INTERNATIONAL STANDARD

ISO 37164

First edition
2021-05

Smart community infrastructures — Smart transportation using fuel cell light rail transit (FC-LRT)

Reference number
ISO 37164:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 268, *Sustainable cities and communities*, Subcommittee SC 1, *Smart community infrastructures*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Light rail transit (LRT) has been used as convenient urban public transportation in cities for over 100 years, due to its smooth acceleration and deceleration performance, good ride comfort and larger passenger capacity than bus vehicles. Although LRT has high energy efficiency and operation stability, as well as producing zero emissions, it has shortcomings. Conventional LRT is powered with electricity supplied from the outside of vehicles through catenaries and pantographs. Setting up catenaries and substations calls for considerably high capital cost and long construction times, and spoils urban views. The voltage of electricity depends on power grids and service lines, resulting in poor interconnection in rail service networks by LRT. If the grid power fails, services are suspended on all LRT lines. LRT equipped with energy storage using batteries and super capacitors is available, but the working distance in relation to charging time is not long enough for commercial services.

Fuel cell light rail transit (FC-LRT) solves such problems with conventional LRT. Normally, hydrogen fuel cells are adopted as power sources for FC-LRT. It is not necessary to equip rolling stock with pantographs, hang catenaries or install substations, resulting in preservation of the urban view and open skies. The elimination of the facilities leads to reduction in construction and maintenance costs and time, and also safety improvements, especially on the risk with high-voltage grids exposed in cities. Fuel-cell-powered vehicles emit no GHGs or small particles, only water. LRT vehicles with energy storage, which do not rely on grids for power supply, can run on tracks independently of voltage, whether electrified or not, wherever the track gauges are the same. The on-board power source makes LRT highly resilient, especially when the power grid fails. Fuel cells enable LRT vehicles to run for longer distances than possible with other on-board energy storage.

Smart community infrastructures — Smart transportation using fuel cell light rail transit (FC-LRT)

1 Scope

This document specifies a procedure to introduce smart transportation into cities by means of fuel cell light rail transit (FC-LRT). This service contributes to a cleaner atmosphere, with zero emission of greenhouse gases (GHGs) and small particles, an urban view free of catenaries and easy installation of LRT transportation operations, providing safe and comfortable rides for citizens.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1
fuel cell light rail transit
FC-LRT
LRT using hydrogen fuel cells for traction

Note 1 to entry: LRT means transportation systems using light rolling stock with steel tires on segregated tracks (e.g. elevated, at ground level or underground).

3.2
conventional LRT
LRT using catenaries or third rails to collect power

4 Concept of smart transportation using FC-LRT

4.1 General

FC-LRT uses hydrogen fuel cells as a power source to drive vehicles. Compared with conventional LRT, FC-LRT has specific advantages. Hydrogen FC-LRT emits only pure water, no GHGs or small particles from the vehicle into the atmosphere around the service line. Hydrogen works as a carrier to store and deliver energy. Over-generated electricity or electricity remaining during off-peak hours can be converted to hydrogen by water electrolysis by using such electricity. Hydrogen can be stored in different forms, including liquid, high-pressure gas and others. Fuel energy stored as hydrogen can be used on demand by generating electricity in fuel cells equipped on LRT vehicles. FC-LRT runs without a power supply from grids. The elimination of overhead catenaries creates good urban views with clear skies. No catenaries or substations are needed. Thus, services can be deployed in cities more easily than conventional LRT. No power from grids makes FC-LRT highly resilient, because power is always available locally on board. The higher energy capacity of hydrogen fuel cells compared with regular batteries enables FC-LRT to run for longer distances than battery LRT. Hydrogen refuelling can be completed more quickly than battery recharging.

One of the goals of smart transportation is to improve service performance and quality compared with conventional services.

The fuel or hydrogen to be used for FC-LRT is produced by consuming electricity. If a hydrogen refuelling station for the LRT can be furnished with generators working only with renewable energy resources, namely sunlight, wind and biomass, and the hydrogen reproduced with surplus power, the LRT system achieves perfect zero-emission transportation services. This is another challenge or goal to be achieved in the future.

4.2 Satisfaction of SDGs

Smart transportation as designated in ISO 37154 should contribute to developing a city and overcoming such city issues by satisfying the purposes designated in ISO 37101 and aiming at achieving the United Nations Sustainable Development Goals (SDGs), in particular goal 7, "Affordable and clean energy", goal 8, "Decent work and economic growth", goal 9, "Industry, innovation, and infrastructure", goal 11, "Sustainable cities and communities", goal 12, "Responsible consumption and production", goal 13, "Climate action" and goal 15, "Life on land".

5 Operation of smart transportation using FC-LRT

5.1 Objectives

Smart transportation in the form of FC-LRT operation solves specific city issues as mentioned in 4.1 by retaining the same operation and services as those already in place for conventional LRT operation. This clause describes how the FC-LRT transportation system shall or should be organized for operation by following the requirements and recommendations in 5.2.

5.2 Minimum requirements and recommendations for organizing smart transportation

5.2.1 General

Not all procedures for operating FC-LRT are necessarily the same as those for conventional LRT, since FC-LRT has specific work, namely the refuelling of hydrogen.

5.2.2 Recharging

Hydrogen refuelling should be arranged depending on the round trip and stand-by time of individual LRT dispatches. Renewable energy resources for hydrogen generation are highly recommended for perfect zero emission in the LRT operation. Hydrogen can be generated on-site at a refuelling station, or off-site in relatively large scale, then supplied thereto by safe ways such as pipelines and tube trailers. Hydrogen fuel quality should satisfy the requirements designated in ISO 14687 while hydrogen storage at a refuelling station should follow the recommendations in ISO 19880-1.

Hydrogen refuelling stations should be built to support LRT service networks, the number and location of which can be determined by the following parameters:

- total service distance;
- number of LRT vehicles to be serviced in the network;
- amount of hydrogen fuel carried on each LRT vehicle;
- dispatching of LRT services;
- refuelling time of hydrogen.

Hydrogen refuelling stations should satisfy the requirements on safety designated in NFPA 2 and ISO 19880-1.

5.2.3 Scheduling and dispatching

Operation scheduling and LRT vehicle dispatching should be optimized and organized to complement the characteristic properties of FC-LRT, including its specific work, namely hydrogen refuelling.

5.2.4 Maintenance work

To the maximum extent practical, all maintenance work, such as cleaning, inspecting and overhauling vehicles, shall be completed so as not to disrupt the specific work of FC-LRT, namely hydrogen refuelling.

5.2.5 Passenger services

Passenger services, including fare payment, entering and exiting, coach accommodation and passenger capacities, shall not be inconvenient or poorer than those offered by conventional LRT.

5.2.6 Driving conditions

FC-LRT shall operate in the same weather and climate conditions and under the same driving conditions as those of conventional LRT.

5.2.7 Driving skills and performance

No specific skills or experience shall be required to drive FC-LRT, compared to conventional LRT.

5.2.8 Hydrogen delivery and storage

FC-LRT uses hydrogen as fuel, which is stored in cylinders and tanks on the LRT rolling stock and at a refuelling station. Hydrogen, which is the second smallest atom, has high permeability through materials, the smallest density and extremely high diffusivity. The ignition temperature is 527 °C and the low flammability limit is 4%. Thus, it is not likely to happen that hydrogen easily explodes in normal living environments, if exiting. However, the experience of hydrogen utilization in transportation services is so short, the practical application of which started after entering the 21st century. Owing to such chemical property of hydrogen, hydrogen should be delivered, stored and used in FC-LRT operation by following ISO 13985, ISO 19881, ISO 19882 and ISO 21009-1 for hydrogen cylinders and tanks, ISO 14687 and ISO/TR 15916 for hydrogen utilization, ISO 16111 for hydrogen delivery, ISO 19880-1 for hydrogen refuelling stations, ISO 22734 for hydrogen generators and ISO 23273 for compressed hydrogen handling.

LRT services, which use hydrogen delivered to a refuelling station, will be suspended when the supplement is disturbed. It is recommended that hydrogen be produced on-site at a refuelling station with buffer storage for steady LRT operation.

5.2.9 Emergency responses

The hazard with hydrogen refuelling stations potentially exits at:

- on-site hydrogen production units;
- hydrogen delivery systems, including mobile storage and remote fill points;
- compressors;
- storage;
- piping connections (non-welded);
- dispensers.

Thus, hydrogen refuelling stations shall be sited to minimise such risks to customers, LRT and refuelling station operators, properties and the environment to an acceptable level. Hydrogen refuelling stations shall include measures to reduce the risk of harm from fires, deflagrations, detonations and blast waves to an acceptance level.

The emergency responses in case of fire, which are described in SAE J2578 and SAE J2579, work for FC-LRT, including fuel shut-off functionality described in SAE J2579, Section 4.

NOTE NFPA 130 and the EN 45545 series describe rail operation and service protection from fire disasters.

Emergency routes shall be secured for easy escape from vehicles at times of emergency by all passengers, especially children, the elderly and people with small children or disabilities. Easy communication channels shall be facilitated especially with LRT service dispatchers in charge of vehicle tracking, equipment monitoring and information provision.

5.2.10 Energy saving

The operation schedule and running performance of FC-LRT should be optimized and controlled in order to save hydrogen consumption.

NOTE ISO 37161 and ISO 37167 give recommendations on how to save energy in transportation services.

6 Maintenance of the quality of smart transportation using FC-LRT

6.1 General

To maintain the intended performance of smart transportation, and to confirm its effectiveness, periodically observe the parameters in 6.2.

6.2 Parameters to be observed

The parameters for comparing smart transportation performance are as follows. Use appropriate units for observation:

- distance of tracks without catenary cables, which are created by installing smart transportation;
- number of substations closed or removed by installing smart transportation, if conventional LRT is fully replaced with smart transportation.

6.3 Modification of smart transportation

When no change is found in the value of the parameters designated in 6.2, change the conditions of smart transportation in 5.2. To correct the transportation conditions, confirm anything unexpected at planning or irregular due to specific local situations taking place in the area where smart transportation was installed. Modify the current conditions of the smart transportation system operated by making sure that irregular conditions are acceptable.