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VOL. 1

SIGHT REDUCTION TABLES

FOR

AIR NAVIGATION

(SELECTED STARS)

EPOCH 2005.0

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FOREWORD

The *Sight Reduction Tables for Air Navigation* consist of three volumes of comprehensive tables of altitude and azimuth designed for the rapid reduction of astronomical sights in the air. The present volume (Volume **1**) contains tables for selected stars for all latitudes, calculated for the epoch of 2005.0, and replaces the previous edition calculated for the epoch of 2000.0; it is intended for use for about 5 years, when a new edition based on a later epoch will be issued. Volume **2** for latitudes 0°– 40° and Volume **3** for latitudes 39°– 89° are permanent tables for integral degrees of declination. They provide sights for bodies with declinations within 30° north or south of the equator, which includes the Sun, the Moon, the navigational planets and many of the navigational stars.

The time argument in the examples is denoted by UT (Universal Time). It is also known as GMT (Greenwich Mean Time).

Sight Reduction Tables for Air Navigation are published in the USA as Pub. No. 249 and in the UK as AP 3270. The National Imagery and Mapping Agency is responsible for the compilation and composition of these tables. The Nautical Almanac Office of the U.S. Naval Observatory and H.M. Nautical Almanac Office, Rutherford Appleton Laboratory have cooperated in their design and preparation.

The content and format of these three volumes may not be changed without the approval of Working Party 70 of the Air Standardization Coordinating Committee.

Users should refer corrections, additions, and comments for improving this product to:

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INTRODUCTION

DESCRIPTION OF THE TABLES

These tables, designated as Volume **1** of the three-volume series of Pub. No. 249, *Sight Reduction Tables for Air Navigation*, contain values of the altitude (to the nearest minute) and the true azimuth (to the nearest degree) of seven selected stars for the complete ranges of latitude and hour angle of Aries. The arrangement provides, for any position and time, the best selection of seven of the stars available for observation and, for these seven stars, data for presetting before observation and for accurate reduction of the sights after observation.

In the calculation of the altitudes and azimuths the mean places of the stars for epoch 2005.0 have been used; corrections for precession and nutation are given in Table **5**, but their omission will not give rise to a positional error greater than two miles in the years 2002–2007. No correction for refraction has been included in the tabulated altitudes, so that the full correction must be applied to the sextant altitudes.

Although Pub. No. 249 was designed for air navigation, it is also used extensively for marine navigation. The main differences in the use of Pub. No. 249 for marine navigation are highlighted at the end of this introduction. Volume **1** may be used without reference to an almanac such as *The Air Almanac* or *The Nautical Almanac*. The tables in this volume may be used with a clock, or other device, giving sidereal time. With the normal procedure of plotting a sight from an assumed position, no interpolation is required for the stars tabulated.

ENTERING ARGUMENTS AND ARRANGEMENT

Latitude. Tabulations are given for every whole degree of latitude from 89° north to 89° south. From 69° north to 69° south all data for a single latitude appear on two facing pages; from 70° to the poles, both north and south, the data for a single latitude appear on one page.

LHA Aries. The vertical argument on each page is the local hour angle of the first point of Aries (LHA ♈). It ranges from 0° to 360°; in general the interval is 1°, but between latitudes 70° and the poles it is increased to 2°.

Selected stars. The tabulated (or computed) altitude (Hc) and the true azimuth (Zn) are given for seven selected stars for each latitude and each entry of LHA ♈. The selection of stars is used unchanged for each group of 15 entries of LHA ♈ (30° for latitudes over 69°, 15° for lower latitudes); within each such group the order of arrangement is that of the azimuths corresponding to the first entry. Of each selection of seven stars, three are marked with a diamond symbol (♦) as being suitable for a three-star fix.

A total of 41 stars is used, of which 19 are of the first magnitude (brighter than magnitude 1.5) and 17 of the second magnitude. The names of first-magnitude stars are given in capital letters. A complete list of the 57 stars selected for astro-navigation is given in the front of this volume, and an asterisk is printed beside those stars not used within. The adopted names and numbers agree with those used in *The Air Almanac*. The S-4 magnitudes are applicable to astro-trackers employing S-4 photo-sensitive response.

Many factors were considered in selecting the stars, including azimuth, magnitude, altitude and continuity. Continuity was sought in regard to both latitude and hour angle, particularly for latitude where changes are not immediately evident by inspection.

USE OF THE TABLES

The tables are intended for use for two distinct operations—the planning of observations, and their reduction. It is important that full use should be made of the tables for the planning of observations.

Planning of observations. Since only seven stars are given it is essential to refer to the tables before observation, in order to ensure that data will be available for the reduction of the observations. This is done by estimating latitude and LHA ♈ for the proposed time of observation, from a knowledge of the DR position and GHA ♈ from Table **4** or an appropriate almanac, such as *The Air Almanac* or *The Nautical Almanac*. On reference to the tables this information gives immediately the seven stars available, together with their approximate altitudes and azimuths. From these seven stars, the observer can select those which best suit his particular purpose and the prevailing conditions; the approximate altitudes and azimuths make identification easy, and enable the sextant to be preset to the approximate altitude.

Example. On 2003 January 1, a navigator proposes to observe at $12^h 22^m$ UT in DR position N54° 15′, E175° 30′.
From Table **4**, for 2003 January 1, (a) = 100° 14′, for 12^h UT on day 1, (b) = 180° 30′, and for 22^m, (c) = 5° 31′.
The sum, (a) + (b) + (c) = GHA ♈ for 2003 January 1 at UT $12^h 22^m$.

	°	′
GHA ♈ =	286	15
Longitude, added if east, subtracted if west =	+175	30
Sum, with multiples of 360° removed as necessary LHA ♈ =	101	45

Reference to page 52 for Lat. 54° N, LHA ♈ 102° shows that the selected stars are *Dubhe* (azimuth 051°), ♦*REGULUS* (117°), *PROCYON* (163°), *SIRIUS* (181°), ♦*RIGEL* (206°), *Mirfak* (284°), and ♦*DENEB* (340°), all being at convenient altitudes between 12° and 59°. No change in the selection will take place for about 50 minutes before or 10 minutes after the time proposed, but if the observations are delayed, *PROCYON* and *DENEB* will be replaced by *Denebola* and *ALDEBARAN*; the same stars are used for latitude 55°, though *Hamal* and *Schedar* replace *Mirfak* and *DENEB* in latitude 53°. The navigator will accordingly plan his program of observations from among these stars, bearing in mind that it is only one day before New Moon. It should be noted that this preliminary calculation of LHA ♈ may often be modified to serve as a basis for the reduction of the sights, without further reference to Table **4** or an almanac.

If observations are made of stars other than those selected, they can be reduced by the use of Volumes **2** and **3** of these tables, provided the declinations are less than 30° north or south. A list of such stars, with their positions, is given in those volumes as well as being indicated in the star lists in *The Air Almanac*. Observations of other stars must be reduced by other methods or tables.

Reduction of sights. GHA ♈ is taken from Table **4** or an appropriate almanac, such as *The Air Almanac* or *The Nautical Almanac* for the actual time of observation and combined with an assumed longitude, close to the DR longitude, to make LHA ♈ a whole degree, or an even degree for latitudes above 69°. The tables are entered with the whole degree of latitude nearest to the DR latitude, the value of LHA ♈ found above, and the name of the star observed; they give, without interpolation, the tabulated altitude (Hc) and azimuth (Zn). The intercept is found in the usual way by comparing the corrected sextant altitude (Ho) with the tabulated altitude:

towards the star if the sextant altitude is *greater* than the tabulated altitude;
away from the star if the sextant altitude is *less* than the tabulated altitude.

The sextant reading must be corrected for instrument error, dome refraction (if applicable), and refraction (from Table **8**) before being compared with the tabulated altitude. The sight is plotted from the assumed position, defined by the whole degree of latitude and the assumed longitude. This assumed position may previously be adjusted for the effect of Coriolis (see Table **9**), advanced or retarded to another time, and (in extreme cases) shifted to allow for precession and nutation (see Table **5**); alternatively these corrections may be made to the position line or, in the case of the corrections from Tables **5** and **9**, to the final fix. The application of these corrections is considered separately on pages v and vi.

INTRODUCTION

Example. On 2003 January 1 in DR position N54° 17′, E175° 46′ at height 9,000 ft. (3 km), an observation of *PROCYON* is obtained at $12^h\ 21^m\ 25^s$ UT; the sextant reading is 40° 34′ and the correction for the instrument error and dome refraction is –4′.

		°	′		°	′	
From Table **4**, for 2003 Jan 1	(a) =	100	14	Sextant altitude	40	34	
for 12^h UT on day 1	(b) =	180	30	Dome refraction, etc.		–4	
for $21^m\ 25^s$	(c) =	5	22	Refraction (Table **8**)		–1	
Sum, GHA ϒ for UT $12^h\ 21^m\ 25^s$	GHA ϒ =	286	06	Corrected Sextant altitude (Ho)	40	29	
Assumed longitude, added because east		+175	54	From the main tables (page 52)			
Sum, less 360°	LHA ϒ =	102		Tabulated altitude (Hc)	40	06	Az. (Zn) 163°
				Intercept		23	*towards*

The assumed latitude is N54°, the assumed longitude is E175° 54′, and the intercept of 23′ is plotted from this position in true bearing 163°. The position line is drawn perpendicular to this direction.

Usually, sights of several stars will be taken in rapid succession to give a fix. The example below illustrates the use of tables for the reduction of a typical set of observations.

Example. On 2003 January 1, in DR position N45° 49′, W25° 35′ (for $23^h\ 47^m$ UT) at height 3,000 ft. (1 km), sights are taken as follows:

Star	UT			Sextant altitude		Instrument error, etc.
	h	m	s	°	′	′
Dubhe	23	44	15	37	43	–5
RIGEL	23	47	33	35	55	–5
Alpheratz	23	51	55	33	19	–6

	Dubhe					*RIGEL*					*Alpheratz*				
	UT			GHAϒ		UT			GHAϒ		UT			GHAϒ	
From Table **4**:	h	m	s	°	′	h	m	s	°	′	h	m	s	°	′
For Jan 1 at 23^hUT = (a) + (b), less 360°	23			86	11	23			86	11	23			86	11
Correction for minutes and seconds (c)		44	15	11	06		47	33	11	55		51	55	13	01
Sum = GHAϒ for given UT	23	44	15	97	17	23	47	33	98	06	23	51	55	99	12
Assumed longitude, subtracted because west				–25	17				–25	06				–25	12
Sum = LHA ϒ				72					73					74	

	Altitude		Az.	Altitude		Az.	Altitude		Az.
	°	′		°	′		°	′	
Sextant altitude	37	43		35	55		33	19	
Instrument error and dome refraction		–5			–5			–6	
Refraction (Table **8**)		–1			–1			–1	
Corrected sextant altitude (Ho)	37	37		35	49		33	12	
Tables, p. 68 assumed Lat. 46° N and LHA ϒ as above; Hc and Zn	37	38	037°	35	34	173°	32	38	280°
Intercept		1	*away*		15	*towards*		34	*towards*

In this example, the assumed longitudes for all observations are taken as close as possible to the DR longitude at $23^h\ 47^m$; shorter intercepts can often be obtained by relating the assumed position to the DR position at the time of observation. The intercepts are plotted from the respective assumed positions, latitude N46°, respective longitudes W25° 17′, W25° 06′ and W25° 12′, transferred as necessary for the motion of the aircraft between the time of observation and that of the fix, for the effect of Coriolis acceleration and for precession and nutation. These shifts may be made to the position lines instead of to the assumed positions from which they are constructed, or, for the last two corrections, directly to the fix.

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USE OF CORRECTING TABLES

As indicated in the foregoing example, corrections are required for the following, in addition to refraction.

Coriolis acceleration. This correction, which is required for bubble sextant observations, is given in Table **9** on the inside back cover and may be applied either to each individual observation or to the fix reduced from several observations. When applied to individual observations, either the position line or the assumed position from which it is constructed must be shifted by the distance *Z* miles perpendicular to the track. The rule for applying this correction is given at the foot of Table **9**.

Precession and nutation. The correction in Table **5** is normally to be ignored. If, in extreme cases, it is necessary to allow for the change in the positions of the stars, the correction may be treated in the same way as the Coriolis correction and applied to the final fix, or to individual position lines or assumed positions. The correction is applicable only to sights reduced with this volume of tables.

Motion of the observer (MOO). If it is desired to get a fix from two or more observations, the resulting position lines must be reduced to a common time, usually the time of one of them. This may be done in two ways: the position lines of observations made earlier or later than this time may be transferred on the plotting chart to allow for the motion of the aircraft in the time-interval concerned, or the corrected sextant altitudes (or intercepts) may be adjusted to allow for the motion of the aircraft in the time-interval concerned.

In the first case, the shift may be applied to the position line or to the assumed position from which it is constructed.

In the second case, the adjustment to corrected sextant altitude may be taken from Table **1** on the inside front cover, interpolating where necessary. Table **1** gives, in the upper part, the correction for a time-interval of 4 minutes, while the lower part enables this to be extended to any time-interval. By reversing the sign of this correction, it may be applied to the tabulated altitude instead of to the corrected sextant altitude, or it may be applied directly to the intercept by the rules given. A small table at the foot of Table **1** gives the sign rules for applying the correction for the different cases.

Example. In the preceding example on page v the aircraft was flying at 400 knots on a track 257°T.

From Table **9** the *Z* correction is found to be 8′ and the assumed positions, position lines or the deduced fix must be shifted a distance 8 miles to the starboard (right) of track (for northern latitude), i.e. in direction 347°T.

From Table **5** the correction for precession and nutation is found to be 1 mile in direction 260°T and is to be applied similarly. Both corrections are made by construction on the plotting chart.

Corrections for the change in position of the aircraft MOO will be applied to the corrected sextant altitudes of the first and third stars, so that the fix will be obtained at the time, $23^h\ 47^m\ 33^s$, of the middle observation.

Body	Azimuth	True Track	Relative Azimuth	Table **1**	Time Interval	Correction from lower Part of Table **1** to Sext.	Correction from lower Part of Table **1** to Alt. Intercept	Adjusted Corr. Sext. Alt.	Adjusted Intercept
	°	°	°	′	m s	′	′	° ′	′
Dubhe	037	257	140	–20	+3 18	–17	17 *away*	37 20	18 *away*
Alpheratz	280	257	023	+24	–4 22	–26	26 *away*	32 46	08 *towards*

where Relative Azimuth = Azimuth – True Track, (adding 360° if necessary).

The above table is largely self-explanatory; the value for the time-interval of $4^m\ 22^s$ is found from the lower part of Table **1** by adding the correction for 4^m to that for 22^s or by doubling that for $2^m\ 11^s$. The time of fix was later than the first observation and the sign from Table **1** was –. The correction to the intercept is therefore away. The time of fix was earlier than the last observation and the sign from Table **1** was +. The correction to the intercept is therefore away.

Motion of the body (MOB). If the time of observation differs from that corresponding to the tabular value of LHA ϒ, the entry for this value may still be used if a correction for the motion of the body (due to the rotation of the Earth) in the time interval is applied to the altitude (or intercept). Table **2** provides for this correction. It enables observations made at different times to be reduced and plotted from the same assumed position, while using the same common value of LHA ϒ. Since the time to which this value of LHA ϒ corresponds is usually that at which the fix is desired, it is convenient to combine the corrections for motion of the body with those for the motion of the observer, as the time intervals are the same.

When both the tables for the changes in position of observer and body are used, the quantities taken from the upper parts of Tables **1** and **2** should be summed and the sum used in entering the lower parts of the tables, (values of the sum less than 60′ being used in the lower part of Table **1** and values greater than 60′ in the lower part of Table **2**).

Example. The second example on page v is reduced using Tables **1** and **2**, assuming that the aircraft was flying at 400 knots on track 257°T, and that the fix is required for $23^h\ 47^m$; the sights are:

Star	UT h	m	s	Sextant altitude °	′
Dubhe	23	44	15	37	43
RIGEL	23	47	33	35	55
Alpheratz	23	51	55	33	19

From Table **4**:	UT h	m	GHAϒ °	′
For Jan 1, 23^h UT = (a) + (b), less 360°	23		86	11
For 47^m, (c)		47	11	47
Sum = (a) + (b) + (c) = GHAϒ for given UT	23	47	97	58
Assumed longitude (west, subtract)			–24	58
LHA ϒ			73	

	Dubhe Altitude °	′	Az.	*RIGEL* Altitude °	′	Az.	*Alpheratz* Altitude °	′	Az.
Sextant altitude	37	43		35	55		33	19	
Instrument error and dome refraction		–5			–5			–6	
Refraction (Table **8**)		–1			–1			–1	
Corrected sextant altitude (Ho)	37	37		35	49		33	12	
Tables, p. 68 assumed Lat. 46° N, LHA ϒ 73°	38	03	037°	35	34	173°	33	19	279°
Intercept		26	*away*		15	*towards*		7	*away*

The adjustments to these intercepts, for changes in position of observer and body (MOO + MOB), are found as follows:

Star	Azimuth °	True Track °	Relative Azimuth °	Table **1** ′	Table **2** ′	Sum ′	Time Interval m	s	Corrections to Intercept ′		Adjusted Intercept ′	
Dubhe	037	257	140	–20	+25	+5	+2	45	3	*towards*	23	*away*
RIGEL	173	257	276	+3	+5	+8	–0	33	1	*away*	14	*towards*
Alpheratz	279	257	022	+25	–41	–16	–4	55	20	*towards*	13	*towards*

The time of fix was later than the time that *Dubhe* was observed. From Table **1**, the sign of MOO + MOB is +, so intercept is towards. The time of fix is earlier than the time *RIGEL* was observed, MOO + MOB is +, so intercept is away. The time of fix was earlier than the time *Alpheratz* was observed, MOO + MOB is –, so intercept is towards.

INTRODUCTION

POLE STAR TABLES

Table **6** gives the *Q* correction to be applied to the corrected sextant altitude of *Polaris*, in the same form as in *The Air Almanac*; the only difference is that it is based on the position of *Polaris* for epoch 2005.0. Refraction is not included. It should be noted that the table in *The Air Almanac* is re-calculated each year and is therefore slightly more accurate than Table **6**.

Table **7** gives the azimuth of *Polaris*, to 0.1°, for latitudes up to N70° and for all hour angles; interpolation in LHA ♈ may sometimes be necessary.

Example. On 2003 January 1 at $02^h\ 43^m\ 32^s$ UT at height 10,000 ft. (3 km), in longitude W48° 06′, an observation was made of the altitude of *Polaris*, sextant reading 54° 51′, instrument error and dome refraction –4′; the latitude is found as follows:

		°	′		°	′
From Table **4**:						
For 2003 Jan 1,	(a) =	100	14	Sextant altitude	54	51
For 02^h UT on day 1,	(b) =	30	05	Instrument error, etc.		–4
For $43^m\ 32^s$,	(c) =	10	55	Refraction (Table **8**)		–1
GHA ♈ at $02^h\ 43^m\ 32^s$ UT	GHA ♈ =	141	14	Corrected Sextant altitude (Ho)	54	46
Longitude (west, subtract)		–48	06	(Table **6**, LHA ♈ = 93° 08′)		–25
	LHA ♈ =	93	08	Latitude	54	21

A correction is theoretically necessary for precession and nutation. Table **5** indicates that the deduced position line (here a parallel of latitude) should be shifted a distance of 1 mile in direction 270°; this leaves the latitude unchanged. The position line should, of course, be shifted for Coriolis acceleration.

Entering Table **7** with the nearest latitude (N55°) and the value of LHA ♈ (93°), the azimuth of Polaris is found as 359.0°.

SPECIAL TECHNIQUES

The arrangement of the tabulations in this volume lends itself to the use of special techniques of observation and reduction, designed to save calculation and plotting or to allow for precomputation. These techniques are not fully described here, but the principles upon which they are based are given below; users will doubtless develop methods to suit their own requirements.

1. If the interval between observations is four minutes (4^m), or a multiple of 4^m, LHA ♈ need only be calculated for one of the observations, since GHA ♈ changes by 1° (to within the accuracy of these tables) in 4^m. For the remaining observations, the same value of LHA ♈ can be used and the intercepts plotted from assumed positions adjusted by the appropriate number of whole degrees of longitude; alternatively the same assumed position can be used and the values of LHA ♈ adjusted by the appropriate number of whole degrees. Since the rate of change of GHA ♈ is not exactly 1° in 4^m these procedures are most accurately used for a three-star fix when LHA ♈ is calculated for the middle observation.

For latitudes greater than 69° (for which LHA ♈ is tabulated in even degrees only) the alternative procedure may be used with an 8^m interval between observations, or with a 4^m interval providing that assumed positions are selected which differ by 1° of longitude and which, together with 1° adjustment to LHA ♈ for the 4^m interval, produce values of LHA ♈ in even degrees.

2. By making the observations at predetermined times (“scheduled shooting”), the tabulated altitudes and azimuths can be extracted beforehand and the same values used both for presetting the sextant and for the subsequent reduction of the sights.

3. All corrections, normally applied to the sextant altitude, may be applied to the tabulated altitude (with reversed signs), or to the assumed position, before an observation is made; similarly, corrections for Coriolis acceleration (Table **9**) and precession and nutation (Table **5**) may be applied to the assumed position, and the respective azimuth and its reciprocal

drawn from it before an observation is made, thus enabling the intercept to be measured off (along the azimuth line *'towards'* or its reciprocal *'away'*), and the position line to be drawn (perpendicular to the azimuth line, through the end of the intercept) very quickly after the observation.

4. GHA ϒ may, if necessary, be deduced from a suitable almanac such as *The Air Almanac* or *The Nautical Almanac*.

5. In air navigation, the correction to the intercept for the motion of the observer, MOO, is obtained from Table **1** or Alternative Table **1** using Ground Speed and Relative Azimuth for arguments. Marine navigators find that d, the Distance Made Good (in nautical miles), is more readily available than Ground Speed. Alternative Table **1** may be used to find MOO using d, and Relative Azimuth for arguments as follows: Use the column of entries for a Ground Speed of 600 knots, take the tabular value for the appropriate Relative Azimuth, multiply by d and divide by 10 (i.e., shift the decimal point one place to the left).

Example. On 2003 January 1 the DR position at $01^h\ 00^m$ UT of an aircraft flying at a height of 18,000 ft. (5 km), on track 345°T and with a ground speed of 300 knots, is S10° 55′, E47° 17′. It has been decided to use the alternative procedure given in the first special technique described above, and observations are made with an artificial-horizon sextant having no instrument error, as follows:

Star	UT			Sextant altitude	
	h	m	s	°	′
ARCTURUS	00	56	00	30	19
ACRUX	01	00	00	35	21
PROCYON	01	04	00	38	40

From Table **4**:		°	′
For 2003 Jan 1,	(a) =	100	14
For 01^h UT on day 1,	(b) =	15	02
GHA ϒ = (a) + (b)	GHA ϒ =	115	16

	ARCTURUS UT		*ACRUX* UT	GHAϒ	*PROCYON* UT	
	h m s		h m s	° ′	h m s	
	00 56 00		01 00 00	115 16	01 04 00	
Assumed longitude (east, add)				+47 44		
LHA ϒ		162° 00′		163° 00′		164° 00′

	ARCTURUS Altitude	Az.	*ACRUX* Altitude	Az.	*PROCYON* Altitude	Az.
	° ′		° ′		° ′	
Sextant altitude	30 19		35 21		38 40	
Refraction (Table **8**)	–1		–1		–1	
Corrected sextant altitude (Ho)	30 18		35 20		38 39	
Tables, p. 182 assumed Lat. 11° S and LHA ϒ as above; Hc and Zn	30 34	060°	35 12	167°	38 30	286°
Intercept	16	*away*	8	*towards*	9	*towards*

In this example, all observations are plotted from latitude S11° 00′, longitude E47° 44′, adjusted for the effect of Coriolis acceleration, precession and nutation, or these corrections may be made to the position lines or to the final fix. The correction to be applied for the effect of Coriolis acceleration (Table **9**) is 1 mile to port (left) of track (for southern latitudes), i.e. in the direction 255°T, and that for precession and nutation (Table **5**) is 1 mile in direction 290°T.

A widely used method of precomputation, not limited to a specific time-interval between observations, is illustrated in the following example. All observations are made before the desired time of fix, and the corrections from Tables **1** and **2** are applied to the sextant altitudes; thus the signs for these are used as they appear in the tables.

INTRODUCTION

Example. On 2003 January 1 at $03^h\ 00^m$ UT the DR position of an aircraft flying at a height of 30,000 ft. (9 km) is predicted to be S42° 50′, E12° 22′. The aircraft is on track 290°T, with a ground speed of 600 knots, and a three-star fix is desired for $03^h\ 00^m$ UT. The following precomputations are made before any observations are taken:

		°	′
From Table **4**:			
For 2003 Jan 1,	(a) =	100	14
For 03^h UT on day 1,	(b) =	45	07
GHA ♈ = (a) + (b)	GHA ♈ =	145	21
Assumed longitude (east, add)		+12	39
	LHA ♈ =	158	00

Entering the tables with an assumed latitude of 43° S, and LHA ♈ 158° (p. 246), it is decided to observe *SPICA*, *ACHERNAR* and *PROCYON*. The respective Hc and Zn for each star is extracted, their respective relative azimuths calculated, and the corrections from Tables **1** and **2** determined for 1 minute of time.

	SPICA		*ACHERNAR*		*PROCYON*	
	°	′	°	′	°	′
Tabulated altitude (Hc)	40	50	17	30	28	01
Azimuth (Zn)	063		204		310	
Relative Azimuth	133		274		020	
Correction for 4^m (Table **1**)		–27		+2		+38
Correction for 4^m (Table **2**)		+39		–18		–34
Combined correction for 4^m		+12		–16		+4
Combined correction for 1^m		+3.0		–4.0		+1.0

One decimal place is required in the combined correction for 1^m to avoid the introduction of errors when multiplying by the time-interval.

The combined corrections for 1^m may be obtained in a similar manner, but without the division by 4, by use of Alternative Tables **1** and **2**, altitude corrections for change in position respectively of observer and body for 1 minute of time, which are included in this volume as an additional bookmark.

After the precomputations above have been completed, observations are made with an artificial-horizon sextant having no instrument error, as follows:

Star	UT			Sextant altitude	
	h	m	s	°	′
SPICA	02	50	00	40	30
ACHERNAR	02	53	00	17	45
PROCYON	02	57	00	28	05

These observations are corrected for refraction (Table **8**), and then for the combined corrections from Tables **1** and **2** to advance each observation to $03^h\ 00^m$ UT. *SPICA* is advanced 10^m, so the correction to be applied to *SPICA* is 10 × (+3.0′) = +30′; *ACHERNAR* is advanced 7^m, so the correction is 7 × (–4.0′) = –28′; *PROCYON* is advanced 3^m, so the correction is 3 × (+1.0′) = +3′. The adjusted, corrected sextant altitude (Ho) is then compared with the tabulated altitude (Hc) for each body, and the fix is plotted in the usual manner from the one assumed position (S43° 00′, E12° 39′) which was used to calculate LHA ♈. Corrections for Coriolis acceleration (Table **9**), 11 miles to port (left) of track (for southern latitude), i.e. in direction 200°T, and for precession and nutation (Table **5**), 1 mile in direction 300°T, may be applied to the assumed position before the intercepts are plotted, to the position lines or to the fix obtained.

	SPICA			*ACHERNAR*			*PROCYON*		
	h m s			h m s			h m s		
UT	02 50 00			02 53 00			02 57 00		
	Altitude		Az.	Altitude		Az.	Altitude		Az.
	°	′		°	′		°	′	
Sextant altitude	40	30		17	45		28	05	
Refraction (Table **8**)		0			–1			–1	
Combined correction (Tables **1** and **2**)		+30			–28			+3	
Adjusted Ho	41	00		17	16		28	07	
Tables, p. 246 assumed Lat. 43° S and LHA ♈ 158°; Hc and Zn	40	50	063°	17	30	204°	28	01	310°
Intercept		10	*towards*		14	*away*		6	*towards*

SIGHT REDUCTION TABLES

FOR

AIR NAVIGATION

(SELECTED STARS)

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