Table 4: Criteria for the Performance of Active Electronic Seals

Functional Requirements	Active electronic seals should be able to transmit real-time coordinates of the container (goods) and the sealing status.
System Module	The components of active electronic seals system module should include at least a mobile communication module (built-in or connectable via vehicle-mounted equipment), a global positioning system, input/output interfaces, a human-machine interface, a battery module, a remote sealing and unsealing control module, and a near-field offline unsealing module.
Hardware Specifications	1. Active electronic seals should have built-in memory capable of storing GPS (Global Positioning System) coordinates and other relevant information for at least 90 hours. 2. Active electronic seals should have both a serial number and a unique identification code, which enables the Customs IoT real-time monitoring system to verify the correctness of the device. 3. After active electronic seals are affixed, the sealing and unsealing status should be monitored throughout the process, and automatic messages regarding sealing should be transmitted. 4. Active electronic seals should be able to identify whether they remain securely sealed during transportation or if they have been abnormally unsealed due to external force. After being unsealed, they should automatically transmit an unsealing message. 5. Under a transmission frequency of once every 30 seconds, active electronic seals should be able to transmit specified messages to the Customs IoT real-time monitoring system for over 10 hours, according to Customs requirements. 6. Active electronic seals should meet durability standards such as

	impact protection level IK07, international protection level IP67, and neutral salt spray test to ensure weather resistance.
Communication Technology	1. When the monitored container is operating normally, the transmission frequency of active electronic seals should be able to reach once every 30 seconds, continuously transmitting for over 10 hours. Additionally, the transmission frequency can be remotely controlled by the Customs IoT real-time monitoring system. 2. In cases where the monitored loaded container is located in a remote area without communication network coverage, active electronic seals should store transmitted data at a frequency of once every 30 seconds. The seals should store the transmitted data for over 10 hours and resend it promptly once communication is restored.
Positioning Technology	1. The loaded container should be parked in a geographical area with good signal coverage and effective GPS signal reception for at least 1 hour. The GPS signals received by active electronic seals are collected, and the ratio of the static standard deviation being less than 30 m should be over 90%. 2. When the loaded container is traveling along the designated customs route and is within a geographical area with good signal coverage and effective GPS signal reception, active electronic seals should transmit GPS signal coordinates while in motion. The ratio of displacement exceeding 30 m compared to the minimum distance between the traveled route and the coordinates received should be less than 20%.
Communication Protocol	Active electronic seals must be capable of actively transmitting wireless communication signals to the Customs IoT real-time monitoring system. The transmitted content and format should include at least the following items: (1) Unique identification code.

	(2) Transmission time. (3) Seal status (sealed/unsealed). (4) Seal coordinates. (5) Abnormal code.
Peripheral Systems and Modules	Active electronic seals should transmit pairing messages via vehicle-mounted equipment, establishing a direct connection mechanism with the Customs IoT real-time monitoring system without involving a third party. Additionally, they should have the capability to simultaneously deliver messages to both the aforementioned system and the firm's fleet self-operated management platform.
System Information Security	Active electronic seals should feature data transmission encryption functionality.