

RTRI Successfully Supplies Power to Commercial Trains Using Superconducting Feeding System

– Over one year of operational verification on the Sunzu Line and demonstration test results in the metropolitan areas on the Chuo Line –

The Railway Technical Research Institute (RTRI), in cooperation with the IZUHAKONE Railway Co., Ltd. Sunzu Line and the East Japan Railway Company (JR East), has installed a superconducting feeding system on commercial railway lines* and has conducted demonstration tests under actual operating conditions. The results confirmed that power transmission can be achieved while maintaining a stable superconducting state.

Railway Technical Research Institute (RTRI)
 IZUHAKONE Railway Co., Ltd.
 East Japan Railway Company (JR East)

Operational Verification on the IZUHAKONE Railway Sunzu Line

Overview

A superconducting feeding system was installed at the Ohito Station on the Sunzu Line (Fig. 1) and began operation on March 13, 2024. The system continues to supply power to commercial trains on the line.

* “RTRI Starts Verification of World’s First Power Transmission for Commercial Line Operation Through Superconducting Feeding System,” March 13, 2024 (<https://www.rtri.or.jp/eng/press/d2sij10000000kpt-att/d2sij10000000ksa.pdf>)

“RTRI Conducts Demonstration Test on Chuo Line, Supplying Power to Commercial Trains Using Superconducting Feeding System,” February 25, 2025 (in Japanese) (https://www.rtri.or.jp/press/g51jdh0000000t2a-att/20250225_001.pdf)



Superconducting cable

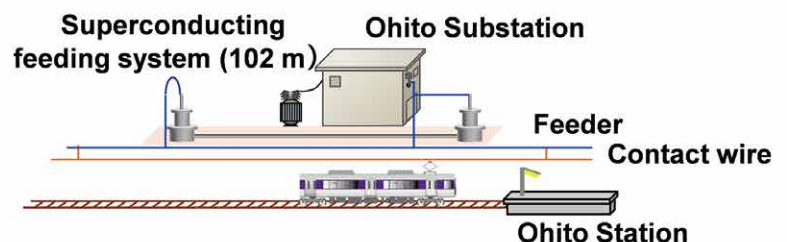


Fig. 1 Train running through a power supply section consisting of the superconducting feeding system (long-term operation on the Sunzu Line)

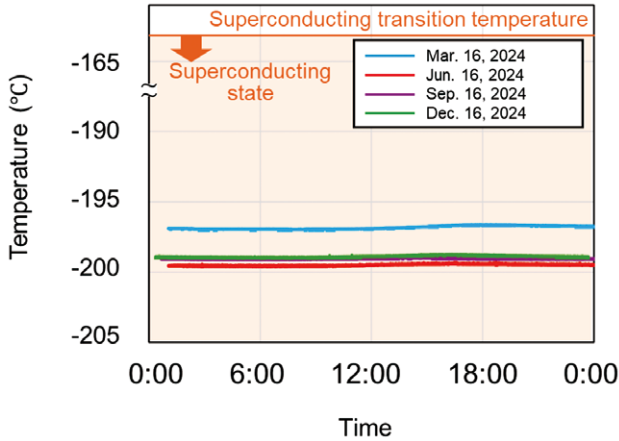


Fig. 2 Daily variation of the cable temperature during operation of the superconducting feeding system

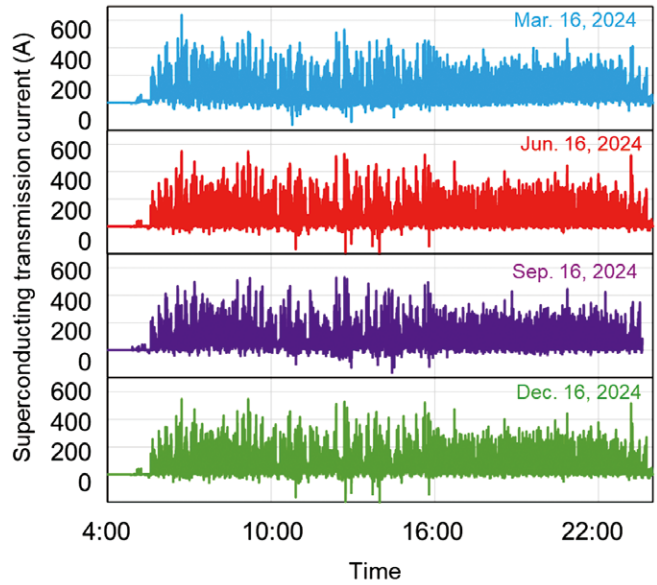


Fig. 3 Daily variation of the current transmitted using the superconducting feeding system

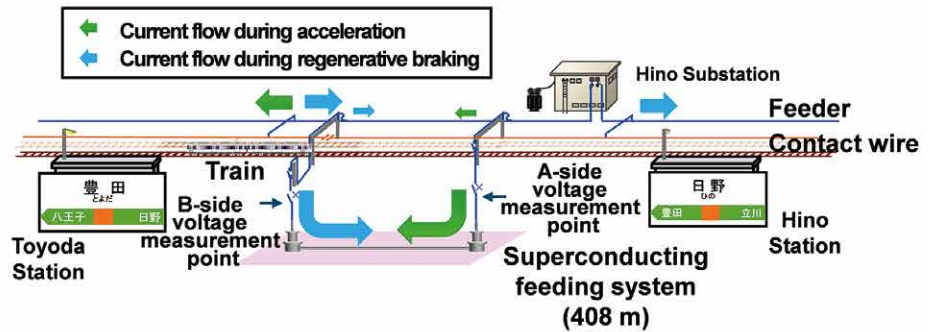


Fig. 4 Train running through a power supply section consisting of the superconducting feeding system (high-current power supply on the JR East Chuo Line)

Status of the Operational Verification

Stable operation was maintained for over one year, supplying power to approximately 40,000 commercial trains to date. The system was observed to maintain a stable superconducting performance through the continuous cooling of the internal section of the cable throughout the day (Fig. 2). The current profile remained nearly identical each day (Fig. 3), confirming constant power transmission corresponding to the train load from the first to the last service. Thus, the durability of the system over one year of operation was confirmed.

Demonstration Tests on the JR East Chuo Line

Overview

A superconducting feeding system was installed at the RTRI Hino Civil Engineering Testing Station, adjacent to the Chuo Line (Fig. 4). From March to April 2025, the system was connected to the outbound track of the Chuo Line, supplying power to commercial trains from the first to the last service each day.

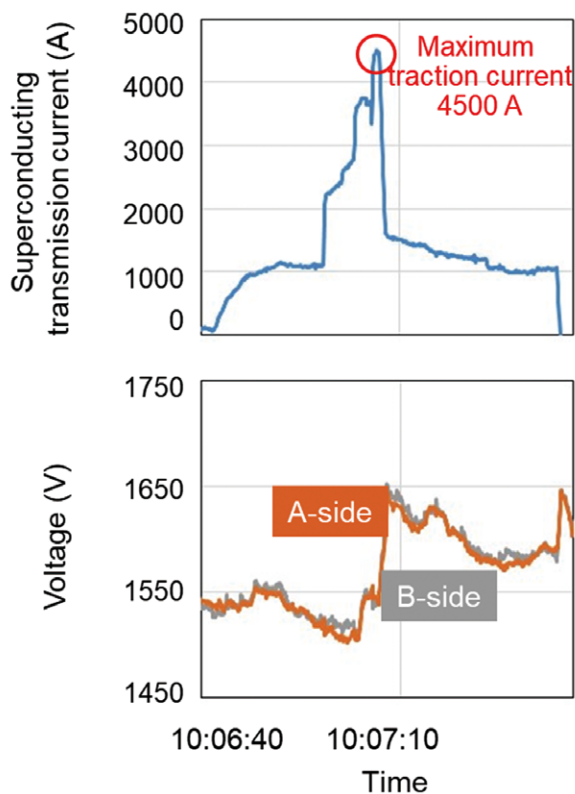


Fig. 5 Examples of current and voltage resulting due to the superconducting traction power supply

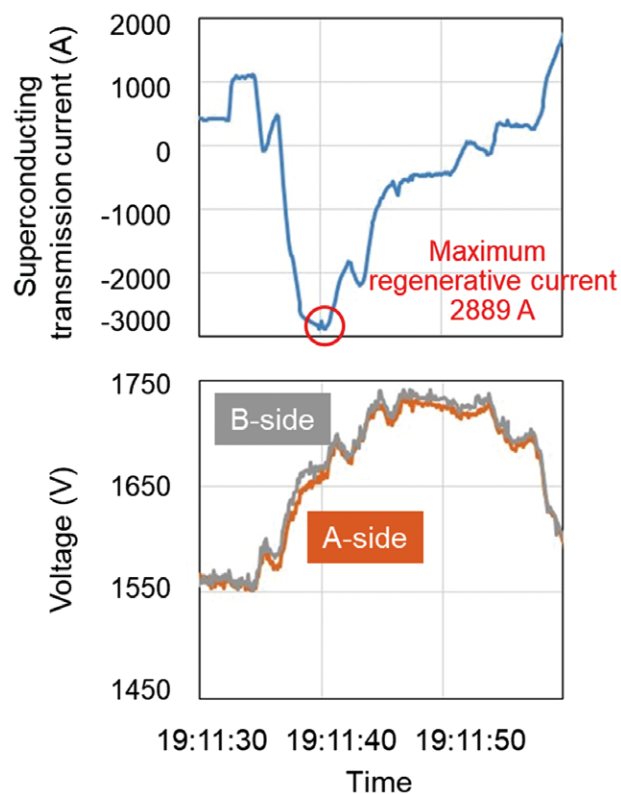


Fig. 6 Examples of current and voltage resulting due to the superconducting regenerative power supply using superconductors

Demonstration Test Results

In the demonstration tests on the Chuo Line, simulating the simultaneous traction operation typical of metropolitan railways, the system successfully supplied a maximum current of 4,500 A (Fig. 5). During regenerative braking, a return current as high as 2,889 A flowed back from the train toward the feeding line (Fig. 6). Even under such high-power-supply conditions on a densely operated line, where the current magnitude and direction frequently fluctuate, almost no voltage difference occurred between both ends of the superconducting cable. The system operated stably and provided the required power as confirmed by the data obtained. These results demonstrate that the superconducting feeding system is capable of providing stable power supply in dense metropolitan railway networks.

Future Challenges

To realize the benefits of this system, such as the consolidation

of the substations for simplified facility management and reduced maintenance requirements, it is necessary to achieve longer power transmission distances. The RTRI will continue to develop technologies for connecting longer cable sections, improving the superconducting materials and their cooling performance, establishing post-installation management and maintenance methods, and enhancing cost efficiency. These efforts aim to advance the research and development toward commercial implementation of the superconducting feeding system.

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