

Q1: What energy savings have you achieved via regenerative braking projects with other clients?

Turner Engineering Corporation (Tenco) possesses extensive experience in the modeling, measurement, and maximization of regenerative braking energy for major transit authorities. Tenco's work includes the quantification of available energy and the critical analysis and testing required to implement system changes that deliver significant, measurable savings.

The following projects are representative examples of this experience:

- **New York City Transit (NYCT):** Tenco led the Regeneration Energy Improvement Project (REIP) for NYCT and the New York Power Authority (NYPA) to quantify and increase regenerative energy savings. Field modifications to the R142 train's propulsion parameters, based on Tenco's recommendations, resulted in the recovery of up to 44% of the total propulsion energy, representing an increase of more than 300% in captured energy.
- **Los Angeles Metro (LA Metro):** Tenco performed the design, integration, and commissioning of a flywheel Wayside Energy Storage System (WESS) on the LA Metro Red Line. This 2 MW system was engineered to capture and reuse braking energy, with an estimated annual savings of **566 MWh** and approximately **\$96,000**. Tenco's analysis demonstrated that the WESS reduces peak power demand by 18-20% and provides average energy savings of 11.5%.
- **Caltrain (Peninsula Corridor Electrification Project):** Recent work on the Caltrain PCEP involved the measurement of regenerative energy from new Stadler Electric Multiple Unit (EMU) trains on the 2x25 kV 60 Hz AC system. As the project's **EMC Engineer**, Tenco's utility impact analysis was a crucial component in demonstrating to the Pacific Gas and Electric Company (PG&E) that regenerated power could be safely fed back into the utility grid.
 - Onboard measurements from a test conducted on June 8, 2024, provide a quantitative example.
 - Over a nine-minute run, a 7-car EMU consumed approximately **325 kWh** of energy.
 - During braking, the train regenerated approximately **150 kWh** of that energy back to the grid.
 - This represents a recovery of nearly **46%** of the consumed energy, which directly translates into significant cost savings for the operator.

Tenco's expertise spans both DC and AC traction power systems and is focused on delivering practical, data-driven solutions that convert regenerative braking from a theoretical concept into a reliable and substantial source of energy savings.

Q2: Could you expand on your expertise in Electromagnetic Interference Testing, and provide details on how you conduct the tests?

Tenco is a recognized industry leader in Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI) for the transit sector. Tenco's expertise is demonstrated by

the development of the standards and limits that govern EMI testing for major transit authorities. EMI qualification has been provided by Tenco for railcars and wayside systems for a premier list of agencies, including LA Metro, LIRR, MBTA, MNR, NYCT, and SEPTA.

Foundational Expertise:

- **Standard and Limit Development:** Tenco was retained by New York City Transit (NYCT) to develop the **AC Train EMC Standard** and the associated **Conducted EMI Test Procedure**. Similarly, assessments were performed by Tenco to establish the EMI susceptibility limits for all of LA Metro's heavy and light rail lines. This foundational work provides Tenco with a comprehensive understanding of the fundamental principles required to ensure system-wide electromagnetic compatibility.
- **Diverse System Qualification:** Tenco's experience encompasses the full spectrum of transit equipment. EMI testing has been performed on numerous new trainsets, propulsion equipment upgrades have been qualified during mid-life overhauls (e.g., LIRR M7), and novel wayside systems have been assessed. For instance, a comprehensive EMC Plan was developed for ABB's Wayside Energy Storage System at NYCT, which required careful adaptation of existing standards to address the unique EMI characteristics of this third-rail connected technology.

EMI Test Methodology:

Tenco's testing methodology is a systematic, four-stage process designed to ensure comprehensive evaluation, regulatory compliance, and system safety.

1. **Establish the Framework - The Electromagnetic Compatibility Plan (EMCP):** The process begins with the development of a project-specific EMCP. The client's system is reviewed, all applicable standards (e.g., NYCT, IEEE) are identified, and the precise EMI limits for the equipment under test are defined.
2. **Develop Detailed Test Procedures:** Based on the approved EMCP, detailed, step-by-step test procedures are prepared. These documents outline the exact test setups, instrumentation, operational modes for the vehicle, and data analysis requirements.
3. **Perform Field Testing and Data Acquisition:** On-site testing is conducted by Tenco's engineering team using calibrated, state-of-the-art instrumentation. Conducted, inductive, and radiated emissions are measured across a wide frequency spectrum. Tests are performed under all relevant operational modes—such as acceleration, braking, and spin-slide conditions—to ensure the equipment is compliant under worst-case scenarios.
4. **Analyze and Report:** The acquired data is rigorously analyzed and compared against the established EMI limits. A comprehensive final test report is provided which clearly presents the data, the analysis, and a definitive statement of compliance. If any non-conformances are identified, Tenco's engineering expertise is applied to assist in diagnosing the issue and developing effective mitigation strategies.