5.0 TRACKING PROCEDURES FOR DIRECTIONAL ANTENNAS USED TO ACQUIRE DATA FROM REAL TIME TRANS-MISSIONS SYSTEM SENSORS

All operators of satellite stations designed to receive any type of direct readout transmission from polar orbiting satellites need to know the satellite's position in time and space in order to know when to operate their equipment and to permit them to geographically locate the received data. Operators of stations using directional antennas also need this information to determine antenna pointing angles, although this is not required of stations using fixed, omnidirectional antennas.

One of the primary sources of information concerning a satellite's position in time and space is the TBUS predict bulletin. These bulletins are issued daily for all NOAA satellites, both polar orbiting and geostationary. The information in the bulletin can be used in a variety of computer programs (or hand plotted, using graphical techniques) to determine the antenna azimuth and elevation angles necessary to follow a polar orbiting satellite passing within receiving range of a given station. In advanced satellite receiving systems, the output can provide commands to directly drive the antenna aiming hardware. The content and primary sources of the TBUS bulletin are described in Sections 5.1 and 5.2. Alternate sources and forms of satellite prediction information are identified in Section 5.2.

The code form of the TBUS bulletin, an example of an actual bulletin, and a decoding exercise are given in Appendix A.

5.1 TBUS BULLETIN

The TBUS bulletin contains information on satellite equator crossing times and longitudes, orbit numbers, orbital period, longitudinal time, and longitudinal increments between successive orbits; also, satellite positions at two-minute intervals (for a reference orbit), transmission frequencies, and other information related to satellite tracking and performance. The orbital information is valid for the third day **after** the date on which the bulletin is prepared and transmitted.

The bulletins are prepared by NESDIS and transmitted through the National Weather Service Telecommunications Gateway (KWBC) to major meteorological centers and relay points around the world, which comprise the Global Telecommunications Service (GTS). The GTS primarily serves the international meteorological community. However, the TBUS bulletin receives further distribution via the Internet, electronic mail, high frequency radio broadcasts and commercial data services.

There are two forms of the TBUS bulletin. One form, identified as TBUS-1, is used to convey information about satellites that are descending in daylight (traveling north-to-south on the sunlit portion of the orbit). The second form, TBUS-2, provides data for satellites that are ascending in daylight (northbound on the sunlit portion of the orbit).

A schematic representation of the TBUS-1 and TBUS-2 bulletins is shown in Figure 5.1-1.

Both bulletins consist of four parts. Part 1 is quite short. It identifies a reference orbit on a given day (three days after the date of the bulletin) and gives the equator crossing time and longitude for this reference orbit. This is followed by an orbital nodal period and a longitudinal increment--the separation between successive equator crossings, measured in degrees. The orbit number of the fourth and eighth orbits following the reference orbit are then listed along with the equator crossing times and longitude of these orbits.

By itself, Part 1 contains sufficient information to permit the user to calculate future equator crossing times and longitudes several days in advance with considerable accuracy. During periods of maximum solar activity, however, the accuracy extrapolated from Part 1 information diminishes if the extrapolations are carried much more than a week ahead.

Parts II and III of the bulletins are quite lengthy. Part II (Day) contains predicted subpoint and height data at two-minute intervals for the portion of the orbit that is sunlit north of the equator. Part III (Day) contains predicted subpoint and height data at two-minute intervals for the portion of the orbit in darkness north of the equator. Part III (night) contains predicted subpoint and height data at two-minute intervals for the portion of the orbit in darkness south of the equator. All times are referenced to the ascending node (northbound equator crossing) and are given as minutes after or before this time (refer to Figure 5.1-1).

Part IV is relatively short, and usually consists of four items: a code group, transmission frequencies of each operating direct readout sensor system, the on-board clock variations and remarks. The code group consists of orbital parameters used to generate parts I through III. It is intended for use by those station operators needing more precision in satellite tracking and having appropriate computer programs to ingest such data and produce both equator crossings and antenna pointing angles.

The remarks in Part IV are in plain language and advise of problems or changes in the mode of operating the satellite, including the AVHRR/3 channels selected for the APT transmissions. Direct readout transmission frequencies are discussed elsewhere; in summary, the APT service for NOAA KLM will utilize 137.50 or 137.62 MHz; the HRPT will transmit on 1698.0 or 1707.0 MHz (1702.5 MHz is available for standby); the DSB beacon will operate on 137.35 or 137.77 MHz.

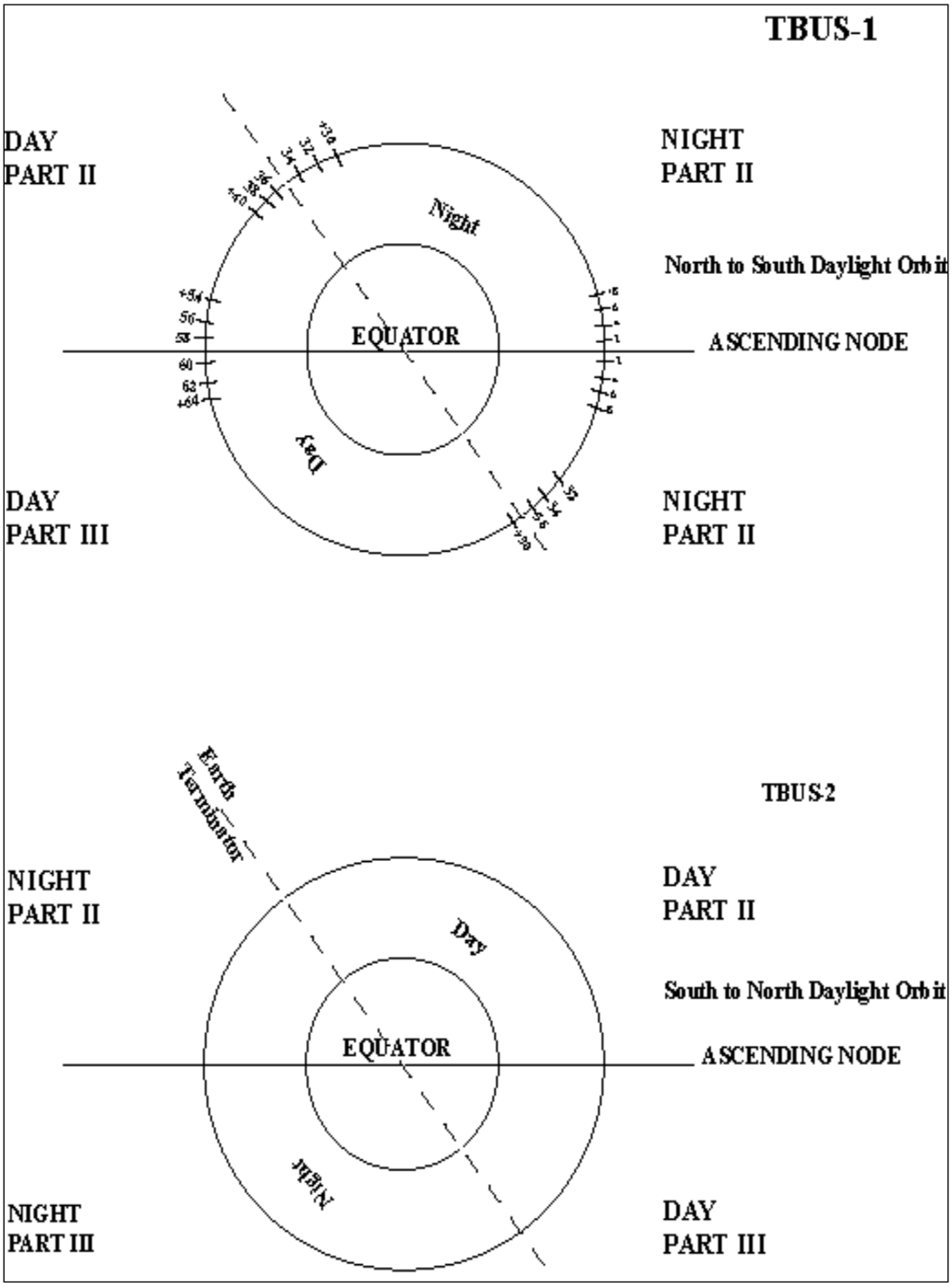

Figure 5.1-1. Schematic representation of TBUS-1/TBUS-2 information.

5.2 ALTERNATE SOURCES AND FORMS OF SATELLITE PREDICTION POSITION INFORMATION

The primary source for orbital prediction information for NOAA operated satellites is directly from NOAA via the Global Telecommunications System (GTS) and the Internet, and the main form of this information is the TBUS bulletin. .

These alternate sources include, but are not limited to, WEFAX broadcasts from U.S. geostationary satellites, electronic mail, telephone bulletin board systems, high frequency radio broadcasts, commercial environmental data providers, and the Aeronautical Fixed Telecommunications Network (AFTN).

NOAA maintains an Internet site (the NOAASIS) that always has the current TBUS bulletins. The TBUS bulletin is also broadcast once daily as part of the WEFAX transmission from U.S. geostationary satellites, for stations within range and with the proper receiving equipment.

With the proper receiving equipment r, some station operators are able to intercept the GTS radio-teletype (RTTY) meteorological transmissions containing the TBUS message. A number of major communications centers on the GTS relay this information via radio-teletype, especially for the use of ships on the high seas. Potential users would have to contact the nearest major center for frequencies and schedules.

In Africa and parts of the Middle East, a number of government meteorological services receive the TBUS bulletin as part of the Meteorological Data Distribution (MDD) broadcast via the METEOSAT geostationary satellite. Satellite readout station operators without other sources of orbital information are urged to contact an office of their national meteorological service to see if arrangements can be made to obtain copies of these messages.

The nonprofit, Radio Amateur Satellite Corporation (AMSAT) and its affiliates around the world serving the amateur radio community, broadcast the two line element messages daily via packet radio teletype. These broadcasts can be received in many parts of the world.

As of mid-1995, the U.S. Coast Guard included the TBUS message in high frequency, radio teletype broadcasts directed at the eastern and central North Pacific Ocean.

A more complete list of satellite navigation sources and points of contact is included in Appendix E.

Apart from the TBUS messages, the other most common form for transmitting orbital information is the two-line element (TLE) messages. These have the advantage of being very compact, and can be incorporated into many computer programs which will produce accurate satellite tracking and gridding information. The two-line, mean Keplerian orbital elements are derived from the NORAD SGP4 (Simplified General Perturbation) model. While similarly named elements appear in both the two-line and TBUS messages, the values are not

interchangeable between systems to compute satellite tracks using the TBUS or NORAD two-line elements. Doing so will result in large errors. Details on decoding the two-line element messages appear in Appendix A.

5.2.1 SOURCES OF ORBITAL INFORMATION FOR NOAA POLAR ORBITING SATELLITES

5.2.1.1 Internet

The NOAA Satellite Information System (NOAASIS) web site is a central location for finding information about NOAA environmental satellites (GOES and POES). Information is provided by various contributors within the National Environmental Satellite, Data, and Information Service (NESDIS) and the external satellite community. This site provides information of particular interest to users who operate their own direct readout receiving stations.

The NOAASIS is operated by the Satellite Product and Services Division, Direct Services Branch, within the Office of Satellite and Product Operations (OSPO). In addition to providing assistance to the global direct readout community, the Data Services Branch has responsibilities for Search and Rescue Satellite-Aided Tracking (SARSAT) and the GOES and Polar Data Collection Systems (LRIT, GOES DCS, Argos DCS).

URL: http://noaasis.noaa.gov/NOAASIS/

For further information, contact NESDIS via email at SPSD.Userservices@noaa.gov, or
Phone: 301-817-4521/4523
Fax: 301-817-3904
Mail:

Direct Readout Services Coordinator
Satellite Products and Services Division

NSOF (E/SPO53)
1315 East-West Hwy
Silver Spring, MD 20910-3282 USA

Celestial World Wide Web site

Operated by T. S. Kelso and has two-line elements only for all NOAA satellites, and many other satellites.

URL: http://www.celestrak.com

5.2.1.2 Telephone Bulletin Board Systems (BBS)

This service is obsolete.

5.2.1.3 Amateur Radio Transmissions

The content of the information is obsolete and has been removed.

5.2.1.4 Commercial On-Line Services

The content of the information is obsolete and has been removed.