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Railway development in Saudi Arabia

Introduction

The first railway in modern Saudi Arabia was the 1050 mm narrow gauge Hedjaz railway from Damascus to Medina opened in 1908 and closed in 1915. Not until the end of the Second World War were modern railways introduced to this country. In 1947, construction work began on the section between the port of Dammam on the Persian Gulf to the Saudi Arabian Oil Company's (ARAMCO) warehouses located at Dhahran. This railway line was built by ARAMCO on behalf of the Saudi Arabian government and opened on October 20th, 1951. The Dammam-Dhahran line was initially operated by ARAMCO until 1968 when it was transferred to the state and has remained a public corporation ever since[1].

The Saudi Arabian network consists of two main lines: Dammam-Abqaiq-Hofuf-Riyadh (449 km) which is used by passenger trains and Dammam-Abqaiq-Hofuf-Haradh-Al Kharj-Riyadh (556 km) used by freight trains. In addition, there is a branch line between Dammam and King Abdulaziz Port. As of 2006, Saudi Arabia had a 1412 km long network of standard gauge track which is not electrified.

Railway projects in Saudi Arabia

There are four important projects launched by the Saudi Railway Organization (SRO) which are now in progress. These include a 444 km railway link between Mecca and Medina via Jeddah, the project of a 950 km land bridge between the ports of Dammam and Jeddah as well as a 115 km line between Dammam and Jubail, and a 2400 km North-South railway between the mines in the north (Al Jalamidh, Az-Zabirah) and the ports in the south (Ras Azour, Jubail)[2].

[1] H. Hughes, *Middle East Railways*, Continental Railway Circle, Kenton 1981, p. 98.
[2] The European Railway Server, www.railfaneurope.net [Accessed 30 May 2013].

The Haramain High Speed railway

The Haramain High Speed railway between Mecca and Medina will be electrified and adjusted to a maximum speed of 360 km/h. This line will have two tracks on its entire length. The central station of Mecca will be situated near the third Ring road while the Jeddah Central station will be located on the Haramain road. The station of Medina will only receive passenger trains. As for other stations on this high speed line, they will be located in the King Abdullah Economic City as well as at the Hajj terminal at Jeddah airport.

The project of the Al-Haramain High Speed railway (HHR) is financed from the state owned Public Investment Fund (PIF) and the money will come from three interest-free loans from the financial resources of the Fund. As for the PIF, it will be compensated for this service through budget allocations in the coming years. This project is very important for several reasons, the foremost of which is the growing number of pilgrims and visitors who come to Mecca and Medina throughout the year especially during the seasons and holidays. The project has many advantages as the Haramain trains will alleviate the pressure and congestions on the roads, provide a very high level of travel comfort and reduce the pollution caused by vehicle emissions. 35 fourteen-section trainsets were ordered by the SRO in Spain. These trains will resemble the Talgo electric high speed EMUs class 112 used by the RENFE. What is more, one similar royal train has also been commissioned by the Saudi Arabian Government. All of the trains will be equipped with the latest signalling and communication system.

The construction of the HHR is supervised by Dar Al-Handasa in joint venture with the Spanish company Getinsa, with the value of the contract amounting to SR 360 million. As soon as the line has been completed, it will be managed by the Scott Wilson Company for a period of 55 months. Apart from managing the railway, the company is obliged to provide administrative and consultative services as well as human resources and materials needed to prepare and complete the work.

The contract for the first phase of construction work for the HHR was awarded to the Al-Rajhi Alliance and the duration of the project implementation was 36 months with a project completion date of April 5, 2012. Because of the fact that some works have recently been added, the completion date for the project was extended to December 31, 2014.

The construction work on the HHR line was divided into two sections: one from the Mecca region (up to kilometre 276) and the other on the Me-

dina region (from kilometre 276 to kilometre 449). The first section features 103 bridges with a total estimated length of 31 km. Only ten bridges have been completed with work currently underway on 54 bridges. On the path of the train 90% of cuttings was implemented along with 55% of embankments. On the first section of the HHR as many as 571 culverts were implemented, 512 of which was built for the disposal of water while the rest was constructed for cars, pedestrians and other services. The second section of the line features 33 bridges with an estimated cumulative length of 4.6 km. On the train's path 86% of the cuttings and 48% of embankments were implemented. On the Medina section, 268 culverts will be constructed most of which are for the disposal of water. On the entire line from Mecca to Medina three camel crossings will also be constructed.

Regarding the railway stations on the HHR railway, the contract, worth SR 142 million, was awarded to Foster & Partners and Buro Happold joint venture. This is one of the world's largest consulting firms with great experience in international designs especially in mega projects. Each station will have a distinct identity along with a building envelope in order to respond to the respective cities they serve. The company will provide extensive facilities and a high quality passenger experience including generous circulation spaces and segregated arrival and departure zones. With regard to public areas, they will be environmentally controlled so as to enhance comfort and have filtered natural daylight throughout. In addition, the local and Islamic architecture will be taken into account particularly for Mecca and Medina.

Included in the second part of the project is the construction of railway tracks, the installation of signalling and telecommunication systems, electrification, operational control centre, the procurement of 35 train sets and their operation, their maintenance for 12 years as well as the establishment of specialized training centres for Saudi graduates. Not only the trains but also the expected operating density and the flow of traffic are taken into account particularly in the seasons of Hajj and Umrah, which will require the development of high quality technical specifications in order to ensure the safety and speed of operation.

The land bridge project from Jeddah to Dammam

The land bridge project aims to connect the Jeddah Islamic Port with the ports of Dammam ad Jubail by means of a 950 kilometre railway. This will also include the upgrade of the existing line between Riyadh and Dammam.

Intended both for passenger and freight traffic, this line will link the Red Sea with the Arabian Gulf in order to serve the shipping of containers either to domestic markets or the markets of the Gulf countries. The land bridge project consists of two proposed railway lines connecting Jeddah with Riyadh and Riyadh with Al-Jubail Industrial City, one of the most important industrial centres in the kingdom of Saudi Arabia and the Gulf region as a whole.

Thanks to the strategic location of Saudi Arabia, this project, launched in 2006, will have a significant impact on the transport routes in the region. It is also a unique opportunity for companies having developed railway technologies, the contractors of civil and mechanical works as well as numerous investors to contribute to this project that will radically change the transport, economics and social relations in Saudi Arabia.

The land bridge will enable the passage of cargo imported from East Asian countries to be transported to King Abdul Aziz port of Dammam and from Europe and North America to Jeddah Islamic port, attracting more cargo transit and generating savings in the regional freight economy. It is estimated that the number of handled containers will exceed 700,000 standard containers in 2015. As a result, over 8 million tons of cargo will be distributed in the kingdom and the neighbouring countries. With regards to passenger transport, it is expected that the lines Riyadh-Jeddah-Mecca, Jeddah-Riyadh and Jeddah-Dammam will serve several million passengers per year.

In November 2006, the landmark resolution in terms of the land bridge was approved by the Saudi council of ministers. It was announced that the government would provide financial support for the project. A 50-year concession was approved by the Saudi government along with the transfer of the Saudi Railway Organisation (SRO)'s assets to the concessionaire and the provision of all the land required for the operation of the railway free-of-charge. The government's resolution further announced the establishment of the Saudi Arabia Rail Regulatory Commission, whose task will be the supervision of the railway transport and the transfer of the existing railway network currently operated by the SRO as well as the transfer of the SRO's staff to the successful investor in accordance with the proposed procedures[3].

With the decree of the Saudi Arabian council of ministers, the Saudi Land bridge was established in order to assume the construction, development, operation and maintenance of the railway which will connect the western regions of the country with the eastern ones and those which links the centre

[3] Saudi Railways Organization, www.saudirailways.org [Accessed 31 May 2013].

of the kingdom with the eastern province. As for the company's capital, it will be within SR 5 billion and the Saudi government will have a 20% share while the remaining 80% share will be for the most successful consortium in the project. Four Saudi investment international consortia qualified to bid for the land bridge project: Agility Logistics Consortium, MADA consortium, Bin Laden Saudi consortium and Tarabot consortium.

Railway lines linking northern and southern parts of Saudi Arabia

The third important railway project launched by the Saudi Arabian government is to connect the north-western region of the kingdom rich in phosphates and bauxite to the port of Ras Al-Zour in the Gulf, which will be built to export these and other mineral ores. On January 7, 2012 the Saudi Arabian authorities signed three contracts valued at SR 2,34 billion ($ 625 million) with the aim of developing the railway network in the kingdom. The project includes linking Riyadh with the town of Hadita on the Jordanian border via Sadir, Kesim, Hail and Jof. The first contract concerns the construction of five passenger railway stations in Madzma'a, Kesim, Hail, Jof and Kariat. The second contract involves the building of railway workshops, gas stations and spare parts warehouses. The third contract, in turn, envisages the construction of 36 buildings located at various places in Saudi Arabia housing communication systems, the tools for necessary repairs and flats for management and workers[4]. According to the resolution by the Saudi Arabian government, the Saudi Railways Company will be in charge of the management and operation of the North-South railway. As for the company's capital it is estimated to be one billion Saudi riyals divided into 100 million shares of equal value where the nominal value is ten riyals per share. However, the extraordinary General Assembly may put all of the company's shares or part of them up for sale.

The Gulf Rail Project

The last important project realized in Saudi Arabia and other Gulf countries is called the Gulf Rail Project because of which all the Gulf countries will be linked with each other by means of modern railway. The Gulf Cooperation Council (GCC) trains are scheduled to start from Kuwait and go to Bahrain via Dammam in Saudi Arabia and from Dammam to the state of Qatar

[4] Elaph, www.elaph.com [Accessed 10 January 2012].

via Salwa. The GCC train will also link Qatar and Bahrain as well as Saudi Arabia and the United Arab Emirates terminating in Oman. It is estimated that the total length of track will be around 2116 km while the total length of the railway on the territory of Saudi Arabia will be 663 km.

The royal decree on assigning the Ministry of Transport to prepare detailed implementation studies of the project has already been issued by the King of Saudi Arabia, and a technical team affiliated to the Ministry of Transport was formed in order to develop further detailed studies and prepare engineering designs for the portion located in the Kingdom of Saudi Arabia. As for the technical team, it has started consultations for the development of primary bases for the work methodology as well as the steps required to be completed in that area according to the schedule that has been laid down.

The GCC rail project was commenced successfully and the design stage of the project has already been completed. With regard to the executive phase on the ground, it was started in 2013 and is expected to be finished in 2017. As the Kingdom of Saudi Arabia is a member of the Economic and Social Commission for Western Asia, it has popularised the project so that it can be expanded to other Arab countries. The Arab countries, in turn, have consented to the completion of the railway project leading to economic interdependence and integration between them. What is more, the GCC project will have a direct positive impact on the economies enhancing mobility and the transport of goods between the GCC countries as well as the freedom of movement of citizens and residents, which will, in turn, advance regional investment.

As for the total length of the railway line in each of the GCC countries, it is 2117 km and the distance is as follows: Kuwait – 145 km, Bahrain – 36 km, Qatar – 283 km, Oman – 306 km, United Arab Emirates – 684 km, Saudi Arabia – 663 km[5].

The rolling stock of the Saudi Arabian Railways

With regard to the first locomotives introduced to Saudi Arabia, they were of different types and manufactured mostly in the US. The first type of locomotives brought to Saudi Arabia, when the ARAMCO company was constructing the line from Dammam to Riyadh, was a 0-4-0 GE shunter delivered in 1947 in a total of three units nos. 29224-29224 and 30593. The power output of these locomotives was 109.5 kW.

[5] Saudi Railways Organization, www.saudirailways.org [Accessed 31 May 2013].

Another five GE locomotives, with the axle-formula Bo-Bo, were supplied to Saudi Arabia from 1947 to 1951 in a total number of seven units. The power output of the four aforementioned locomotives was 277 kW while the fifth had a power output of 292 kW.

The Alsthom Bo-Bo locomotives working in Saudi Arabia were brought from the Netherlands between 1954 and 1956, totalling seven units in all. They were purchased by the Saudi Arabian railways in 1976. Their power output was 620.5 kW. From 1947 to 1951, the Saudi Arabian railways (SRO) received six RS1 type four-axle locomotives manufactured by Alco with a power output of 730 kW. This was followed by the delivery of ten G18N Bo-Bo locomotives made by EMD in 1968 and 1974. The power output of these locomotives was also 730 kW.

In 1953, the SRO bought two FP7 locomotives made by EMD. They had four axles and a power output of 1095 kW. From 1956 to 1959, seven FP9A type locomotives made by EMD were delivered to Saudi Arabia. They had four axles and their power output was 1288 kW. In 1961, one GP18 type locomotive was bought by the Saudi Arabian Railways. This locomotive was manufactured by EMD and its power output was 876 kW. In 1973, the SRO commissioned one GP38-2 type locomotive manufactured by EMD. This four-axle locomotive had the power output of 1472 kW. In 1976, the SRO company purchased six locomotives type G18W. These locomotives had four axles and their power output was 809 kW. Also in 1976, three locomotives class GT22CW were supplied to Saudi Arabia. These six-axle locomotives made by EMD had the power output of 1656 kW. The last series of diesel locomotives delivered to Saudi Arabia in 1978, and mentioned in the book by H. Hughes, are six SDL38-2 locomotives made by EMD. These six-axle locomotives had the power output of 1460 kW[6].

As for the contemporary locomotives and train sets working on the Saudi Arabian network, they predominantly come from the US but a few locomotives were also made by Francorail and CNR Corporation (China).

Of all the Alco locomotives class 1000, delivered to Saudi Arabia in 1947, only one 1000 model is still in operation. These four-axle locomotives have the power output of 736 kW. Two four-axle locomotives made in 1953, by EMD, were purchased from ARAMCO and classified as class 1500. They were numbered 1006 and 1007. Their maximum speed is 110 km/h and their power output is 1141 kW. In 1956, the Saudi Arabian railways

[6] H. Hughes, op. cit., p. 111.

bought 7 locomotives type FP9A labelled as class 1502. These locomotives have a maximum speed of 110 km/h and their power output is 1288 kW. In 1968, the Saudi Arabian Railways (SRO) commissioned ten diesel locomotives class 1006 (G18N) whose maximum speed and power output are 110 km/h and 809 kW respectively. In 1973, one GP38-2 locomotive labelled as class 2000 was purchased by the SRO. The maximum speed of this locomotive is 110 km/h while its power output is 1472 kW. In 1976, the SRO received six locomotives class 1016 (G18W). These four-axle locomotives had the power output of 809 kW. In 1976, three GT22CW locomotives were also brought to Saudi Arabia. These six-axle locomotives can travel at a maximum speed of 110 km/h whereas their power output is 1656 kW.

Six SDL38-2 locomotives were delivered to the Saudi Arabian railways in 1978. Their maximum speed is 110 km/h while their power output is 1472 kW. One GP18 locomotive was rebuilt from class 1502 in the 1970s. This four-axle locomotive has a maximum speed of 110 km/h and their power output is 1104 kW. In 1981, the SRO company purchased five four-axle locomotives class 1100 (SW1001). Their maximum speed is 110 km/h and their power output is 809 kW. Six locomotives for Saudi Arabia were also made by Francorail in 1982. These locomotives run at a maximum speed of 160 km/h and their power output is 2650 kW.

Another series of locomotives built for hauling passenger trains is the class 3500. These six-axle locomotives were delivered to Saudi Arabia in 1981/1984/1997/2005 in a total number of 31 units. They were built by EMD. Their maximum speed is 160 km/h and their power output is 2576 kW.

In 2009, the SRO company commissioned five diesel locomotives for construction trains in CNR Corporation, China. These six-axle locomotives have a maximum speed of 100 km/h and their power output is 1880 kW. In 2012, the Saudi Arabian railways bought 25 six-axle SD70ACs type locomotives from EMD. Their maximum speed is 110 km/h while their power output is 3267 kW.

As for the train sets used by the SRO, eight six-section DMUs were built in 2012 by CAF in Spain, relabelled in Saudi Arabia as class 5000. They consist of a motor car and five coaches. In 2012, the SRO ordered nine more such trains to be used for the north-south railway in 2014[7]. A fact worth mentioning is that in May 2012 the General Management of the Saudi Arabian Railways stopped the operation of the Spanish train sets because of a defect in their

[7] The European Railway Server, www.railfaneurope.net [Accessed 1 June 2013].

technical programming. The representatives of CAF arrived in Saudi Arabia in order to repair the trains' programming and modify it so that it could meet the standards of the climatic and environmental conditions in Saudi Arabia[8].

The light railway (metro) in Mecca

In Mecca, there is a metro line famous for having the highest passenger capacity in the world. Known as the Makkah Mass Rail Transit Project, the metro was built in only 22 months and opened in 2010. Even though there is only one metro line in Mecca, it was announced in 2012 that the Saudi Arabian government had allocated $ 16.5 billion for the construction of the remaining four lines with a cumulative length of 182 km comprising 88 stations[9]. The metro line in Mecca is elevated and is 18.1 km long[10].

The first metro line in Mecca was completed in November 2010 and the service was initially limited to pilgrims from Saudi Arabia and the Gulf states. Having been built primarily to transport pilgrims to the holy sites at Mina, Muzdalifah and Mount Arafat near Mecca during the annual Hajj, the metro is intended to alleviate road congestion as well as replacing around 4000 buses.

The metro rolling stock comprises 17 train sets type A made of 12 cars (276.8 m long and 3.1 m wide) with overhead power supply manufactured by CNR Changchun Railway Vehicles, China. It was designed to be driverless and each 12-car train set has the capacity of carrying 3000 people which means that around 25,000 passengers can be transported per hour in each direction. Before entering the 300 m long platforms equipped with Westinghouse platform screen doors to control boarding, the pilgrims wait in two control zones each large enough to hold 3000 passengers. During the Hajj, tickets cost SR 250 or SR 100 on the last day of the pilgrimage.

The southern line of the metro is planned to be extended to the Grand Mosque while four other parallel lines are envisaged to serve the holy sites creating a network which would connect the area to Jeddah airport as well as to the future Al-Haramain high speed line connecting Mecca with Medina[11].

[8] Elaph, www.elaph.com [Accessed 3 May 2012].

[9] W. Mahdi, *Saudi Cabinet Approves $16.5 Billion Mecca Metro System*, Bloomberg Business, www.bloomberg.com/news/2012-08-14/saudi-cabinet-approves-16-5-billion-mecca-metro-system.html [Accessed 1 June 2013].

[10] Urban Rail, www.urbanrail.net [Accessed 1 July 2013].

[11] *Hajj pilgrims take the metro to Makkah*, Railway Gazette, www.railwaygazette.com/news/single-view/view/hajj-pilgrims-take-the-metro-to-makkah.html [Accessed 1 June 2013].

Conclusion

The railway transport in Saudi Arabia is blossoming and is being developed all the time. Such projects as the Haramain High Speed railway from Mecca to Medina, the land bridge between Dammam and Jeddah, the Gulf Rail Project and the construction of new railways linking the northern and southern parts of this country are awe-inspiring. The Saudi Arabian government policy as to the development of railway of their state is well-thought out and far-sighted as it will enable the citizens and foreigners to move rapidly not only to their work places but also to the holiest Muslim shrines in Mecca and Medina. It will also contribute to the rapid development of the country thanks to the constructed railway land bridge through the Arabian Peninsula as well as the new lines connecting the north with the south of Saudi Arabia, where a great deal of freight will be transported. The Gulf Rail Project, in turn, will be a pivotal moment for cargo traffic in the Gulf countries with regards to the economic and urban development of each of these states. As for the Meccan light railway system, it certainly accelerates the development of this holiest city of Islam taking into consideration its status as having the largest capacity in the world as well as prospects of further expansion within the city.