

## GEN 2.7 SUNRISE/SUNSET TABLES

1. The tables on the following pages have been approved by C.A.O of IRAN. The tables include 88 aerodromes.

2. The tables are calculated for 2021.

3. Night. The hours between the end of evening civil twilight and the beginning of morning civil twilight.

*Note.— Civil twilight ends in the evening when the centre of the sun's disc is 6 degrees below the horizon and begins in the morning when the centre of the sun's disc is 6 degrees below the horizon.*

### 4. Sunrise and Sunset

4.1 Sunrise and sunset are the moment when the upper limb of the Sun appears and disappears over the local horizon. The rising and setting times are given with respect to sea level.

4.2 The times of sunrise and sunset depend on the observation date and observer's location (longitude & latitude). Sunrise and sunset are also affected by the atmospheric refraction when sunlight passes through the atmosphere.

4.3 When the sunlight from the Sun's upper edge reaches the horizon at sunrise and sunset, the actual altitude of the center of the Sun is about 50 arcminutes below a horizontal plane. About 16 arcminutes of this actual altitude is the apparent radius of the Sun. The remaining 34 arcminutes is the average amount of atmospheric refraction at the horizon.

4.4 In practice, the actual times depend on unpredictable atmospheric conditions that affect the amount of refraction at the horizon. Local topography and the height of the observer can affect the times of rise or set even more. The times computed for rise or set may be in error by a minute or more. However it is not practical to attempt to include such effects in routine. So, the times are computed precisely, then rounded off to the nearest minute.

### 5. Civil Twilight

5.1 Generally, the brightness of the sky after sunset or before sunrise correlates with the degree of solar depression, that is the angle between the sea level horizon and the center of the solar disk. Twilight is that period of dusk after sunset or dawn before sunrise during that is caused when sunlight is scattered by the upper layers of the Earth's atmosphere. The duration of twilight after sunset or before sunrise depends on time and position.

5.2 Twilight is officially divided into three periods, all of which are based simply on the distance the center of the Sun has reached below the horizon. The first of these is known as civil twilight. This occurs when the Sun is at least 6° below the horizon. The others are Nautical twilight (12°) and Astronomical twilight (18°).

5.3 Morning civil twilight begins before sunrise when the solar depression angle is 6° and evening civil twilight begins after sunset and ends when the solar depression angle is 6°. So before the morning civil twilight or after evening civil twilight artificial lighting is required for reading and for most outdoor activities and they are considered the beginning or end of night for aviation purposes, respectively.

### 6. Computation Method

6.1 "Astronomical Algorithms" by Jean Meeus used to calculate the times. This Book is based on the semi-analytic planetary theory VSOP87.

6.2 VSOP87 was developed by the scientists at the Bureau des Longitudes in Paris, France and presented as FORTRAN program.

6.3 The VSOP87 theory can be described as a long-term mathematical model of the solar system. It is a useful and advanced astronomy tool that allows us to compute with considerable accuracy where the Sun and planets at any given moment over spans of thousands of years.

6.4 There are six different versions of the theory VSOP87 which may be recognized by the type of coordinates and the reference frame.

6.5 J. Meeus uses a truncated version of VSOP87D in his book. The reference frame is defined by the dynamical equinox and ecliptic J2000 (JD2451545.0) for the main version VSOP87 and ecliptic of the date. The main version of VSOP87 defines elliptic variables as a function of time.

6.6 The VSOP data is organized a sets of periodic and Poisson series.

6.7 The calculations are based on the time in Julian centuries after the J2000 epoch. This method yields sun positions to within 1 arc second (1/3600 degrees). Then, we can use the definitions were explained for computing the times.

## 2. Alphabetical index

Sunrise/sunset tables of the following aerodromes contained in AIS website (<https://ais.airport.ir>)

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