Atomic Clock Failure in NavIC Satellite Raises Concerns for India’s Indigenous GPS

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India’s indigenous satellite navigation system NavIC has faced a technical setback after the atomic clock onboard the satellite IRNSS-1F malfunctioned. The atomic clock is a critical component that provides extremely precise timing signals required for satellite navigation and positioning services. The malfunction could affect the accuracy and reliability of navigation services provided by the system.

Importance of Atomic Clocks in Navigation Satellites

Each navigation satellite carries three rubidium atomic clocks that generate precise time signals. Navigation receivers calculate a user’s location by comparing signals from multiple satellites; therefore, accurate timekeeping is essential. If atomic clocks fail, the satellite may not be able to provide reliable positioning data.

Impact on NavIC Constellation

Navigation systems typically require at least four operational satellites to provide accurate positioning services. With clock failures in some satellites, the number of fully functional satellites in the NavIC constellation has reduced, raising concerns about the system’s redundancy and long-term reliability.

Earlier Instances of Atomic Clock Failures

Technical issues with atomic clocks have occurred previously in NavIC satellites. For example, all three atomic clocks onboard the satellite IRNSS-1A failed, rendering the satellite ineffective for navigation services and necessitating replacement launches.

Kamaraj IAS Academy
Plot A P.127, AF block, 6 th street, 11th Main Rd, Shanthi Colony, Anna Nagar, Chennai, Tamil Nadu 600040
Phone: **044 4353 9988 / 98403 94477** / Whatsapp : **09710729833**

About NavIC (India’s GPS)

Full name: Navigation with Indian Constellation (NavIC).

Developed by the Indian Space Research Organisation.

Earlier known as Indian Regional Navigation Satellite System (IRNSS).

Provides positioning, navigation, and timing (PNT) services over India and up to about 1,500 km beyond its borders.

Satellite Constellation

The original system consists of 7 satellites (3 in geostationary orbit and 4 in geosynchronous orbit).

Replacement and next-generation satellites are being launched under the NVS series.

Types of NavIC Services

Standard Positioning Service (SPS) – for civilian and commercial users.

Restricted Service (RS) – encrypted service for defence and strategic applications.

Strategic Importance

NavIC reduces India’s dependence on foreign navigation systems such as:

GPS

GLONASS

Galileo

BeiDou

Uses of NavIC

Navigation for transport, aviation, and maritime sectors

Disaster management and search-and-rescue operations

Military and strategic applications

Vehicle tracking and mobile navigation services.