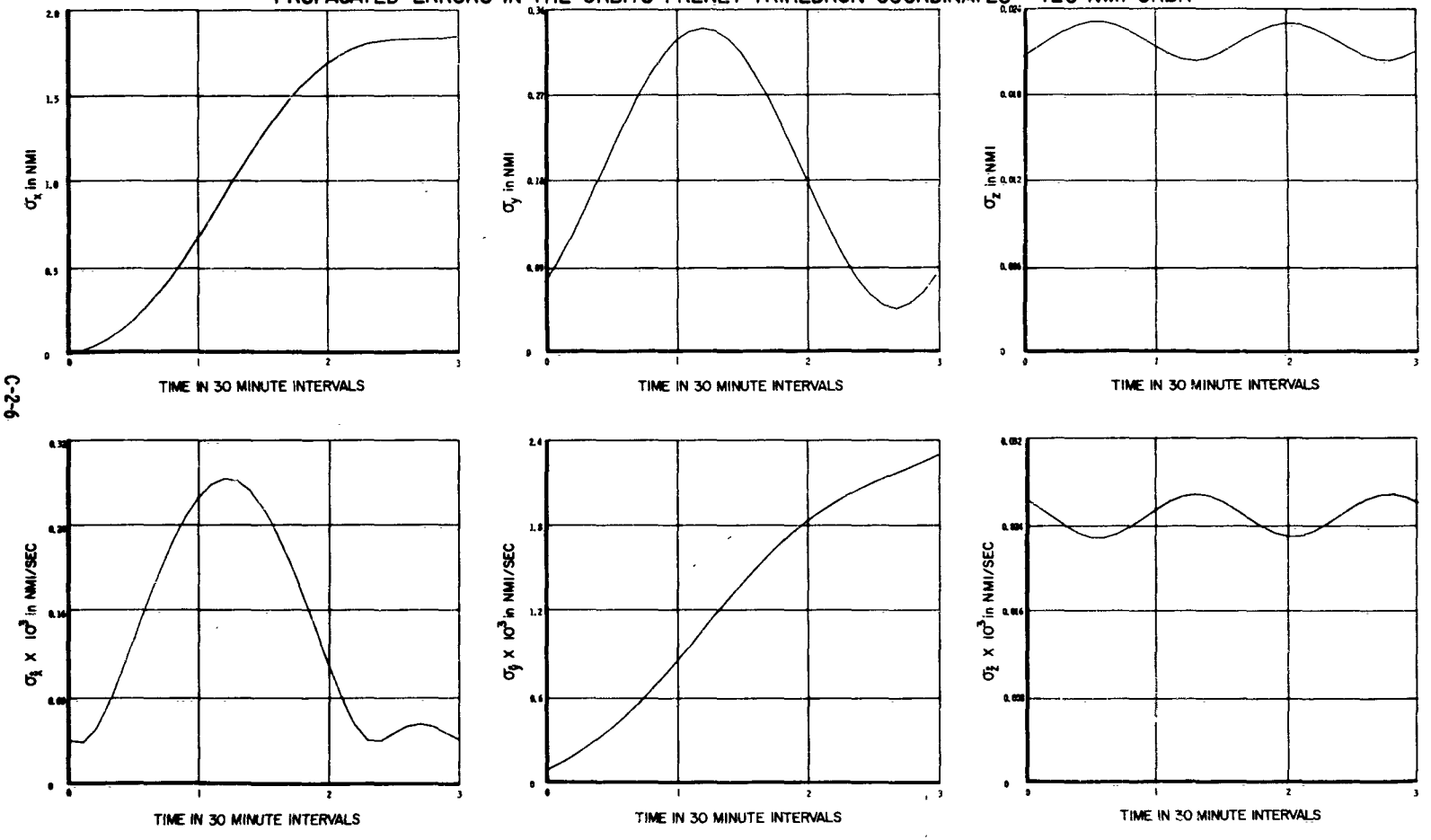


C-2-5

Sensor: Range, Range Rate and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (45^0 Latitude Separation)

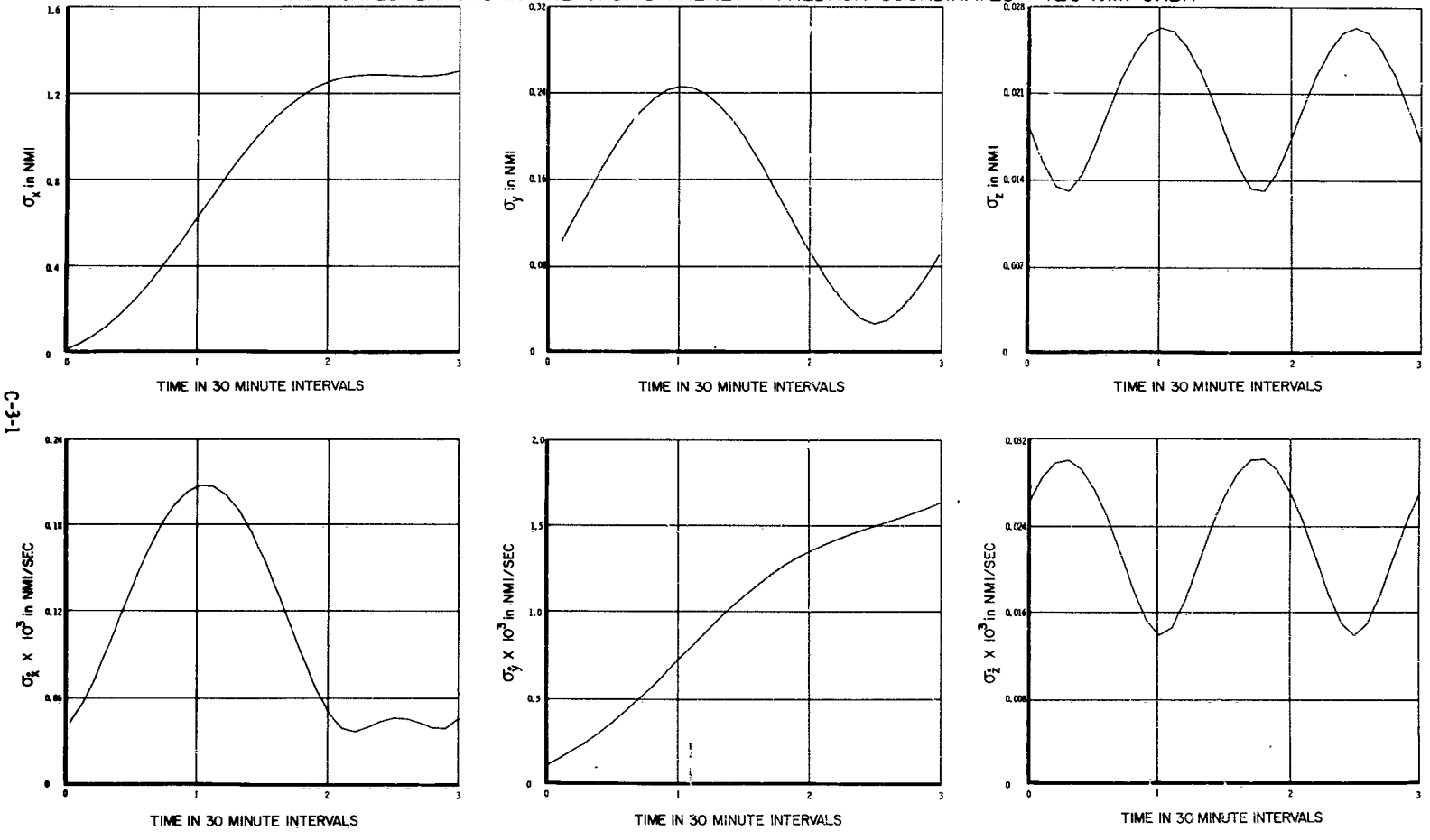
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 60° of Azimuth
Tracking From 2 Stations (45° Latitude Separation)

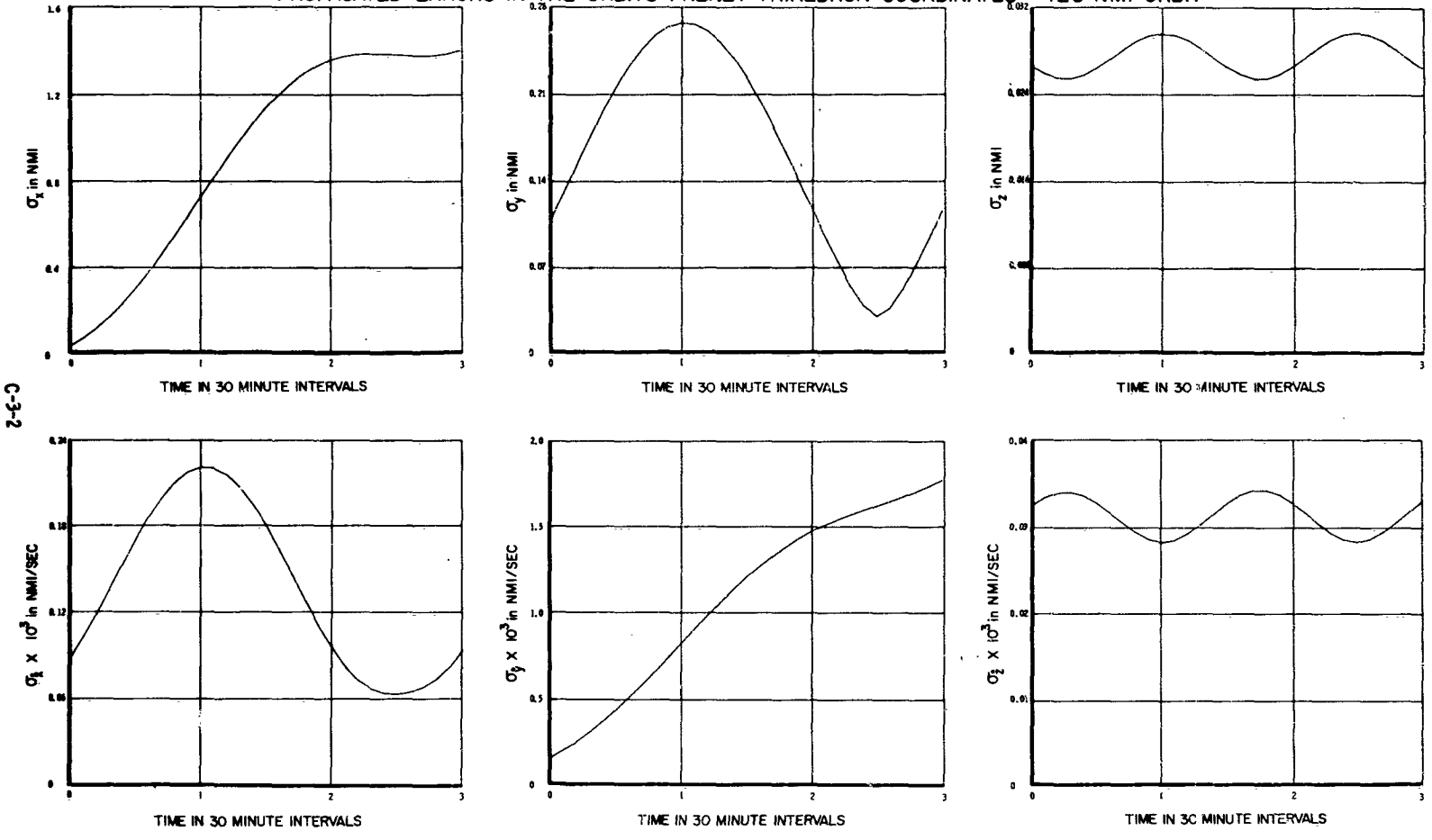
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 50 ft, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

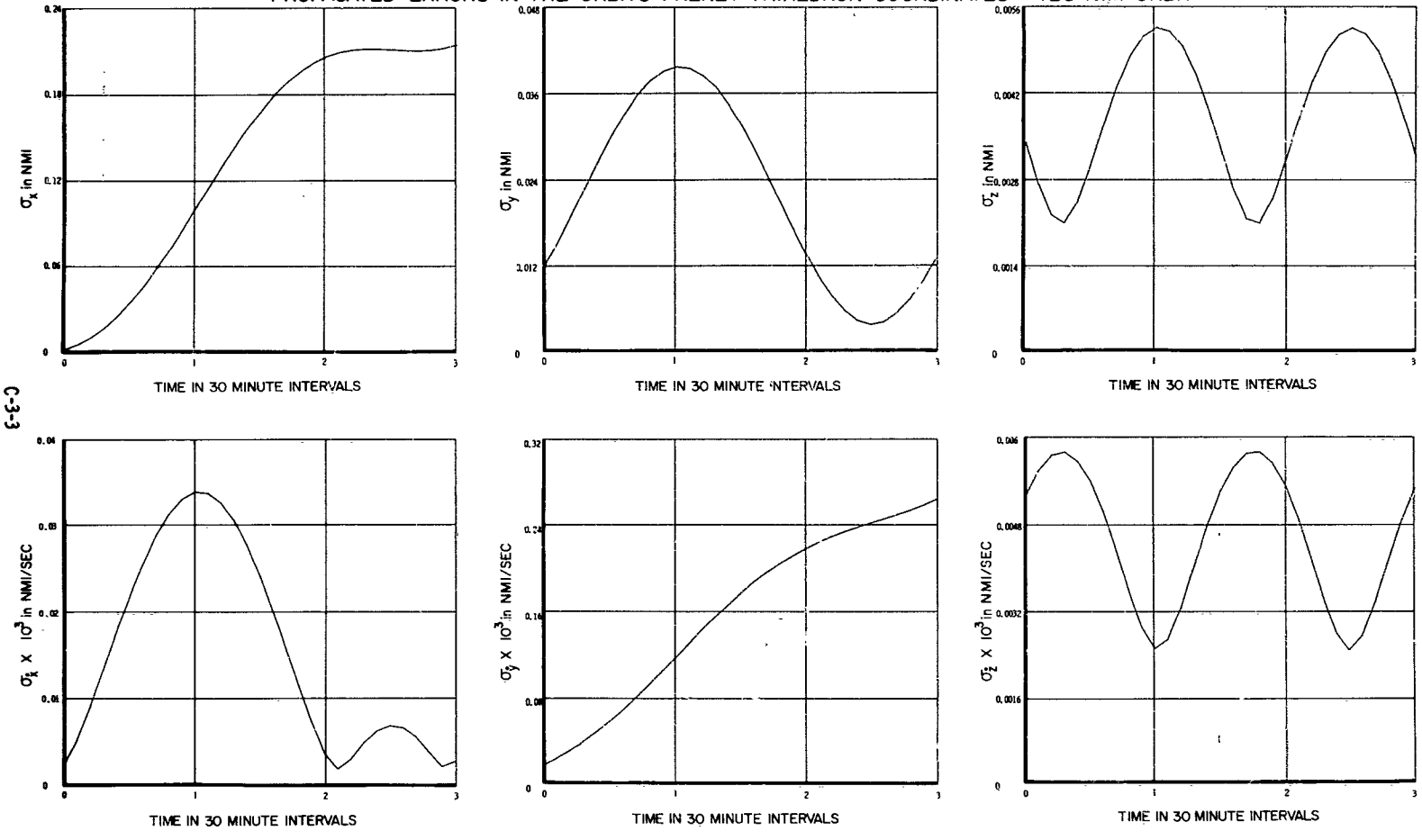
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range and Angles
Sensor Errors: 300 ft, 1 Milliradian (Random Error)

Tracking Through 60° of Azimuth
Tracking From 2 Stations (90° Latitude Separation)

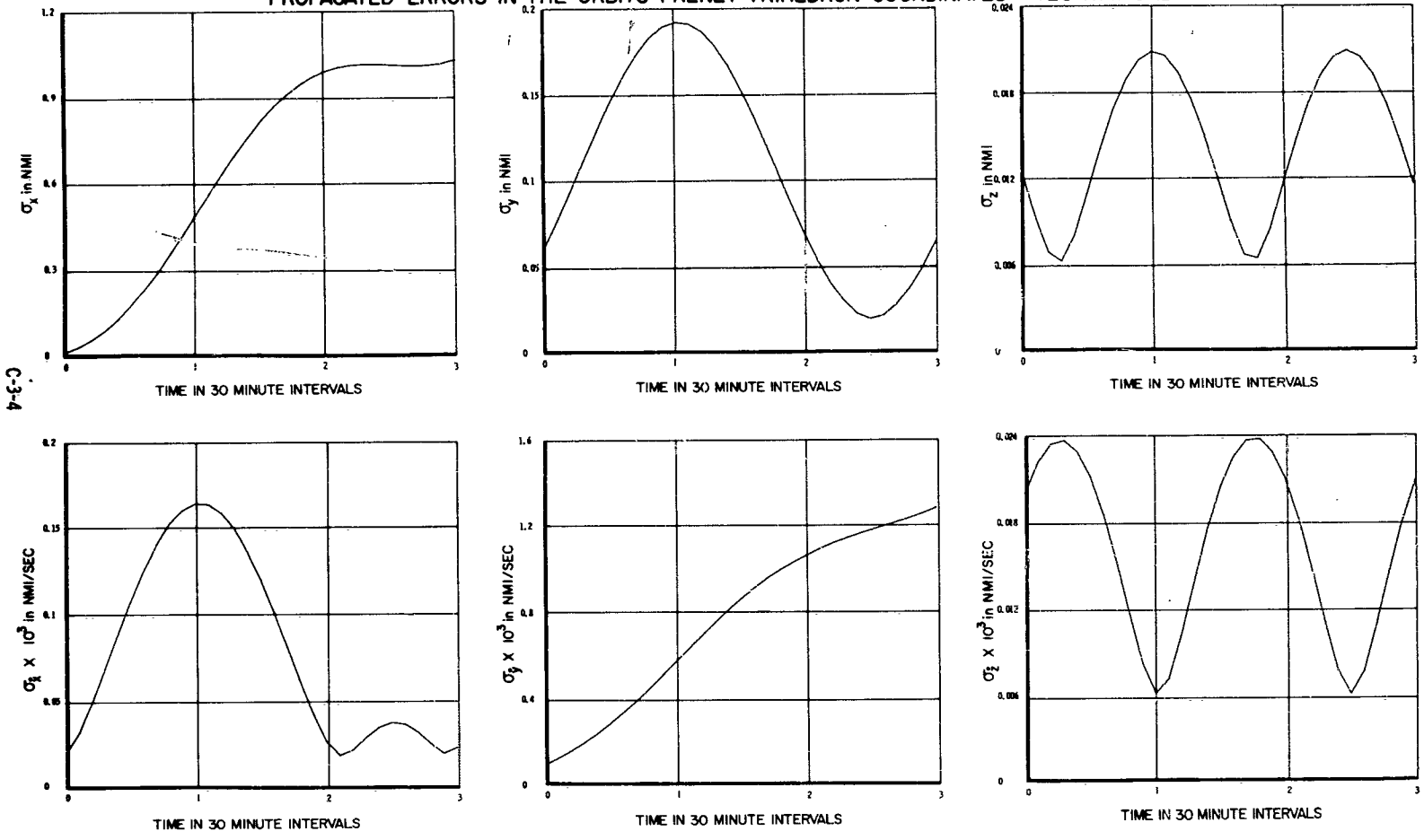
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

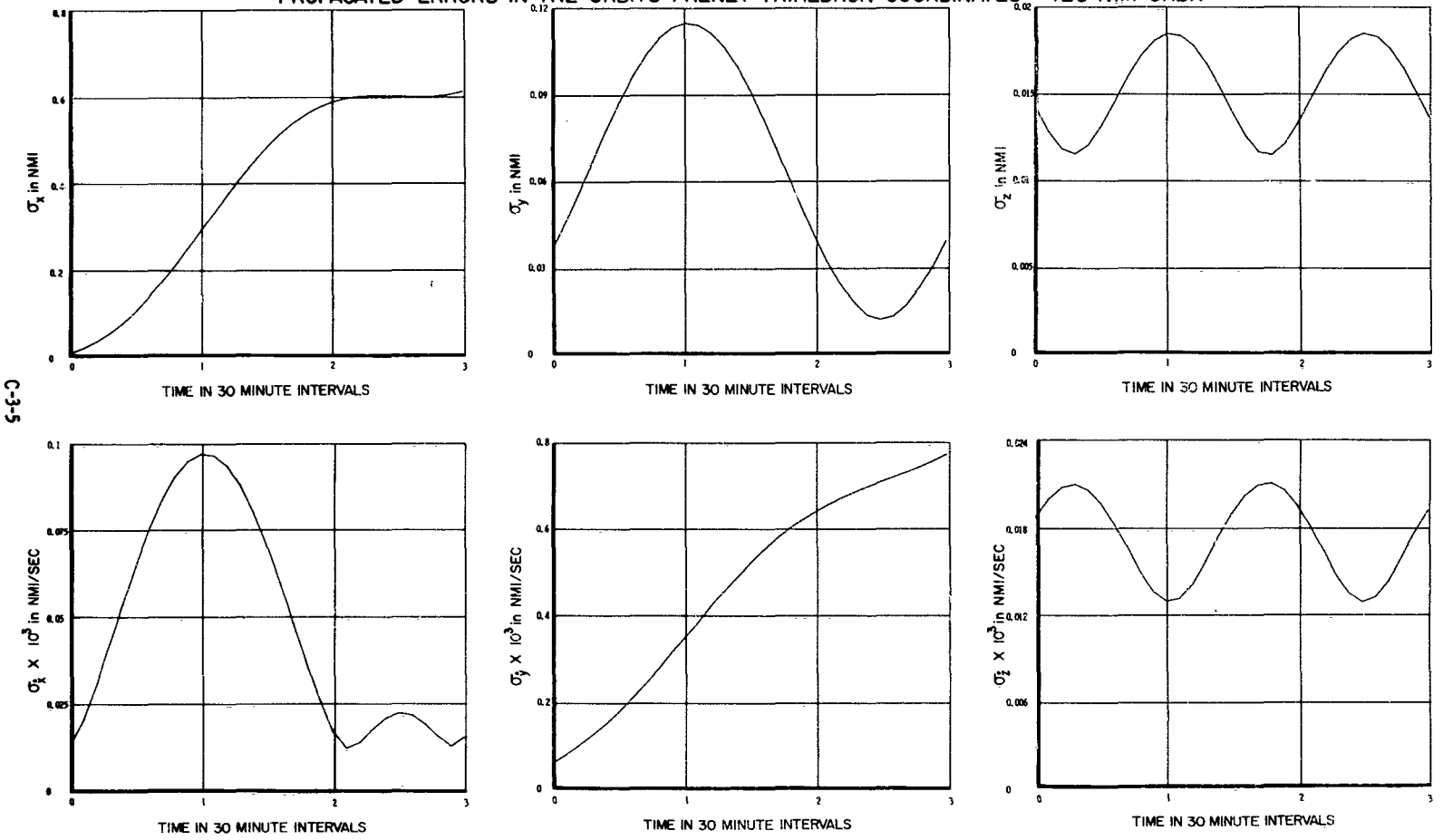
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 50 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 60° of Azimuth
Tracking From 2 Stations (90° Latitude Separation)

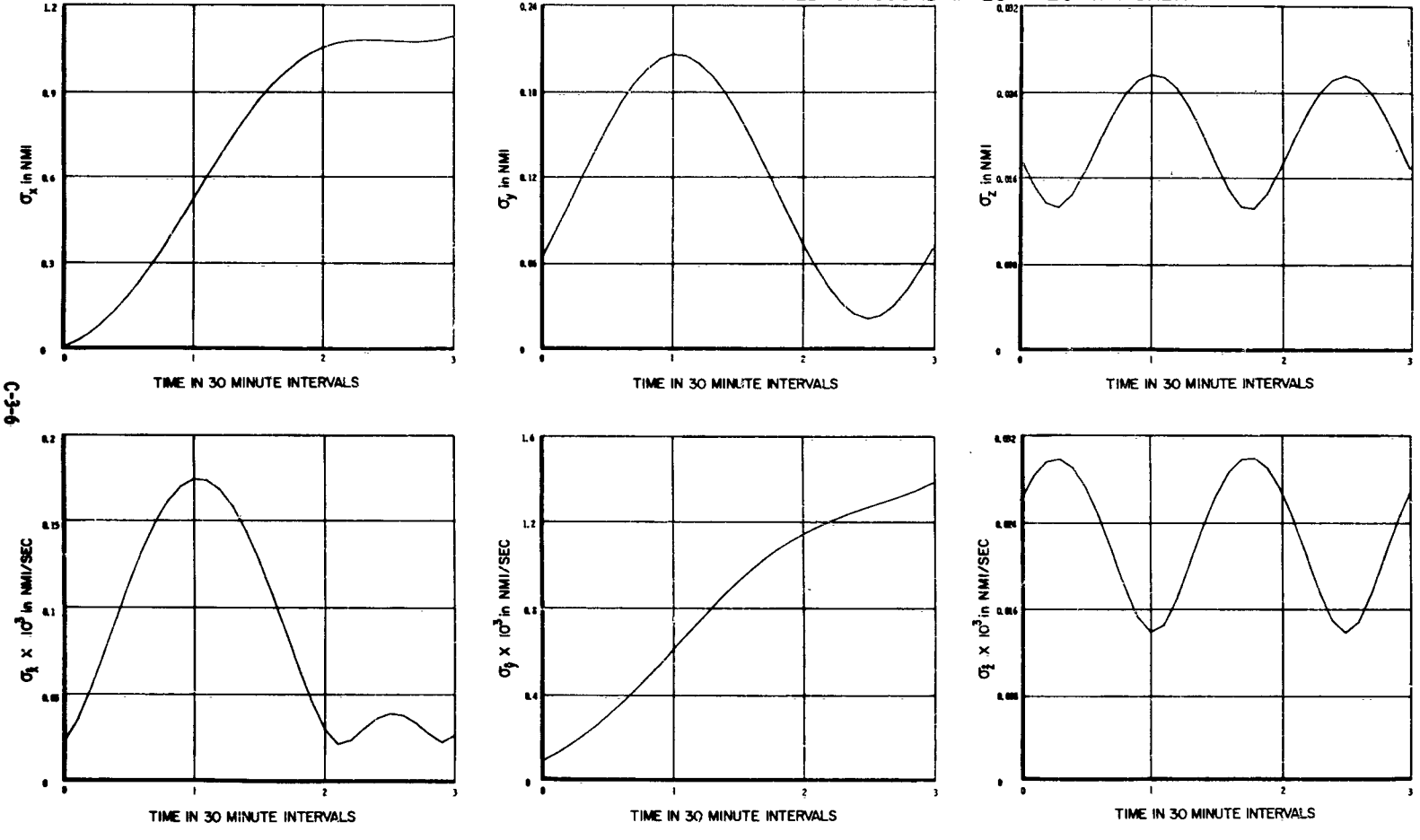
PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate and Angles
Sensor Errors: 300 ft, 0.1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

PROPAGATED ERRORS IN THE ORBIT'S FRENET TRIHEDRON COORDINATES – 125 NMI ORBIT



Sensor: Range, Range Rate, and Angles
Sensor Errors: 300 ft, 1 fps, 1 Milliradian (Random Error)

Tracking Through 60^0 of Azimuth
Tracking From 2 Stations (90^0 Latitude Separation)

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