



COPENHAGEN METRO, M1+M2

Information

Document ID: CM-X-OMRT2-02-07-INFO-0004
Version: 1.0
Issue date: 2016-11-15
Issued by: Metroselskabet I/S
Pages: 12

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1 Background

For the continued operation and maintenance (O&M) of the Copenhagen Metro, M1+M2 Metroselskabet I/S are inviting O&M providers to prequalify for the tender of the O&M services.

The O&M services have until now been carried out by Ansaldo STS.

Ansaldo has with the approval of Metroselskabet engaged Metro Service A/S as the O&M Provider.

This description is for information purposes only. The conditions and specifications for the new O&M contract are included in the tender package.

2 Metroselskabet

In October 2007 the former Ørestadsselskabet, which was responsible for the construction of the Metro, was divided into By og Havn and Metroselskabet I/S.

The purpose of Metroselskabet is to:

- Operate the Copenhagen Metro, M1+M2.
- Build and operate the new metro lines – Cityringen including extensions to Nordhavn and Sydhavn.

Metroselskabet is a company owned by:

- The Municipality of Copenhagen 50.0 pct.
- The Danish State 41.7 pct.
- The Municipality of Frederiksberg 8.3 pct.

3 The Copenhagen Metro, M1+M2 today

3.1 General

The Copenhagen Metro, M1+M2 is a driverless metro system serving the citizens of Copenhagen and Frederiksberg. The Copenhagen Metro, M1+M2 has two lines running from suburban Vanløse to Vestamager and Lufthavnen (Copenhagen Airport), both situated on the island of Amager.

The lines share common tracks between Vanløse and a bifurcation after Christianshavn. The sections from Nørreport to Vestamager and Lergravsparken opened in 2002. The section from Vanløse to Nørreport opened in 2003 and the final section from Lergravsparken to Lufthavnen opened in 2007.



Figure 1: Copenhagen Metro line M1 and M2

It takes 23 minutes to travel from Vanløse to Vestamager or Lufthavnen. Most passengers spend a maximum of 6-7 minutes at a time in the Metro. The lines are 21 km – 10 km in tunnels and 11 km on elevated tracks and embankments. There are 22 stations of which 9 are situated underground. The control and maintenance center is situated in connection with the terminal station Vestamager.

The Copenhagen Metro, M1+M2 is part of the public fare system in the Copenhagen metropolitan area which also includes; the suburban railway (S-tog), intercity- and regional trains, local railways and busses.

The Copenhagen Metro, M1+M2 therefore cannot change their ticket prices single-handedly.

3.2 Timetable

The Copenhagen Metro, M1+M2 runs 24 hours seven days a week.

The interval between departures varies according to the time of the day and weekday. The passengers are only informed of the time interval between the trains and the average travel speed including stops is approximately 40 km/h.

3.3 Passenger vehicles

There are in total 34 driverless metro trains delivered by Ansaldo Breda (now Hitachi Rail). The trains are 39 meters long with three cars on shared bogies and have 6 doors on either side. The total normal capacity of each train is 300 passengers.



Figure 2: Copenhagen Metro, M1+M2 Passenger Vehicle

The trains have no driver cabin, but both front ends are equipped with a lockable control panel for manual driving in emergency situations. Besides the metro trains, a number of service vehicles are available.

3.4 Daily operation of the Metro

Managing and controlling the Metro takes place from the central control room at the Control and Maintenance Center. The Metro trains and stations are designed to function without dedicated staff. There are no regular procedures tying staff to the trains or stations, but staff circulate the system and permanent surveillance of the operation takes place from the central control room.

It is possible for the passengers to get in contact with the control room from permanent emergency call points in trains and at stations, and it is possible for the control room to communicate with the passengers via the trains' and the stations' public address system.

Both trains and stations are monitored via CCTV (Closed-Circuit TV). All recordings are stored.

Ticket Vending Machines and Rejsekort equipment are located at all stations.

3.5 Passengers with special needs

The Metro system is designed to be used by any group of passengers with special needs. This applies to amongst others; children, parents with prams, groups of children, physically and visually disabled.

Important elements are; the platform-level boarding, lifts between street level and platform, tactile markers and the call points mentioned above.

Bicycles are with certain restrictions allowed on the trains.

3.6 Traffic handling

The Copenhagen Metro, M1+M2 is double-tracked and the traffic is normally handled as right-hand driving. However, the system allows automatic operation in both directions on all tracks.

All stations are constructed with centrally placed platforms and the two tracks are connected between approximately every third station.

The trains are automatically driven to and from the control- and maintenance area , where the daily routines such as internal and external cleaning and shunting take place.

The trains are only handled manually in the proper workshop areas. The automatic and the manual areas are clearly separated. Besides the shunting possibilities at the control and maintenance center there are pocket tracks along the rail lines.

3.7 Technique and safety

The Copenhagen Metro, M1+M2 has a traditional 1435 mm rail gauge.

The traction power is 750 V DC and is supplied via a third rail.

The automatic train control system for the trains (ATC system) is a line block system. There is no external signaling. The trains run according to an internal time table. It is, however, possible to control them on the basis of the distance between the trains (even distribution of running trains).

All stations are equipped with platform screen doors, the underground stations and the "Lufthavnen" station have full height doors, the rest of the stations have half-height doors (platform gates).

All platforms and trains are equipped with emergency stops which can be activated by the passengers. Furthermore, all trains are equipped with derailment and collision detectors in the front, the activation of which will result in an emergency brake being applied.

4 Safety approval of The Copenhagen Metro, M1+M2

The safety of The Copenhagen Metro, M1+M2 has been approved according to a process agreed with the Danish Ministry of Transport in June 1995.

In May 1996 the Act on Railway Safety was passed (lov om jernbanesikkerhed). This includes the regulation for railway service on light rails which describes the special conditions of The Copenhagen Metro, M1+M2. In 2008 the act was replaced with Act on Railway (lov om jernbane).

Today the Danish Transport and Construction Agency (Trafik- og Byggestyrelsen), which reports to the Danish Minister of Transport, is the safety authority with regards to inspections and approvals.

The Accident Investigation Board (Havarikommissionen) is responsible for investigating specific hazardous events on the basis of the information required by law.

The safety approval mentioned earlier rests on four cornerstones:

1. BOStrab - defines on a comprehensive level the requirements for the safety of the technical installations and for the safety of the O&M provider and its employees. BOStrab is supported by a long list of technical detailed requirements embodied in the so-called "Richtlinien".
2. The CENELEC-norms - defines a safety life-cycle process (EN-50126 called the RAMS norm) for the entire installation and the safety requirements for the software for the communication and signaling systems for railways (EN-50128) and, finally, safety requirements for hardware for the communication and signaling systems for railways (EN-50129).
3. NFPA-130 - defines the requirements for emergency exits and installations which either prevent fires from breaking out or diminish the effect of fires which might have broken out.
4. The association and the use of an independent assessor who, in the case of The Copenhagen Metro, M1+M2, is TÜV InterTraffic in Cologne. The assessor is the independent, technical "expert" that controls details in connection with the technical solutions and also controls that the supplier's technical deliveries adhere to the determined safety requirements.

5 Operation and maintenance

The assets of the metro are

- Tunnels and structures, hereunder stations (the full station box, which also includes technical rooms, bicycle parking areas, stairs) transfer areas/tunnels, shafts, bridges and embankments
- Railway infrastructure including Power supply, Traction Power, Permanent Way, ATC, Automatic Platform Gates, Platform screen doors, Passenger security and information systems, SCADA, Access control systems and Intrusion detection systems, Radio communication systems and Transmission systems, Passenger counting system, Rejsekort system and Ticketing system
- Electrical and mechanical installations and equipment in tunnels, structures, stations, transfer areas/tunnels, shafts and CMC
- Passenger Vehicles and Service vehicles
- Control and Maintenance Center incl. outdoor areas
- Documentation, Manuals, Procedures

- IT systems and programmes
- Management systems
- Movable (løstøre)
- Consumables
- Spare parts

The list is not exhaustive.

5.1 Operation

Operation includes all activities related to passenger service and operation of the assets of the metro, including:

- Responsibility for all operation-related activities, operational reliability including the safety of operation
- Coordination of procedures and actions during fall back and emergency situations
- Staff circulating the trains and at stations
- Providing Passenger information and customer service
- Providing Ticket control
- Emergency Management planning
- Surveillance
- Reporting and documenting
- Operation of Management systems incl. SAP and IT systems
- Training and education of staff

5.2 Maintenance

Maintenance comprises preventive and corrective maintenance and cleaning of all assets of the metro, including:

- Planning of maintenance and cleaning
- Reporting and documenting maintenance and cleaning
- Maintenance of Management systems incl. SAP

Today the maintenance standard is based on the operation and maintenance manuals of the supply contracts which in details determine; the maintenance

tasks, its execution intervals, consumption of spare parts etc. to achieve the expected service life.

Part of the planned maintenance is based on The Copenhagen Metro, M1+M2 safety objectives and is thus intended to eliminate the risk of dangerous mistakes as far as practicable.

Based on the above-mentioned the preventive as well as the corrective maintenance is planned, controlled and reported in the maintenance system.

6 Reporting – Operation and maintenance

The state of the operation and maintenance of the Copenhagen Metro, M1+M2 is reported continuously to provide Metroselskabet with precise and sufficient documentation of the performance of the contract regarding; safety, management, operation, maintenance, passenger service etc.

7 Systems

The tasks of the O&M contract are managed by means of several systems.

A number of different systems is an integral part of operation and maintenance of The Copenhagen Metro, M1+M2. These can be divided into the following two main groups:

1. Closed systems e.g. ATC, SCADA, passenger security and information system.
2. IT systems for planning, administration, QA, accounting, storage control, planning and reporting on maintenance and data bases for configuration and recording. SAP is used as an overall modular designed platform for EDP.

All systems are owned by Metroselskabet and will be at the O&M provider's disposal.

8 Legal basis and standards

The construction, operation and maintenance of The Copenhagen Metro, M1+M2 are stipulated in a series of laws, announcements and standards.

These include amongst others:

- Lov om Metroselskabet og Arealudviklingselskabet (Act on Metroselskabet and Arealudviklingselskabet) regulating the structure and operation conditions of Metroselskabet.
- Lov om jernbane (Act on Railway) generally defining the conditions for railway operation and establishing the special conditions for safety on light rails, including the basic standards for approval of safety, organisation and process.

- Bekendtgørelse om jernbanevirksomhed på letbaner (Notice on Railway Operation for Light Rail) defining the particular conditions applying to The Copenhagen Metro, M1+M2, including a definition of the O&M provider as both infrastructure manager and railway operator.
- Bekendtgørelse om sikkerhedsgodkendelse af jernbaneinfrastrukturforvaltere (Notice on safety approval for infrastructure managers etc.) describing the requirements to the O&M provider for obtaining a safety certificate as infrastructure manager.
- Bekendtgørelse om sikkerhedscertifikat til jernbanevirksomheder (Notice on safety certificate for railway operators) describing the requirements to the O&M provider for obtaining a safety certificate as railway operator.
- Bekendtgørelse om tilladelse til at drive jernbanevirksomhed (Notice on approval for railway operators) containing requirements for obtaining approval for railway operations.
- Jernbanesikkerhedsdirektivet (Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community's railways). Contrary to other countries Denmark has chosen to include The Copenhagen Metro, M1+M2 in the implementation of the safety directive in Danish law.
- Elsikkerhedsloven, Lov nr. 525 af 29/04/2015 (Electrical Safety Act).

For further information about the above please refer to the homepage of Danish Transport and Construction Agency www.trafikstyrelsen.dk and Danish Safety Technology Agency www.sik.dk.

Furthermore, the abovementioned documents lay down part of the basic standards for The Copenhagen Metro, M1+M2. From the basic standards the following norms and standards are particularly emphasized:

- ISO 9001-2000 regarding quality management
- BOStrab with appurtenant Richtlinien
- DS/EN 50126 regarding the RAMS process
- DS/EN/50128 regarding safety requirements for software
- DS/EN/50129 regarding safety requirements for electronics.

9 Cityringen and extensions to Nordhavn and Sydhavn

Cityringen is a new underground metro under construction in Copenhagen. It will start operation in 2019.

The O&M services of Cityringen will be carried out by Ansaldo STS for a period of 5 years plus an optional extension of 3 years.

An extension to Nordhavn is also being constructed and is expected to open by the end of 2019 and construction of an extension to Sydhavn is currently being tendered with expected opening in 2023.

The Cityringen line will be M3 and the extensions to Nordhavn and Sydhavn will form M4 sharing tracks with M3 between København H and Østerport, more precisely between Havneholmen shaft and Østersøgade shaft.

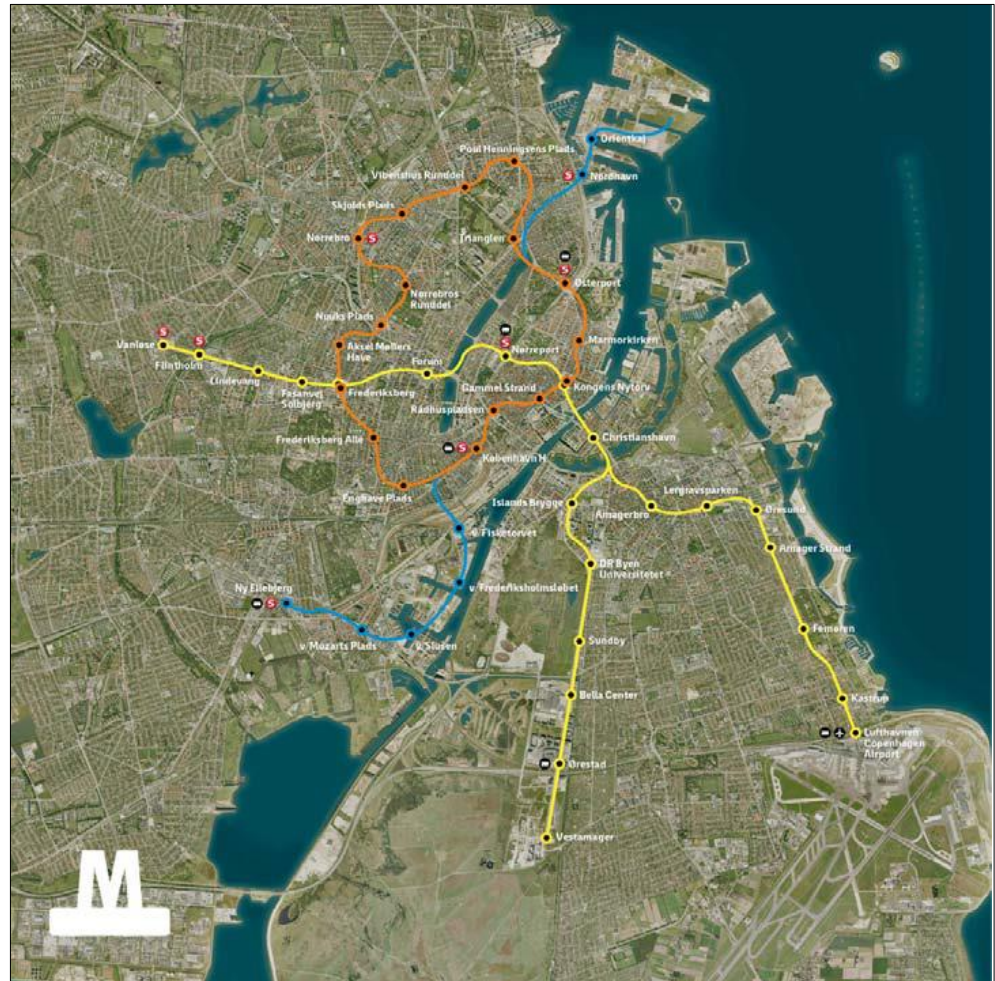


Figure 3: Copenhagen Metro, M1+M2 line M1 and M2 (yellow), Cityringen (orange) and extensions to Nordhavn and Sydhavn (blue)

Cityringen consists of 17 stations, the extension to Nordhavn includes a further 2 stations, one underground and one above ground. The extension to Sydhavn is planned to have 5 stations.

Cityringen will consist of two single track tunnels each approximately 16km in length, the extension to Nordhavn adds approximately 2,5km doubletrack and the extension to Sydhavn adds approximately 4,5 km doubletrack, mainly in two single track tunnels. Cityringen and the extensions to Nordhavn and Sydhavn will have their own Control and Maintenance Center located in Vasbygade. There will be no track connection between Copenhagen Metro, M1+M2 and Cityringen, but there will be two transferstations; Kongens Nytorv and Frederiksberg. The two metrosystems will be fully independent of each other.

Cityringen and the extensions shall operate 24 hours/7 days a week with a planned operational headway of approximately 100 sec. during rush hours.