GOES N Series
Data Book

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Foreword

The multimission Geostationary Operational Environmental Satellite (GOES) program is a key element in National Oceanic and Atmospheric Administration (NOAA) operations. GOES weather imagery and quantitative sounding data offer a continuous and reliable stream of environmental information used to support weather forecasting, severe storm tracking, and meteorological research. Evolutionary improvements in the geostationary satellite system since 1974 (i.e., since the first Synchronous Meteorological Satellite, SMS-1) have been responsible for making the current GOES system the basic element for U.S. weather monitoring and forecasting. Spacecraft and ground-based systems work together to accomplish the GOES mission.

GOES aids activities ranging from severe storm warnings to resource management and advances in science. GOES data adds to the global community of knowledge, embracing many civil and government environmental forecasting organizations that work to benefit people everywhere and help save lives.

The GOES-NOP satellites (sometimes referred to as the GOES-N series) are built by Boeing Satellite Systems Inc (subsequently referred to as Boeing) for NOAA, under the technical guidance and project management of the National Aeronautics and Space Administration's (NASA's) Goddard Space Flight Center, Greenbelt, MD.

GOES-13 (formerly GOES-N) was successfully launched on May 24, 2006 and handed over to NOAA on January 24, 2007 at 105 degrees west longitude. GOES-O and GOES-P continue the improved image navigation and registration, additional power, fuel lifetime capability, space weather, solar X-ray imaging, search and rescue, and communication services being provided by GOES-13.

Designed to operate in geosynchronous orbit, 35,790 km (22,240 statute miles) above the equator, thereby remaining stationary relative to the earth's surface, the GOES-NOP satellites continuously view the continental United States, neighboring environs of the Pacific and Atlantic Oceans, and Central and South America. The three-axis, body-stabilized spacecraft design enables the sensors to "stare" at the earth and thus more frequently image clouds, monitor earth's surface temperature and water vapor fields, and sound the atmosphere for its vertical thermal and vapor structures. Thus the evolution of atmospheric phenomena can be followed, ensuring real-time coverage of

short-lived dynamic events that directly affect public safety, protection of property, and ultimately, economic health and development.

The GOES-NOP satellites are the principal observational platforms for covering dynamic weather events and the near-earth space environment for the first decades of the 21st century. These advanced spacecraft enhance the capability of the GOES system to continuously observe and measure meteorological phenomena in real time, providing the meteorological community and scientists with improved observational and measurement data of the Western Hemisphere. In addition to short-term weather forecasting and space environmental monitoring, these enhanced operational services also improve support for atmospheric science research, numerical weather prediction models, and environmental sensor design and development.

The main mission is carried out by the primary payload instruments, the Imager and the Sounder. The Imager and Sounder are Government-furnished equipment (GFE) manufactured by ITT Industries, Inc. The Imager is a multichannel instrument that senses radiant energy and reflected solar energy from the earth's surface and atmosphere and produces visible and infrared images of earth's surface, oceans, cloud cover, and severe storm developments, providing the familiar weather pictures seen on television newscasts every day. The Sounder provides data for vertical atmospheric temperature and moisture profiles, surface and cloud top temperature, and ozone distribution. Sounder data are also used in computer models to produce mid- and long-range weather forecasts. The Imager and Sounder feature flexible scans for small-scale area viewing in regions of the visible and infrared spectrum allowing meteorologists to improve short-term forecasts. GOES provides nearly continuous imaging and sounding, which allow forecasters to better measure changes in atmospheric temperature and moisture distributions and hence increase the accuracy of their forecasts. GOES information is used for a host of applications, including weather, ocean, climate, cryosphere, land, and hazards. The GOES-O and GOES-P Imagers have improved resolution in the 13 micrometer channel from 8 km to 4 km. The finer spatial resolution allows an improved cloud-top product, height of atmospheric motion vectors and volcanic ash detection.

A new Solar X-ray Imager (SXI), GFE manufactured by Lockheed Martin, will monitor the sun's X-rays for the early detection of coronal mass ejections and solar flares. This early warning is important because these solar flares affect not only the safety of humans in high-altitude missions, such as the Space Shuttle and International Space Station, but also military and commercial satellite communications.

The GOES-NOP satellites also carry space environment monitoring instruments, built by Assurance Technology Corporation (formerly Panametrics Inc.), which monitor X-rays, extreme ultraviolet and particle emissions including solar protons, alpha particles, and electrons. These space environment monitoring instruments also include a magnetometer, built by Science Applications International Corporation (SAIC), which samples the Earth's magnetosphere.

A data collection system (DCS) on GOES-NOP receives and relays environmental data sensed by widely dispersed surface platforms such as river and rain gauges, seismometers, tide gauges, buoys, ships, and automatic weather stations. Platforms transmit sensor data to the satellite at regular or self-timed intervals, upon interrogation by the satellite, or in an emergency alarm mode whenever a sensor receives information exceeding a preset level.

The GOES-NOP satellites also provide emergency communications (EMWIN). This subject is covered more fully in Section 8 of this document.

The GOES-NOP satellites transmit data collected to NOAA's Wallops, VA, ground station, which relays the data to the NOAA Satellite Operations Control Center (SOCC) in Suitland, MD. The information is then processed and distributed to users throughout the world. The search and rescue (SAR) subsystem onboard each satellite is a dedicated transponder that relays the distress signals broadcast by UHF emergency locator transmitters (ELTs) carried on general aviation aircraft, emergency position indicating radio beacons (EPIRBs) aboard some classes of marine vessels, and portable personal locator beacons (PLBs). The SAR mission is performed by relaying the distress signals emitted from the ELT/EPIRBs via the satellite to a Local User Terminal (LUT) ground station located within the field of view of the spacecraft.

Those desiring further information about the GOES system should contact the NOAA National Environmental Satellite, Data, and Information Service (NESDIS), and/or search the following Internet addresses:

http://www.noaa.gov/

http://www.nesdis.noaa.gov/

http://www.nws.noaa.gov/

http://www.ngdc.noaa.gov/

http://www.scijinks.nasa.gov/

http://www.swpc.noaa.gov/

http://rsd.gsfc.nasa.gov/goes/

http://goes.gsfc.nasa.gov/

http://sxi.lmsal.com/

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Preface

To further enhance the utility of the GOES system, this Data Book presents a summary and technical overview of the GOES-NOP system, its satellites, subsystems, sensor suite, and associated ground communication and data handling subsystems. The Data Book is intended to serve as a convenient and comprehensive desktop technical reference for people working on or associated with the GOES-NOP missions as well as general information suitable for public distribution. Sufficient technical information and performance data are presented to enable the reader to understand the importance of the GOES-NOP mission, the system's capabilities, and how it meets the needs of the users.

Certain performance data presented herein, e.g., Imager and Sounder radiometric performance, were predicted from or measured on previous GOES satellites. As the satellites undergo on-orbit operations and actual data are obtained, such technical information in this book may not necessarily reflect current capabilities. Furthermore, this Data Book is **not** meant to be a technical specification with absolute worst case performance numbers but rather a general document which informs the reader of nominal and typical GOES system performance and operational capabilities.

In January 1998, Hughes Space and Communications Company (HSC) of El Segundo, CA, was awarded contract number 98069 from NASA's Goddard Space Flight Center in Greenbelt, MD. The contract included the design, manufacture, integration, and launch of two Geostationary Operational Environmental Satellites, GOES N and GOES O, with options for GOES P and GOES Q. In June 2003 the GOES P option was exercised and the GOES Q option was cancelled. The GOES-NOP program is funded, managed, and operated by NOAA. HSC became Boeing Satellite Systems, Inc (BSS) in October 2000. Upon completion of GOES-NOP, Boeing will have built a total of eight spacecraft in the GOES series.

Based on the highly successful Boeing 601 spacecraft, the new satellites more accurately locate severe storms and other weather phenomena, resulting in more precise warnings to the public. The three-axis Boeing 601 body-stabilized spacecraft design enables the primary sensors to "stare" at earth and thus frequently image clouds, monitor earth's surface temperature, and sound earth's atmosphere for its vertical temperature and water vapor distribution. Atmospheric phenomena can be tracked, ensuring real-time coverage of short-lived dynamic events, such as severe local storms, tropical hurricanes

and cyclones, meteorological events that directly affect public safety, property, and ultimately, economic health and development.

Boeing furnishes the communications subsystem with a search and rescue capability to detect distress signals from ships and airplanes, and also furnishes space environmental monitoring instruments and operator training. Ground station upgrades are provided by Boeing's teammate Integral Systems Inc. Boeing also integrates three government-furnished instruments: the Imager and Sounder built by ITT Industries, Inc., and an SXI built by Lockheed Martin.

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