

Guide for Fehmarnbelt Fixed Link sub-contractors on

- **Electrical & Mechanical equipment and services (TEM)**
- **Tunnel Power Supply (TPS)**

This guide deals with Electrical & Mechanical equipment and services (TEM) as well as Tunnel Power Supply (TPS) related to the Fehmarnbelt Fixed Link between Denmark and Germany, an 18 km immersed tunnel comprising two rail tracks and four road lanes. Sub-contractors interested in bidding on parts of these works for the main TEM and TPS contractors can find relevant information here on the bidding consortia, including who to contact for further information on work and services required.

Femern A/S anticipates that the prequalified contractor consortia in the ongoing bidding phase will need to negotiate sub-contracts with many small and medium-sized companies in Denmark, Northern Germany and elsewhere. Femern A/S is unable to facilitate direct contact between consortia and subcontractors, but would refer interested parties to this guide as well as our sub-contractor guide for the main contracts where more general information is available.



Femern A/S is tasked with designing and planning of a fixed link between Denmark and Germany across the Fehmarnbelt. Femern A/S is a subsidiary of the Danish, state-owned Sund & Bælt Holding A/S, which has experience from the construction of the fixed links across the Great Belt and the Øresund.

General information

The construction of the Fixed Link between Rødbyhavn and Puttgarden will be carried out as a number of contracts developed and managed by Femern A/S, a subsidiary of the state-owned Sund & Belt Holding A/S.

Femern A/S has divided the task into four major civil works contracts, a large contract on electrical and mechanical equipment and services as well as a number of railway contracts and smaller contracts that prequalified consortia will be bidding on.

The four main tunnel contracts, Tunnel North, Tunnel South, Portal and Ramps, Dredging and Reclamation, are in tender with nine prequalified international consortia. These four contracts are expected to be signed in 2015.

Three consortia have pre-qualified to bid for the Electrical & Mechanical equipment and services (TEM) contract and three consortia have pre-qualified for bids on the Tunnel Power Supply (TPS) contract. The contracts have a combined value of hundreds of millions euro. Contract signing is expected in early 2016.

Later there will be tender processes for two contracts on aesthetic lightning and toll equipment as well as for railway installations such as track work and overhead catenary/conductor rail systems. Apart from this, a number of contracts related to advanced activities on land at Lolland have been signed and work is in progress.

It may be a good idea for smaller companies to team up with others since the principal contractor consortia will be sourcing solutions spanning many different disciplines, i.e. turnkey contracts similar to those in the traditional building and construction industry. Medium sized enterprises will have better opportunities for independent agreements with the principal contractor consortia.

The principal contractor consortia are expected to emphasise that their sub-contractors should be able to supply good and reliable personnel, have a good command of English, which is the working language, demonstrate flexibility, possess core competences in their field and are prepared to work on cross-border projects.

In addition, it could be necessary for subcontractors to document experience in areas such as: management and quality control; labour market issues, including apprenticeships; occupational health & safety regulations; communication; references, e.g. international tasks; certification in accordance with ISO standards and reliability of supply and delivery.

(This guide will subsequently be updated with relevant information on upcoming tenders related to TEM and TPS).

Electrical & Mechanical (TEM) equipment and services

Three prequalified consortia comprising international contractors are bidding for the TEM contract at the Fehmarnbelt Fixed Link. The TEM tender covers a wide range of electrical and mechanical equipment for the entire tunnel, portals and control centre including a large software development project for the control system.



Tunnel special element

The link will consist of two rail tunnels and two dual carriageway road tunnels, the latter separated by a service and escape gallery. The link will be constructed as an immersed tunnel from 89 precast concrete elements, of which 79 are standard elements and 10 are special elements.

There will be a portal building at each end of the tunnel, which will contain the electrical and mechanical plant and equipment. These will serve as hubs for the utility services from Germany and Denmark, such as power, water, drainage, radio and telecommunications and the services distributed throughout the tunnels. Both buildings will be almost entirely below ground.

The standard elements will be interspersed with special elements located at intervals of just under 2 km along the tunnel. The special elements will have a larger cross section and will accommodate drainage sumps and a suite of plant rooms for the various electrical and mechanical installations that are needed to provide safe, secure and reliable operational service. The plant rooms will be below road and rail level, and the installations in each standard element will, in principle, also be identical.

The immersed tunnel approach offers opportunities to install the services in continuous sequences starting from the portals. Having ten identical special elements allows the services to be configured in modules that serve half the distance between special elements. This will increase overall system availability and will provide a means of testing and commissioning the services in sequence from the portals to the first special element and to the subsequent special elements. If this approach is adopted, the workload and risk

associated with final testing and fine adjustment, when the final tunnel elements are in place, can be reduced.

The challenges, however, arise from the fact that once manufactured, there is little that can be done to change the element structure.

The procurement process for the electrical and mechanical systems will in general seek:

- Experience in delivering large multi-disciplinary electrical & mechanical infrastructure projects
- Design expertise, including 3D Design/BIM expertise, whole life-cost focus, systems integration and interface management
- Design experience that shall include expertise in building a centralised software based supervisory control and data acquisition system based on modern IT architecture
- The construction in general also includes a safety culture and effective CSR policy, well-organised site management and logistics
- Systematic approach to verification, validation and commissioning
- Effective maintenance organisation and strategy

Special elements and standard elements

The 79 standard elements are on one level. They will all have the same geometrical shape and measure 217 metres in length, 42 metres in width and 9 metres in height. The standard elements will be identical, as will the installations contained in them. They are designed to accommodate all the box-outs, cast-in service containment routes, embedded anchors and niches, etc. for all electrical and mechanical equipment such as pumps, transformers and ventilation jet fans.

The 10 special elements between the standard elements are on two levels and measure 39 metres in length, 45 metres in width and 13 metres in height. The special elements will feature a lay-by for service and roadside assistance crews and a lower deck beneath the rail and road deck, which will accommodate the necessary servicing equipment for mechanical and electrical plant such as:

- MV substations
- LV main distribution boards
- UPS equipment
- Equipment related to Instrumentation Control and Automation (ICA)
- Sumps and pumps
- Fire suppression in special element technical rooms
- Hoists, hatches, raised floors, access doors etc.
- Access control
- Industrial lifts serving the two levels for moving equipment
- Rooms for rail equipment

Given that all equipment and requisite plant are basically to be contained by the special elements and the only effective source of clean and fresh air is via the gallery, it will be crucial to provide highly reliable ventilation and, not least, cooling, for sensitive equipment.

A particular challenge is inherent in the need for cooling in the unlikely event that electrical power fails. The electrical distribution systems must be designed to cope with such a situation and to provide suitable emergency supplies to allow orderly closure of the tunnel and to run control equipment to allow rapid resumption of service once power is restored.

Surface water, spillage and water from firefighting operations in the tunnel can be collected by gravity in a sump in the special elements and then pumped from one special element to another and eventually to collecting sumps in the portal buildings. Here clean water can be accommodated and discharged into the surface water drainage system and dirty water into the local sewerage system.

Portal buildings and Link Control Centre

The portal buildings are primarily spaces to accommodate plants and equipment linking the services in the tunnel with the local utility services. Equipment in the portal buildings will be very similar to that found in the special elements, with the addition of facilities to provide interfaces with the external utilities. Equipment in the portal buildings will also accommodate redundant server rooms for the IT-platform running the Instrumentation Control and Automation (ICA) system.

There will be facilities for storing and removing water from the tunnel and tunnel entrance area. Tanks and pumps will provide water for the firefighting systems in the tunnel. Electrical substations will be connected to the cables running from the utility supply company substation on Fehmarn and the primary large substation, which Femern A/S will have built on shore near Rødbyhavn. Connections to telecommunications and radio systems will also take place at the portal building.

A Link Control Centre (LCC) for the tunnel services is planned for installation in buildings to be developed as part of the toll facility. The LCC will incorporate the man-machine interfaces with the ICA-systems and communications equipment in the tunnel, as well as equipment necessary to operate the toll facility.

Tunnel communication, monitoring and control systems

Accurate and reliable systems are required throughout the entire tunnel to minimise accidents and failures. This requires the development of an integrated suite of communication, monitoring and control systems to ensure that any disruption to tunnel operation is quickly identified and corrected. The control system will be the primary tool for the operational management of the tunnel and must facilitate the gathering of operational statistics and the management of system maintenance.

The control system consist of three major parts: An IT platform capable of delivering a redundant and robust platform for all IT-based services within the fixed link area. An ICA system deployed on the IT platform - the system will operate a portfolio of coordinating systems and supporting services controlling and monitoring all physical and mechanical

installations within the fixed link area. The ICA system will also implement all business and control logic. A control room environment will give the operators access to a comprehensive graphical user interface for management, surveillance and control of the fixed link. Signals from plant and equipment distributed throughout the tunnel need to be available for monitoring at the LCC using the functionality typically found in ICA systems.

A key means of minimising and responding to operational incidents will be the traffic management system. To be effective, this system will have to extend several kilometres beyond each side of the tunnel. Apart from the provision of fixed and visible emergency call points, provision must be made for a wide variety of radio-based systems, which can be used by emergency services and staff responsible for the daily operations of the tunnel.

Road tunnel

Each of the two motorway tubes will contain two lanes, and a full emergency lane.

The ventilation system is based on a longitudinal approach, and in order to be effective this requires active traffic management through signage driven by an intelligent traffic management system. In order to secure a high level of safety, strict requirements will be applied for tunnel lighting. In addition, a number of aesthetic effects will be implemented, such as varied lighting, to enhance driver concentration and safety during passage of the tunnel. This will be handled in a later contract.

The road tunnel will be monitored constantly by means of a comprehensive traffic monitoring and control system comprising features such as dynamic signage and radio communication to keep drivers informed while driving through the tunnel or in the event of an incident.

The services required in the road tunnels will include the following:

- Tunnel ventilation
- Fixed firefighting system, such as a deluge or water mist system
- Wet fire hydrant system
- Road lighting
- Emergency escape doors to the gallery (100 m intervals)
- Emergency escape doors from the rail tubes
- Emergency call points
- Antenna system
- Air quality monitoring system
- Fire detection system
- CCTV system
- Public address system
- Traffic management signs

Gallery

The gallery will be about 2 meters wide and divided into three horizontal zones. The middle zone will provide access for service personnel and in an emergency will act as a place of safety. The top and bottom zones will be used as service corridors and will, in particular,

accommodate the various services linking the special elements and the operational plant in the tunnel.

Pipes for the sewerage system and pipes for water to supply fire hydrants and deluge systems will be placed in the zone beneath the floor. In the upper zone, there will be room for the installation of cable trays, service pipes and distribution equipment for lighting, LV power, and equipment for the various systems and services related to communication, monitoring and control (the ICA system). Service platforms will be required to reach installations mounted in the upper part of the gallery.

Since the gallery is a vital artery for the tunnel, the installation of equipment within it presents a number of challenges to ensure installation methods that are both safe and effective.

Rail tunnel

The two rail tubes in the tunnel are designed for the safe transit by trains travelling at speeds of up to 200 km/h.

The services required in the rail tunnels include:

- Tunnel ventilation
- Air quality monitoring
- Dry fire hydrant points
- UPS supported lighting
- Emergency escape doors at 100 m intervals
- Auxiliary power supplies at every fourth door
- Distributed antenna system (ensuring the various radio services to operate effectively)

Space will be available in the tunnel walkway to accommodate the cables forming one leg of the medium voltage (MV) ring distribution system to obtain system redundancy. The installation and commissioning of the main systems for the railway will be undertaken by other contractors. But parts of the TEM services installed may be subject to approval procedures by the railway authorities.

Maintenance

To ensure a smooth transition from construction and commissioning to operation, contractors will be asked to provide support and maintenance services during the early years of operation. The objective will be to ensure that the Fehmarnbelt tunnel becomes operational with the strongest possible maintenance team in place. It should be capable of dealing with problems from the transition to the operational phase quickly and effectively. The contractor must deliver a system for Asset and Maintenance Management to ensure that the tunnel is continuously open for service.

Consortia and contact persons for Electrical & Mechanical equipment and services (TEM).

The following three consortia have been prequalified to bid for the TEM contract,

Alstom Transporte

Consortium members:

Alstom Transporte S.A.U.
Alstom Transport Danmark A/S
Indra Sistemas S.A.
Technimont Civil Construction S.P.A.

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Short description of consortium:

Alstom Transport develops and markets a large range of systems, equipment and services in the transport sector. Alstom Transport solutions include among other things rolling stock, signalling, services and infrastructure etc. which can be offered separately, bundled or supplied as fully integrated solutions.

Alstom's force of employees numbers around 25.000 and spans five continents. Our solutions take into account the lifecycle of each product, from design to recycling, as well as its total lifecycle cost and future environment. The network of alliances and partnerships developed by Alstom allow the company to fulfil customers' growing demand for localisation whilst developing adapted products.

FEMC – Femern Electrical and Mechanical Contractors

Consortium members:

Cegelec Mobility
Actemium Cegelec GmbH
Vinci Energies GSS

Contact:

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M. Gunnar Colberg (Purchasing Manager for supply and services, Cegelec)
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M. Fabrice Vermont Desroches (Tender Manager for other requests, Cegelec)
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Short description of consortium:

Cegelec and Cegelec Mobility's story is closely linked to the development of the energy & electricity sectors. The company can trace its roots back to 1913. In 2010 Cegelec became a subsidiary of the VINCI Group's energy Division. With 63,000 employees in 46 countries and 9.25 billion Euro in revenue in 2013, VINCI Energies makes its expertise available to companies and public authorities for which it rolls out, equips and operates energy, transport and communication infrastructure, industrial sites and buildings. Cegelec Mobility core business offers a wide range of activities across the transportation infrastructure sector, taking advantage of the synergies between Rail and Road & Tunnels sectors in the field of power supply (traction power, electrification, MV and LV), mechanical & electrical services (ventilation, lighting, signalisation, fire detection and fighting, CCTV) and traffic management systems (e.g. SCADA). Cegelec Mobility provide its customers with engineering, construction and commissioning services for different types of projects (execution, design and build, PPP).

Actemium Cegelec GmbH designs, installs and maintains systems and equipment in all key industries as well as for the public sector. The company is headquartered in Frankfurt am Main. Actemium is a subsidiary of VINCI Energies International. Reference projects examples include the control and lighting technology of the Frankfurt airport runways, traffic control of the Hamburg Elbe Tunnel, power installation at the University Hospital in Magdeburg.

VINCI Energies GSS combines expertise and know-how in engineering and project management, as well as processes control and knowledge, working with integrated operational teams in partnership with other industrial companies and/or using the Group internal synergies. The company's work is based on four pillars: Power & Systems. Infrastructures & Mobility. Oil & Gas. Nuclear.

STRABAG Bravida Consortium

Consortium members:

STRABAG AG

Bravida Danmark A/S

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Lieu Bich (Head of Bid Management, Bravida)

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Short description of consortium:

STRABAG is an European-based technology group for construction services that create solutions for clients by integrating the most diverse services and assuming responsibility for them. The company employs about 73,000 people and is capable of offering services along the entire construction value chain – from design to planning, from construction to property and facility services, from operation all the way to demolition. A dense network of subsidiaries in European countries and on other continents is helping to expand the area of operation beyond the borders of Austria and Germany. STRABAG offers complete solutions in the areas of tunnel equipment, traffic systems and electrical plant engineering. STRABAG is also operating in Denmark.

Bravida Danmark A/S is a large supplier of technical installation and service solutions for building, plants and infrastructure in Scandinavia. Bravida employs more than 8,000 people in over 150 locations throughout Sweden, Norway and Denmark. Bravida Danmark provides solutions in a large range of areas, including energy, heating, water and air systems. The services cover technical installation and solutions for building, plants and infrastructure, including services within railway technology.

Tunnel Power Supply (TPS)

Three consortia comprising international contractors have been prequalified and are bidding on the TPS contract at the Fehmarnbelt Fixed Link. The TPS tender covers construction of a turnkey power substation east of Rødbyhavn to supply the tunnel's technical installations and deliver traction power for the trains.



Tunnel standard element

The terrain on Lolland is low lying, close to sea level. Owing to this the substation will be established on an elevated area surrounded by a wall that will serve as storm surge protection in case of dyke breaches or extremely high water levels at sea. Energinet.dk will construct two independent supply lines from Rødby and Nakskov respectively. They will be built as underground 132 kV cables and will end at the substation with distribution rails to which the fixed link's transformers will be connected.

The TPS contract covers installation of the other part of the substation that covers the transformers and coupling equipment for the overhead catenary power supply, tunnel supply and supply for the substation itself. Buildings will be constructed for the coupling equipment, control room and staff facility

A number of specialist tasks can be undertaken by well-prepared subcontractors including:

- Detailed design
- Supply chain management
- Installation.
- Testing, verification and validation.
- Commissioning

As regards the construction site, subcontractors will be required who are capable of taking on a number of miscellaneous tasks and can manage day-to-day routine tasks on an ongoing basis. This could involve:

- Security services
- Transport of goods etc.
- Caretaker function
- Emergency preparedness
- Waste management (potentially as an advanced recycling centre)

- Room rental
- Mobile telephone service
- Maintenance of transport facilities (vans, trucks) etc.

Consortia and contact persons for TPS

The following three consortia have been prequalified to bid for the TPS contract:

Bravida Danmark A/S

Consortium members:

Bravida Danmark A/S

Contact:

Lieu Bich (Head of Bid Management, Bravida Danmark A/S)

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Short description of consortium:

Bravida Danmark A/S is a large supplier in Scandinavia of technical installation and service solutions for building, plants and infrastructure with more than 8,000 skilled people in over 150 locations throughout Sweden, Norway and Denmark. There are 1,250 employees in Denmark. The company provides solutions in a large range of areas, including energy, heating, water and air systems. The services cover technical installation and solutions for buildings, plants and infrastructure, including services within railway technology. The company has a zero vision when it comes to workplace accidents. The Bravida CSR policy contains elements such as business ethics, human rights, apprenticeships, health and safety, environment and quality management systems.

The Management System is organised in accordance with ISO 9001, ISO 14001 and The Danish Working Environment Act. The Company hold a number of certifications - e.g. as an authorised supplier to Banedanmark.

Cegelec Mobility – Siemens A/S Consortium

Consortium members:

Cegelec Mobility

Siemens A/S

Contact:

Emmanuel Segui (Purchasing Manager on supply and services, Cegelec Mobility)

Niels Erik Hoey (Procurement Manager on supply and services, Cegelec Mobility)

Fabrice Vermot Desroches (Tender Manager, Cegelec Mobility)

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Short description of consortium:

Cegelec is a subsidiary of the VINCI Group (energy division). It has 63,000 employees in 46 countries and a 9.25 billion Euro revenue. VINCI Energies makes its expertise available to companies and public authorities for which it rolls out, equips and operates energy, transport and communication infrastructure, industrial sites and buildings. Cegelec Mobility delivers a range of activities across the transportation infrastructure sector, taking advantage of the synergies between Rail and Road & Tunnels sectors in the field of power supply, mechanical & electrical services (ventilation, lighting, signalisation, fire detection/fighting, CCTV and traffic management systems such as SCADA and ITS).

Siemens has more than 362,000 employees, and a 76 billion Euro sales, and is working with innovation, engineering and technology worldwide. Siemens Mobility offers an extensive portfolio of sustainable technologies in the areas of transportation and logistics, traction power products and solutions. The Rail Electrification Business Unit is a large supplier in its field. In our portfolio we have products, systems and solutions in the fields of traction power supplies, overhead contact lines and power systems control for urban and mainline transportation, as well as for industrial applications.

ELEKTROBUDOWA SA

Consortium members:

ELEKTROBUDOWA SA

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Short description of consortium:

ELEKTROBUDOWA SA was established in 1953. It is a joint-stock company listed on the Warsaw Stock Exchange. The company provides a complete range of construction and installation services and deliver projects for the power sector, the petrochemical industry, the mining industry and turnkey projects in connection with public utility facilities. The company operates on international markets and has about 2,000 employees. The company uses the experience and capabilities of carefully selected suppliers in order to maintain quality and economic efficiency of its services.