Living Lab

Transport Infrastructure Efficiency Strategy

TIES LIVING LAB PROGRAMME

Cooling panels for deep underground networks (IP4)

October 2022

INTRODUCTION

Underground transit systems are popular in cities around the world, and they can be a very efficient method for moving a large number of people quickly and safely. But many cities have ageing systems that are in urgent need of upgrading. In London, much of the "Tube" was built in the first half of the 20th century and although many parts have been upgraded some of the older, deeper lines can be inefficient and uncomfortable at today's higher service levels.

This information paper describes a demonstrator project established under the Transport Infrastructure Efficiency Strategy (TIES) Living Lab Programme. The Cooling Panels physical asset demonstrator project – one of four designed to prove the benefits of modern methods of construction (MMC) – involved designing, manufacturing and testing novel cooling panels suitable for the challenging environment of the London Underground deep Tube network. The project was designed and managed by Transport for London (TfL) and supplied by Strategic Rail Consultants (SRC) Infrastructure.

BACKGROUND

TfL introduced a comprehensive plan to improve the Tube in the early 2000s. The work has involved refurbishing hundreds of stations, upgrading lines to provide faster, more frequent services, and rebuilding some central London stations that had become too small to deal with the number of people passing through every day.

More than a billion passenger journeys are made on the Tube network in a typical year, which is more than two and a half times the number in the early 1980s. It is therefore clear that extra capacity is needed on the London Underground. No less important is the need to dramatically reduce the greenhouse gas emissions in line with the Government's target of net zero emissions by 2050.

The Piccadilly line, one of the deepest lines of the network, is particularly in need of these improvements. TfL plans to upgrade the line as part of its contribution to achieving carbon net zero by 2030: reducing energy consumption by 20%.

A new fleet of air-conditioned trains featuring regenerative braking technology will be launched in 2025, replacing rolling stock that is up to 50 years old. The works also include upgrading depots and trackside infrastructure.

The new trains will make it possible to run up to 23% more trains per hour during peak times from 2027.

With more passengers and more trains – and a changing climate – keeping the system cool will be more important than ever. The platform air handling units (PAHUs) currently used for cooling have not performed well in the harsh environmental conditions in the deep Tube lines. To address this, TfL designed and developed a new "Cooling Panel" technology, which was one of the demonstrator projects for the TIES Living Lab.

CHALLENGES

In the past, the approach would have been to develop bespoke cooling panels that would replace the sub-optimal PAHUs in the areas of immediate need. Instead, the project set out to help reduce operational and capital expenditure by designing a cooling system that is suitable for the challenging environment.

The project was designed to meet the following challenges:

- Provide the cooling capacity in the Tube tunnels needed to enable the increase in the number of trains per hour
- Reduce maintenance costs compared with the PAHU cooling system.

Once proven through the TIES Living Lab project, the system is intended to be used for future network improvements on other lines and, indeed, in other cities.

FROM PROTOTYPE TO FINISHED PANELS

The existing approach to cooling in the Piccadilly line – the PAHU system – required a high level of maintenance to cope with the harsh conditions where dust particles frequently cause blockages on the PAHUs.

The cooling panels were built and tested in a laboratory environment

As part of the introduction of new deep Tube trains on the Piccadilly line, TfL undertook a cooling system assessment that identified a need for additional cooling at five Tube stations.

With a minimum of five stations to be upgraded, there were clear benefits of developing a new cooling panel concept, designed and built to suit the specific conditions of the Underground.

The project comprised three phases:

- Phase 1: A prototype cooling panel was built and tested in a laboratory environment at TfL's Hearne House. Two different fan options were assessed, centrifugal and tangential, with the aim of developing further the preferred option. Functional tests were then undertaken to determine the system performance before the design was fully developed and manufacturers selected. The cooling performance tests showed a good correlation between predicted and measured performance in terms of watts of cooling provided.
- Phase 2: The preferred fan/panel option will be tested in a dusty environment to evaluate the impact and performance of the fan. For this, the team is planning to install the devices in the disused Mark Lane (District line) station, dating back to 1884.
- Phase 3: Test results were used to modify an operational prototype panel, which was installed at a disused station in Holborn, central London. This was to test the installation and validate the cooling performance against the cooling modelling in the deep Tube environment.

Trialling the system at a disused platform within the deep Tube environment

RESULTS

Following the success of the first prototype tested at Hearne House (Phase 1 works), the project team decided to develop the design and test the panel at Holborn station while testing the fan at a dusty environment (Mark Lane) in parallel.

To date, the cooling panel and fan performance data have been tested and recorded for the tests at Holborn. At Mark Lane, TfL will run the fan for 6–12 months to obtain further data on the performance of the fan.

LEAVING A LEGACY

Initial results have demonstrated that the panels look likely to be a feasible solution to cooling the network.

The next step is for a concept design to be installed as a trial of a test panel in a live station environment (Knightsbridge), where the maintenance regime can also be assessed.

Should this be feasible, the concept will be developed further and tested (funding dependent).

Originally targeted for five stations, a further seven sites have been identified as potential locations for applying the cooling panel technology.

The concept that has been developed through this TIES Living Lab project may provide a significant uplift in reliability performance, and could be readily adapted for other networks, including those managed by Network Rail, HS2, and any mass transit systems that are entering overhaul or upgrade works (e.g. New York, Paris, Madrid).

This work was coordinated and designed by Transport for London and delivered by experts from Strategic Rail Consultants (SRC) Infrastructure and the TIES Living Lab under the Cooling Panels physical asset demonstrator project, overseen by the Cost and Performance Benchmarking Steering Group.

Living Lab

Transport Infrastructure Efficiency Strategy

The TIES Living Lab is a transformative collaboration of 25 partners together with Government, i3P and the Construction Innovation Hub that use data, technology and Modern Methods of Construction within live transport infrastructure projects to deliver significant value-adding benefits across the transport infrastructure sector. The programme is funded via a grant from Innovate UK through the Transforming Construction programme, plus contributions from the Department for Transport, HS2, Transport for London, Network Rail and National Highways.

The four strategic outcomes of the collaboration are to:

1. Improve the way Transport Infrastructure projects are set up to maximise value
2. Achieve better assurance of project and programme value and what assets should cost (benchmarking)
3. Accelerate the wider adoption of MMC
4. Establish the TIES Living Lab as a catalyst for long term cultural change across sectors by making a compelling case for long term HM Treasury funding to scale this facility.

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