

## Superconducting Feeder Cable System Tested on 600V-DC-Powered Commercial Service Tracks

The Railway Technical Research Institute has been developing the superconducting feeder cable system. Most recently, RTRI conducted a shut-off test and power feeding test on 600V-DC-powered commercial lines for the first time in the world. These tests were implemented in cooperation with the Bureau of Transportation of the Tokyo Metropolitan Government and Tokyo Metro Co., Ltd., in order to check whether this system can be applied to commercial service operation.

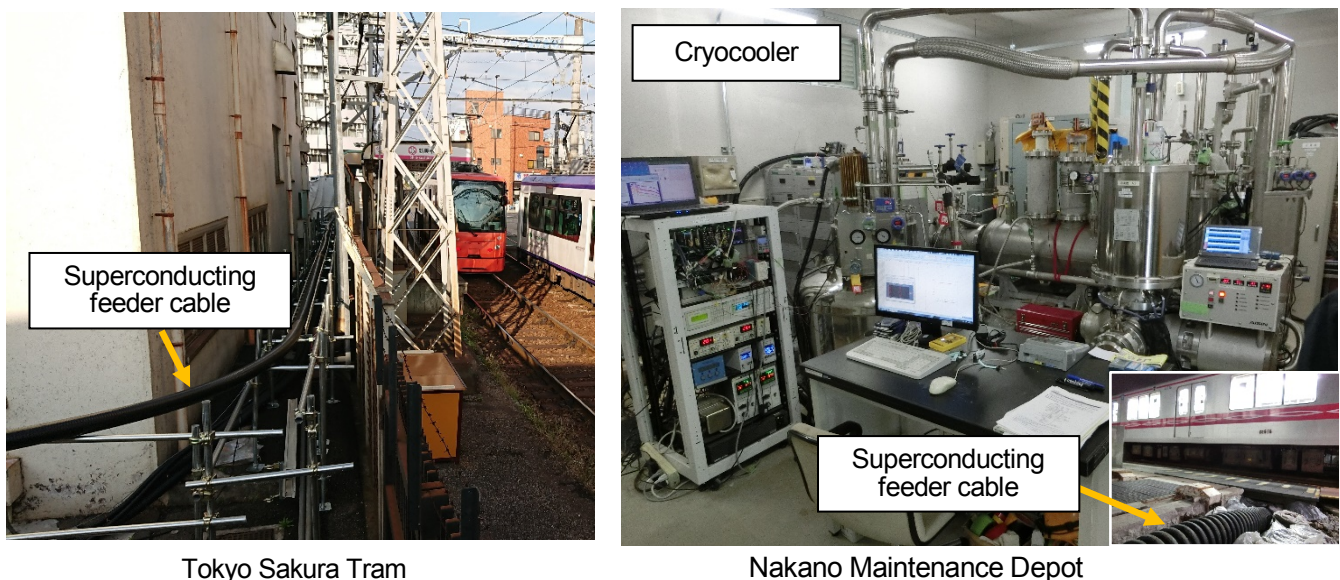


Figure 1: Superconducting feeder cable system used for the tests

### 【Results of shut-off tests】

In the shut-off test, the superconducting feeder cable system is parallelly connected to the regular power feeding circuit of a tram line powered with 600V DC and is shut off while a test train is running. With this test, it is confirmed that the train keeps running, being powered by the regular feeding circuit, even after the superconducting system is shut off.

A 30-meter-long superconducting cable was placed next to a substation of the Tokyo Sakura Tram, a light rail line operated by the Bureau of Transportation of the Tokyo Metropolitan Government. It was cooled to cryogenic and superconducting condition with liquid nitrogen and parallelly connected to the 600V DC regular power feeding circuit of the tram line (Figure 1, left).

A single tramvehicle ran and accelerated on the section between two stops on the Sakura Tram line and, during the accelerated running, the superconducting feeder cable system was shut off from the regular circuit by a breaker. At the instant of shut-off, the current flowing through the superconducting cable flowed through the regular circuit (Figure 2) and the test train was able to continue acceleration, powered by the regular circuit, even after the shut-off. This result has confirmed that, when a trouble occurs to the superconducting cable system, trains can keep running by switching the feeding system from superconducting to regular one.

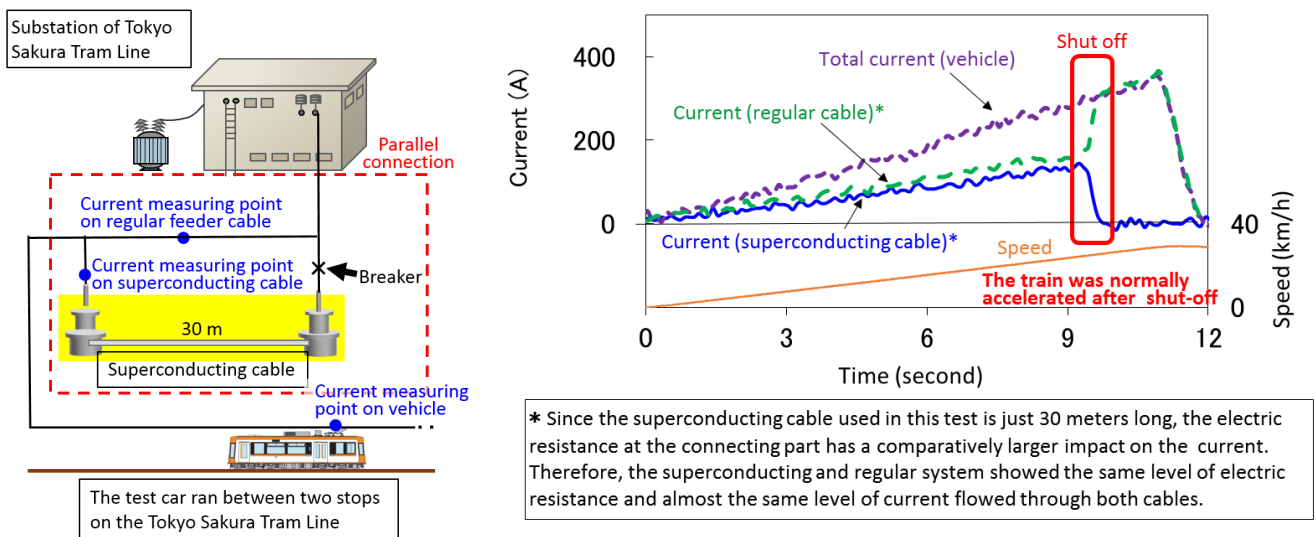


Figure 2: System layout of shut-off test and the results

**【Results of power feeding tests】**

This test is conducted to confirm that the superconducting feeder cable system can transmit the power to accelerate trains on a 600V DC-powered railway line and transmit regenerated current created in braking.

In this test, the 55-meter superconducting feeder cable was set at the Nakano Maintenance Depot of Tokyo Metro Marunouchi Line, cooled to cryogenic and superconducting condition with liquid nitrogen, and then parallelly connected to the 600V DC regular feeding circuit of the tram line (Figure 1, right, Figure 3). The cable was placed just below the rail, a space that suffers a lot of shaking by running trains.

Then, a 6-vehicle test trainset of Marunouchi Line ran between Honancho and Nakano-Sakaue stations and it was confirmed that, during the acceleration, maximum 1881A current flowed through this system and when brake was applied, regenerated power was transmitted through the superconducting cable to a train standing in the Nakano Depot. (Figure 3 and 4) The maximum 1800A current is the largest one that flowed through this cable while an actual vehicle is running. The vibration caused by train running did not damage the superconducting state of this system.

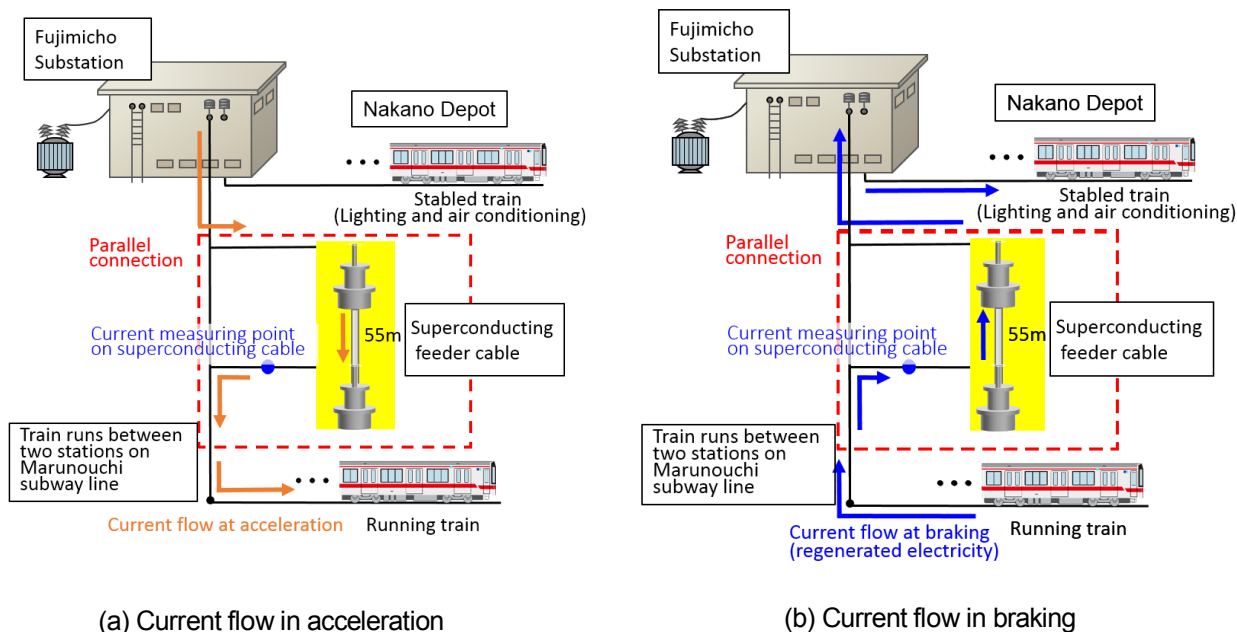


Figure 3: System layout of power feeding test and flow of current

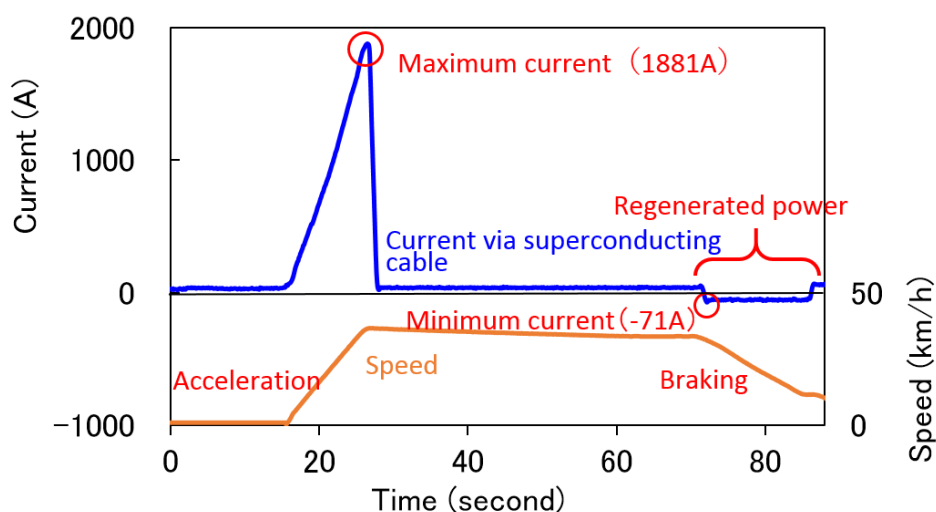


Figure 4: Results of power feeding test

RTRI will continue to address the issues to be cleared to use this system in commercial services by further implementing feeding tests to verify whether it is able to transmit electricity over the distance between actual substations (several kilometers).

- ◇ Part of this project has been implemented as “the Program to Promote Strategic Innovation” by the Japan Science and Technology Agency (JST). The development of superconducting feeder cable has been supported by the subsidy of the Ministry of Land, Infrastructure, Transport and Tourism and carried out as a project of the New Energy and Industrial Technology Development Organization and of “the Program to Create Future Society “ by JST.