

# New Urban Transport System for Middle East

## Monorail System for Dubai Palm Jumeirah Transit System

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*OVERVIEW: Since first gaining experience with the Inuyama Monorail that commenced operation in 1962, Hitachi has been a supplier of key monorail system products both in Japan and overseas including vehicles, track switches, transformer systems, and automatic train supervision systems. The Palm Jumeirah Transit System is a monorail system designed based on the track record and experience that Hitachi has built up over many years. Entering operation in April 2009, the system is the first monorail to be installed in the Middle East and the first guided transportation system to be operated in the United Arab Emirates, and as a new symbol for Palm Jumeirah island, the system is in active use as a means of transportation for island residents and tourist visitors.*

### INTRODUCTION

PALM Jumeirah is an artificial island of approximately 6.16 km<sup>2</sup> constructed off the coast of the United Arab Emirate of Dubai, a nation that has focused on developing its tourism industry in recent years. The construction of the island itself and the development of business on the island are the responsibility of the government-owned development company Nakheel PJSC<sup>(1)</sup>. The island is the site of many hotels, theme parks, condominiums, and villas, and the construction of shopping malls, high-rise buildings, and other infrastructure is planned.

Palm Jumeirah Transit System was constructed to provide access to the island from the mainland as well as transportation around the island and consists of 5.4 km of double-tracked line. The line has a total of four stations, of which one is on the mainland and three on the island, and an associated depot for vehicle storage, inspection, and other activities is located at Gateway Station on the mainland (see Fig. 1 and Fig. 2).

Nakheel placed a high value on Hitachi's capabilities including its vehicle designs and many years of experience in the supply of monorail system components (see Table 1) used in Japan and elsewhere and contracted the company to supply the vehicles, automatic train supervision system, and other key system components for the Palm Jumeirah Transit System (see Table 2)<sup>(2), (3), (4)</sup>. This article gives an overview of various system components in the Palm Jumeirah Transit System.

### FEATURES OF VEHICLE SYSTEMS

The vehicles consist of three cars per set. The following sections describe the main features of the vehicles.

#### Design Concept

Based on a vehicle concept suitable for a resort area, both the exterior and interior use designs based on the keynote colors of blue and white to reflect the island's beaches and sky, and numerous curved shapes are used throughout to convey a soft image (see Fig. 3).



*Fig. 1—Palm Jumeirah Transit System Track Map. The line runs from Gateway Station on the mainland to Atlantis Aquaventure Station at the far end of the island, with intermediate stations at Trump Tower and Palm Mall where high-rise buildings and shopping malls respectively are planned for construction.*



Fig. 2—Monorail Vehicle for Palm Jumeirah Transit System. The monorail vehicles are the first to use a double-skin structure based on the A-train concept.

**Carbody Structure**

Fig. 4 shows the vehicle trainset and dimensions and Table 3 lists the main specifications.

TABLE 1. Past Monorail Projects  
Hitachi has supplied eight monorails in Japan and three monorails overseas.

Year of first operation	Monorail name	Distance (km)	Number of stations	Remarks
1962	Inuyama Monorail (Japan)	1.4	3	Shutdown in 2008
1964	Yomiuri Land Monorail (Japan)	3.1	4	Shutdown in 1978
1964	Tokyo Monorail (Japan)	17.8	10	
1970	Osaka Expo Monorail (Japan)	4.3	7	Only operated during Osaka Expo
1985	Kitakyushu Urban Monorail (Kitakyushu Monorail, Japan)	8.8	13	
1990	Osaka Kosoku Tetsudo (Osaka Monorail, Japan)	28.0	18	
1998	Tokyo Tama Intercity Monorail (Japan)	16.0	19	
2003	Okinawa Urban Monorail (Yui Rail, Japan)	13.1	15	
2005	Chongqing Monorail (Chongqing, China)	19.2	18	
2007	Sentosa Express (Sentosa Island, Singapore)	2.1	4	
2009	Palm Jumeirah Transit System (Dubai, United Arab Emirates)	5.4	4	

Although carbody structures made in the past used a single-skin structure because of the need for monorail vehicles to consider restrictions such as the vehicle weight, by choosing to use lighter weight components without compromising strength, the special-purpose vehicles for the Palm Jumeirah Transit System are the first monorail vehicles to use a double-skin structure.

TABLE 2. Products Supplied to Palm Jumeirah Transit System  
Hitachi integrated the vehicles and wayside equipment and supplied these as a system.

Vehicles	Carbody
	Bogie
	On-board electrical equipment (propulsion device, propulsion motor, etc.)
	Brakes
Wayside equipment	Air conditioning
	ATS
	Track switch
	SCADA
	Electricity distribution and feeder system (transformers and power rail, etc.)
	Communication systems (train radio, telephones, CCTV, clock systems, etc.)
	Passenger information system (passenger information display system, passenger announcement)
	Station facilities (platform screen doors, intercom, etc.)
Depot equipment (maintenance vehicle, car washer, etc.)	

ATS: automatic train supervision system  
SCADA: supervisory control and data acquisition system  
CCTV: closed-circuit television



Fig. 3—Design of Front End of Monorail Vehicle. Sightseeing seats that give passengers a good view of the surroundings are located at the front end of the monorail vehicles while the mid-sections of the vehicles are fitted with round seats where passengers can relax.

Further, the extruded shapes of aluminum alloy that comprise the carbody structure are welded together using FSW (friction stir welding), a technique that leaves minimal deformation and stress in the welded components.

### Vehicle Fire Prevention Measures

Based on the National Fire Protection Association (NFPA) 130 standard, the monorail is designed with a fireproof floor structure made of stainless steel plate and fireproof doors to the gangways so as to be

TABLE 3. Main Vehicle Specifications  
Monorail vehicles are available in small, middle, and large sizes, each of which has different dimensions and axle load, and the middle size model was selected for the Palm Jumeirah Transit System.

Item	Specification	
Vehicle type	Straddle type middle size monorail	
Trainset	Fixed three-car trainset (Tc-M-Mc)	
Passenger capacity	Tc and Mc: 98, M: 106	
Power feeding system	DC 1,500 V	
Track beam width	800 mm	
Axle load	10 t (maximum)	
Maximum speed	70 km/h	
Acceleration and deceleration	Acceleration	1.0 m/s <sup>2</sup> (3.6 km/h/s)
	Deceleration	Maximum in normal operation: 1.11 m/s <sup>2</sup> (4.0 km/h/s)
		Emergency: 1.25 m/s <sup>2</sup> (4.5 km/h/s)
Operation system	ATO driverless with attendant	

Tc: trailer car with cab Mc: motor car with cab M: motor car  
DC: direct current ATO: automatic train operation

able to withstand a fire for more than 30 minutes and ensure sufficient time for passengers to evacuate the vehicle safely in the event of a fire. As this is the first monorail to be built with a fireproof floor structure, a certified testing laboratory in the UK conducted tests on a model that replicated the floor structure used in the actual vehicles to verify the performance of the fireproofing.

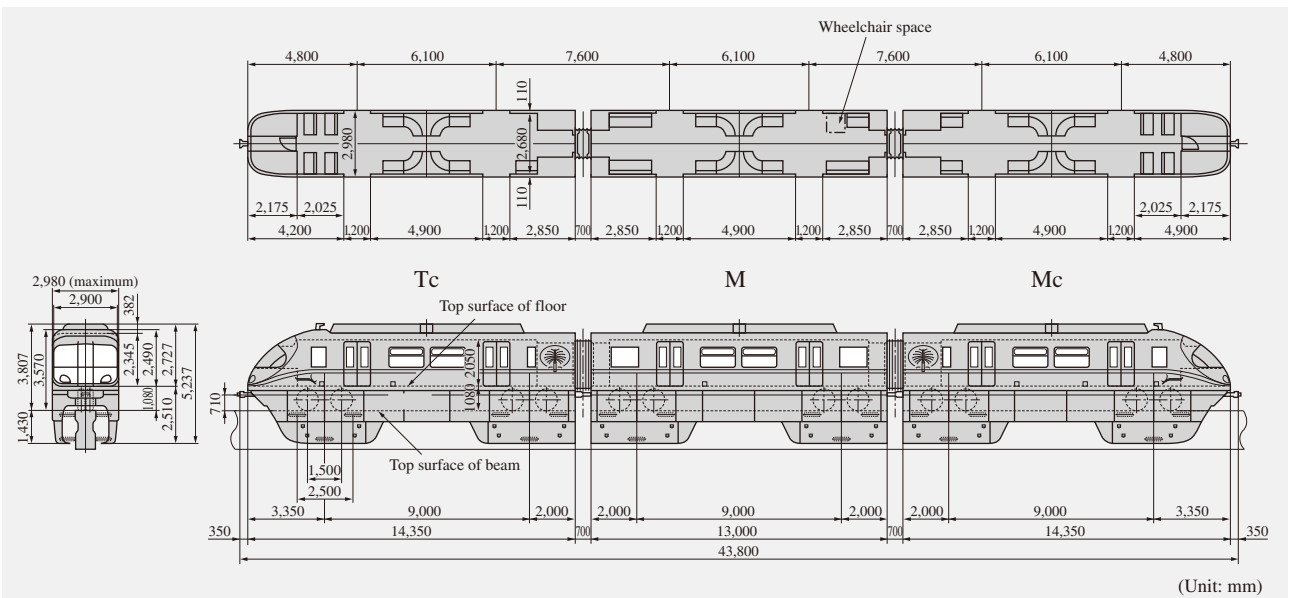


Fig. 4—Vehicle Trainset and Dimensions. The monorail has a fixed three-car trainset with a total length of 43.8 m. A fireproof floor structure and fireproof doors to the gangways are adopted in case of a fire on the monorail.

**Environmental Measures**

The design of each item of equipment took account of the high temperatures and humidity that are characteristic of the Middle Eastern climate, and to prevent equipment failure due to high temperature, additional cooling systems using Peltier devices which have a simple cooling mechanism were fitted in particular to equipment that reaches high temperatures<sup>(5), (6)</sup>.

**SYSTEM CONFIGURATION DESIGNED FOR FULLY AUTOMATIC OPERATION**

In commercial operation, the Palm Jumeirah Transit System is a fully automatic system that does not require manual operation by a driver or operation control center staff (see Fig. 5).

**Automatic Operation System**

The on-board equipment systems are configured to automate all actions relating to the monorail operation such as driving and operating the passenger doors. In the event of an emergency, however, the system allows the train attendant staff to intervene and take prompt action.

Departure commands, route assignment, and other monorail operations are controlled automatically by the ATS (automatic train supervision) system<sup>(7)</sup>.

**Information Aggregation**

Because operation is fully automatic, surveillance of the overall system and monitoring of various information needs to be carried out from the operation control center or elsewhere, and therefore the system is designed so that on-board equipment fault data, vehicle status, and other information can be viewed at all times on the monitor in the vehicle and also, via train radio, on the display terminals in the ATS operation console. Also, the SCADA (supervisory control and data acquisition) operation console can display the operating status of the wayside equipment required for commercial operation and operate the electricity distribution equipment.

Other features include a video surveillance monitor system using CCTV (closed-circuit television) cameras installed in the stations, depot, and elsewhere and a train radio system that allows communication between the train attendant staff and passengers on each vehicle and the operation control center staff.

**Improved Reliability of Main Equipment**

Redundancy is improved by a system configuration that uses duplex systems for the ATS central control unit, SCADA central control unit, network system, electricity distribution equipment, and other key components needed for commercial operation to

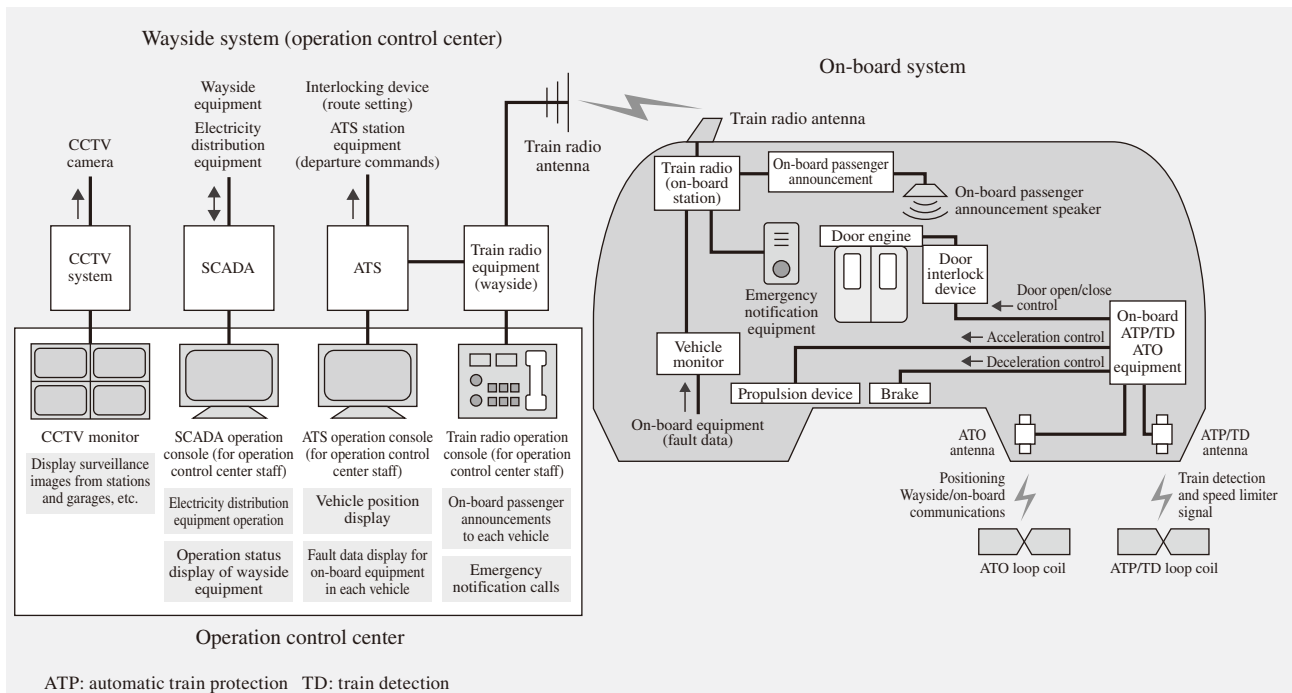


Fig. 5—System for Fully Automatic Operation.

The system is designed to automate all operations associated with driving the monorail and to collect data at the operation control center.

prevent services from being disrupted by the failure of one of the systems.

The system reliability is also improved by using facilities and equipment that have been proven through extensive past use both in Japan and overseas.

## CONCLUSIONS

This article has given an overview of various system components in the Palm Jumeirah Transit System.

It is common practice on overseas railway system projects, including monorails, for a single company to integrate all systems and supply on a full turnkey basis, and it is becoming common for the supplier also to handle O&M (operation and maintenance) after the service commences operation.

In the future, Hitachi intends to pursue full turnkey projects including O&M, not only in China, Southeast Asia, and the Middle East where Hitachi has supplied systems in the past, but also in emerging nations where measures to reduce CO<sub>2</sub> emissions in recent years are driving a shift from using automobiles as the primary means of transport to transportation systems in which public transport has a central role.

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