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## The Barcelona metro implements smart ventilation control to prevent infection

The innovative RESPIRA<sup>®</sup> system maximizes the amount of fresh air taken in from the outside and helps regulate the temperature and humidity to improve comfort in the network.

This summer, Transports Metropolitans de Barcelona (TMB) will implement an innovative pilot test of **smart ventilation regulation** in the **metro network** to improve environmental quality, hygiene and passenger comfort in stations. The digitization project has been developed in concert with SENER Engineering, which supplied its RESPIRA<sup>®</sup> control system. This project follows up on previous work carried out on line 1 to verify the importance of dynamic ventilation control, and which managed to lower the ambient temperature.

RESPIRA<sup>®</sup> is an **artificial intelligence platform** that is capable of lowering the heat index of passengers and metro workers by defining several criteria and reading parameters in real time, such as the temperature, humidity and indoor air quality in the stations and electricity consumption. These data are used by a dynamic algorithm to predict the environmental conditions inside stations (depending on the weather forecast, expected ridership levels and other factors) and then apply a mode of operation to each fan with the goal of improving the heat index while also minimizing electricity consumption.

The conventional lines of the Barcelona (1 to 5), which transport 94% of all riders, will be used to test this advanced ventilation regulation model starting in July. Metro de Barcelona is currently carrying out some preliminary work, namely: adapting the control and regulation programs of the entire conventional ventilation network (187 station fans and 142 tunnel fans), developing new features for controlling fixed installations remotely, and equipping part of the network with temperature and humidity sensors.



Ventilation of a station on line 1 of the Barcelona metro and system monitoring console / © SENER



For the director of the metro network, **Ramon Bacardí**, this is a "good example of applying technology to improve service quality and have a direct effect on the customer's travel experience." He also noted "the contribution of the ventilation system to provide a safe and comfortable environment for the metro network at a time when passenger volume is rising once more. Also, for reasons of sustainability and social equality, we need for public transport to be seen again as the best option for metropolitan mobility in the Barcelona area."

The Director of Innovation at SENER, **Òscar Julià**, says that "RESPIRA<sup>®</sup> is one of the many digitization initiatives that the company is currently working on. For SENER, the digital transformation involves integrating new technologies into businesses from the start, the ultimate goal being to make them available to society through innovations that improve people's lives and are sustainable and environmentally friendly." He added, "In the current context, RESPIRA<sup>®</sup> can also play a very important role in improving the health and comfort of hundreds of thousands of riders who use the metro annually as a way to reach their destination."

### **Against the spread of COVID-19**

Smart ventilation control will **maximize the amount of fresh air** from the outside, a measure that will allow for increased hygiene inside the metro network and reduce the risk of spreading the coronavirus, which is responsible for COVID-19, and other microorganisms, in keeping with guidelines from health authorities. The enhanced environmental conditions in the stations in terms of temperature and humidity will be noticeable in the form of improved comfort for both passengers and employees.

Currently, this test project in the Barcelona metro is being studied by the Spanish Ministry of Science and Innovation as a solution that can be extrapolated to other large infrastructures.

The project also offers a series of advantages to the operator, such as equipment availability, rapid detection of abnormal operations, improved maintenance, lower electricity consumption, maximum performance of the installation and help in determining those areas where new investments are justified from a cost/benefit ratio perspective, thus contributing to the efficient and sustainable management of assets.

### **Comprehensive engineering study of line 1**

TMB and SENER previously collaborated on a **pioneering and comprehensive engineering study** of the ventilation in line 1 of the Barcelona Metro. For the first time in an operational transportation network, the infrastructure, trains and equipment were mathematically modeled and all possible operating modes of the ventilation and the existing infrastructure were studied analytically. As a result, in March 2019, the ventilation setpoints were changed, yielding a 1.2° C reduction in equivalent days compared to the previous year in the hottest stations on the line.



The new ventilation regime, implemented on the five conventional lines, involves exhausting air through the ventilation shafts in the tunnels and channeling it through the station fans and access points, maintaining the same air flow throughout the year. The key element is to take advantage of low temperatures in winter and nighttime periods to gradually lower the average temperature in the tunnels. This strategy has already allowed a first step to be taken in increasing the amount of fresh air from the street in passenger areas as a way to prevent COVID-19.

Reducing the temperature was one of the objectives pursued. But the study also demonstrated the importance of properly operating the ventilation equipment and hinted at the possibilities of a **smart and dynamic control method** that takes into account the ambient conditions outside and inside the stations to provide for an optimized ventilation strategy by sending individual setpoints to the fans, based on the time and day. This opened the doors to the digital transformation of one of the basic systems of the Barcelona metro infrastructure.

**TMB** is the leading public transportation operator in Catalonia, one of the largest in Spain and one of the few in Europe with general, rail and surface connections. It manages an 8-line, 121-kilometer long, 156-station metro network, 25% of which is automated, and it also runs the city's buses. In 2019, it had 615 million riders in Barcelona and ten other municipalities in the metropolitan area. For TMB, the smart metro ventilation control project is consistent with its efforts to promote innovation for the benefit of its users and public at large, and it is compatible with the sustainable development goals of the 2030 Agenda, which are part of the business strategy; specifically, to promote the health and well-being of the population, the efficient use of energy, innovation in industry and responsible production and consumption.

**SENER** is a private engineering and technology group founded in 1956, which seeks to offer its clients the most advanced technological solutions and which enjoys international recognition thanks to its independence and its commitment to innovation and quality. SENER has more than 2,300 professionals at its centers in Algeria, Argentina, Brazil, Canada, Colombia, South Korea, Chile, China, United Arab Emirates, Spain, United States, Morocco, Mexico, Poland, Portugal, United Kingdom and South Africa. The group's operating income is in excess of 589 million euros (2018 data).

SENER Infrastructure has considerable experience in transport infrastructure, having worked on studies and projects involving over 15,000 km of rail lines, 1,200 km of metro and light rail (LRT) lines, and more than 70 urban transport systems, making the company one of the world's leaders in this field. In Barcelona, SENER played a pivotal role in Line 9 of the metro, as it was the company responsible for providing technical assistance to integrate all the systems and infrastructures. It also took part in supervising work on systems, stations and civil construction.



Transports  
Metropolitans  
de Barcelona

