R701-1

Interfaces TTI-civil engineering

Overview of interfaces between tunnel installations and the tunnel structure

COB
Netherlands knowledge centre for underground construction and underground space

About

In order to use a tunnel safely, both a good structure and effective technical installations are required. It is therefore important during construction or renovation that the disciplines civil engineering and installation engineering are coordinated. This checklist provides an overview of important interfaces.

The COB project Identity the risks, as part of the tunnel programme, focused on preventing surprises during a tunnel renovation; inspections and preliminary research do not always provide sufficient insight. Among other things, the working group found that where tunnel-technical installations (TTI) and the tunnel structure meet, risks often arise. That is why these interfaces have been inventoried per (sub) system and component, with pointers for harmonizing the two aspects. This overview is an update of the *Raakvlakkenmatrix Handboek Tunnelinstallaties T116* (Dutch, 15 December 2009, 2nd edition).

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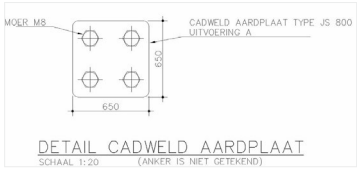
Contents

Terminology

Term	Explanation
ESC	Emergency short-cut: a mechanical construction for folding up part of the guide rail; this allows emergency vehicles to pass through to the other carriageway.
Clear width	Net space of a cutout, opening.
SB	Service building.
DN 150	A DN size indicates the diameter of the pipe.
HDPE	High density polyethylene (HDPE or PE-HD), conduits are usually made of this material because it is less brittle than PVC.
High voltage	Anything above low voltage.
Emergency station	Cabinet in the wall of an engineering structure that contains various safety facilities, particularly communications and fire extinguishing facilities, for road users and the emergency services. Emergency stations are not intended to protect road users from the effects of fire. There are different types of emergency stations, indicated by A, B and C. These are further defined in the SG.
Low voltage	Less than 1000 V AC or 1500 V DC.
Medium-voltage	Obsolete term due to modifications to standard.
Section	Repeating part of a tunnel; tunnels are often constructed in sections.
Section length	Length of a section.
Joints	Junction between different sections.
CTT	Central tunnel tube.
No-break	See UPS
Emergency power generator (EPG)	Combustion engine with generator (usually diesel) to generate electrical energy in the event of failure of the normal energy supply.
Pump room	Room where pumps are installed.
Pump sump	Room in which there is water together with submersible pumps.
Sunken pump	Deep area in which the pumps are installed
Static head	The height the liquid gains by being pumped.
STI	*Speech transmission index*, measure for intelligibility. A scale from 0 to 1 where 1 is excellent and 0 is unintelligible.
Storz coupling	Specific type of coupling. Often used by the fire brigade to connect hoses to pipes.
TT	Tunnel tube.
UPS	Uninterrupted power supply: system of batteries that can continue to deliver (part of) the energy supply for a limited period of time after the failure of the regular energy supply.
MG	Moveable guardrail: a mechanical construction that can clear a passage between two carriageways, for example in the context of maintenance of a tunnel tube or as a passage for emergency services during an incident.
SG(-C)	Safety guidelines (part C): guidelines for road tunnels. This document is a precursor to the National Tunnel Standard and contains background information regarding the required facilities.

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
1.1.1	High-voltage equipment room	SB procurement area	Connectivity	The bending radius of high voltage cables may not exceed 10 to 12 x cable diameter.	The bending radius of cables and pipes must be taken into account for ducts.	Provide cable cellar for high voltage cables if they enter from below.	
1.1.2	High-voltage equipment room	SB procurement area	Connectivity	The power supply must be connected to the available high-voltage connection.	A high-voltage room must be provided, in line with the specified dimensions in accordance with the energy supplier.	Does not apply to very short tunnels and underpasses, these may be equipped with a 3-phase low-voltage connection.	
1.1.3	High-voltage equipment room	SB procurement area	Required space	Specify space required for the energy building/service building.	Allow for sufficient space for incoming supply circuit.		
1.1.4	High-voltage equipment room	SB procurement area	Required space	Specify space and requirements in connection with grid operator maintenance.	Separate access to the room from the outside of the building.	Maintenance/inspection area/ accessibility.	
1.1.5	High-voltage equipment room	SB procurement area	Provision of access to and transport within service building	Specify dimensions in a timely manner.	Allow for sufficient space for the transportation of transformers and distributors to the SB procurement area.	Door widths, hatches, door width 2 metres, corridors, horizontal transport, vertical transport (hatches or lift).	

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
1.2.1	Earthing plates for earthing	TT	Prevention of stray currents	The earthing cable must be connected to the earthing plates or earthing rail.	The reinforcement of the concrete structure of the tunnel and the services building must be fitted with a minimum of X earth plates on both sides of the sections, these must be positioned within a radius of Y meters from the cable route.	By default a minimum of two earthing plates that may be no more than 5 metres from the cable route.	
1.2.2	Earthing plates for earthing	TT	Prevention of stray currents	The earthing cable must be connected to the earthing plates.	The reinforcement of the concrete structure of the tunnel elements and the services building must be fitted with a minimum of X earthing plates where the service duct is near the cable ducts. These should be positioned within a radius of Y meters from the cable.	By default a minimum of two earthing plates that may be no more than 5 metres from the cable route.	
1.2.3	Earthing plates for earthing 	TT	Prevention of stray currents	The ground plates on the expansion joints are connected to each other by means of a copper wire so that a continuous connection is created. The earthing plate must be positioned as close to the expansion joint as possible so that the copper wire is as short as possible. The earthing frame is also connected to bare copper busbars with a minimum diameter of 50 mm² located on both sides of the service tunnel duct.	Each section of a tunnel element is equipped with an earthing frame made of Ø12 welded-on reinforcement rods which are positioned transversely to the tunnel. Longitudinally, the earthing frames are connected to each other by means of a Ø16 reinforcement bar in each centre wall, which is fitted with an earthing plate at the end of the section.		
1.2.4	Various installations and components, present in the tunnel.	TT	Prevention of touch hazards	Touchable metal parts of live tunnel equipment must be conductively connected to the tunnel reinforcement.	Reinforcement must be suitable for making conductive connections to electrical components.	Where possible, in the case of a bored tunnel this is not feasible for all the individual elements.	
1.2.5	Service building	SB	Security	TTI must not be affected by lightning strikes on the services building.	Install a lightning conductor on the services building. According to standard NEN-EN-IEC 62305 class LPL II.		
1.2.6	Façade cladding steel structures service building	SB	Earthing	Any façade cladding, steel doors, grilles or other steelwork to be installed must be earthed.	Any façade cladding, steel doors, grilles or other steelwork must be fitted with earthing equipment.		
1.2.7	Various lightning sensitive components	SB	Security	All metal roof parts, such as chimneys, ventilation hoods, metal eaves, etc. must be fitted with a lightning conductor installation in accordance with NEN1014 PL3.	All metal roof parts, such as chimneys, ventilation hoods, metal eaves, etc. must be made ready for the connection of a lightning conductor.	Reference to old standard still in SATO.	
1.2.8	Civil constructions	SB, TT	Earthing	State the civil engineering items that must be earthed.	Prepare civil structures for earthing.		
1.2.9	Civil constructions	SB, TT	Earthing	State the civil engineering items that must be earthed.	Position conduits, for various earthing positions.		

1.2.10	Earthing	SB	Required space	State the space and position of the desired earthing in the energy/ services building.	Reserve space for the earthing installation in the Energy/Services Building.		
1.2.11	Earthing	SB	Required space	State the space requirements for measurements and earthing inspections.	Reserve space for taking measurements around earthing and lightning components.	Enabling measurements to be taken on the earthing system. Therefore, there must be sufficient accessibility.	
1.2.12	Civil constructions	SB, TT	Earthing	State the civil-engineering earthing positions.	Link the various civil engineering assets to earth.		
1.2.13	Civil constructions	SB, TT	Earthing	State the civil-engineering earthing positions.	Link the various civil engineering assets to earth.	Special facilities for equipotential bonding, the tunnel may deliberately have not been constructed on soil (for example Willemspoortunnel).	

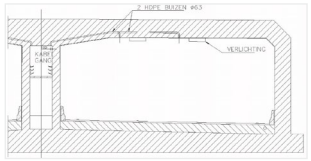
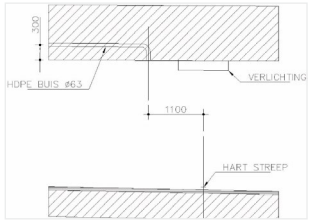
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
1.3.1	Wall sockets	TT	Maintainability	The energy supply for maintenance in the tunnel tube must fit in a casing of [dimensions]. It must be possible for supply cables of these devices to pass through conduits with an internal diameter of X mm.	Cutouts will be provided on both sides of the tunnel tube for energy supplies for maintenance purposes. These cutouts have internal dimensions of [dimensions]. Three conduits with an internal diameter of at least X mm are fitted, and minimum bending radius of Y mm.	Standard [dimension] is 850x550x300 mm. Choose a sufficiently large conduit, e.g. 70 mm with a bending radius of at least 500 mm.	
1.3.2	Wall sockets	TT	Maintainability	Power supplies in the tunnel must fit into a technical room of 850x550x300 mm. It must be possible for supply cables of these devices to pass through conduits with a 70 mm internal diameter.	Cutouts will be provided on both sides of the tunnel for energy supplies for maintenance purposes. These cutouts have internal dimensions of 850x550x300 mm. Three conduits with an internal diameter of at least 70 mm are fitted, minimum bending radius of 500 mm.		
1.3.3	Power supply cabinets	Access roads	Security	List the items along the route that must be protected against .	Provide power supply cabinet crash protection.		
1.3.4	Distributors	SB	Support	Specify locations, sizes and weights of distributors.	Provide sufficient supporting foundations for distributors.		
1.3.5	Distributors	CTT	Security	Specify locations of the distributors.	Provide fire partition between distributors for various tubes.		
1.3.6	Conduits	CTT	Connectivity	Specify locations of the distributors and the necessary conduits.	Embed conduits for the distribution of power supplies within the tunnel.		
1.3.7	Cables	SB, TT, CTT	Connectivity	Specify positions of cable conduits.	Provide sufficient cutouts.		
1.3.8	Distributors	CTT	Required space	Specify the dimensions of distributors (in the central tunnel tube/services building/energy building) including space for works.	Reserve space for distributors including space for working in the central tunnel tube/services building/energy building).		
1.3.9	Distributors	CTT	Required space	Specify dimensions of distributors (in the service duct/services building/energy building) including space for works.	Reserve space for distributors including space for working in the service duct/ services building/energy building).	Take transport to and from technical rooms in the service duct or hatches from the road surface, cross-connection into account. 	

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
1.4.1	Generator	SB EPG	Maintainability	Generator must be replaceable.	Floor must be able to support the load from the entrance to the generator room and facilitate replacement.	Consider hoisting beam winches and other supporting equipment.	
1.4.2	Generator	SB EPG	Reduction of fuel loss	Report detected fuel leakage via the control system.	Use a fluid-tight floor.		
1.4.3	Generator	SB EPG	Supply and extraction of air	Supply fresh air through an air shaft.	Incorporate cutouts for the inlet and outlet air shafts.	Separate air ducts for cooling air and exhaust air.	
1.4.4	Generator air vent	SB EPG	Pest and vandalism resistance	Install a pest- and vandalism-proof grille.	Position the grille at a height that reduces the risk of vandalism.		
1.4.5	Generator	SB EPG	Reduction of noise emissions	As a minimum, the legal requirements with regard to noise production must be complied with.	Install sufficient sound insulation.	Comply with local noise standards. Consider zoning plan, nearest façade or terrain boundary.	
1.4.6	Generator	SB EPG	Support	Generator must transmit as little vibration as possible to the floor.	Floor must be suitable for absorbing residual mechanical vibrations from the generator.		
1.4.7	Generator	SB EPG	Support	Weight of the total generator is a maximum of x Kg.	Floor must be able to bear the load from this component without passing on any vibration.	Floor load capacity (numbers are just examples!): 200 mW: 2.5 tonne/m² 100 mW: 1.75 tonne/m² 750 kW: 1.36 tonne/m² 300 kW: 1.10 tonne/m²	
1.4.8	Generator air vent	SB EPG	Supply and extraction of air	Specify required cutout for the air grille.	Make cutouts for the air vents.		
1.4.9	Generator connections	SB	Required space	Specify cutouts for fuel lines, cooling lines and emergency connections.	Make cutouts for fuel lines, cooling lines and emergency connections.		
1.4.10	Generator	SB EPG	Support	Specify mounting frame for EPG.	Embed mounting frame for EPG.		
1.4.11	Generator	SB EPG	Cooling	Specify required cooling for EPG.	Provide necessary air ducts for EPG cooling.		
1.4.12	Generator	SB EPG	Required space	Specify dimensions for EPG, cooling, fuel storage and space for emergency supply.	Provide space for EPG, cooling, fuel storage and emergency supply.	Space requirements for fuel storage depend on the desired volume (in litres). The requirements differ for each project with regard to dealing with power cuts.	
1.4.13	Hoisting structure	SB	Required space	Specify dimensions and weight of hoisting structure for EPG maintenance.	Provide space for the installation of a hoisting structure for carrying objects up to a maximum of X Kg.		
1.4.14	Diesel tanks	SB EPG	Required space	Tanks must be replaceable and inspectable.	Check load-bearing capacity of floor, apply liquid-tight floor, provide emergency shelter in case of leakage, ventilation.	Strict requirements must be met.	
1.4.15	Diesel tanks	SB EPG	Fuel supply	Specify space taken up by pumps, day tanks, pipework.	Make cutouts.		

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
1.5.1	Battery packs	SB no-break	Required space	UPS battery packs may be no larger than X by Y mm.	Provide space for the UPS system of X by Y mm.	Space to be determined.	
1.5.2	Inverter	SB no-break	Reduction of noise emissions	Select a low-noise UPS.	Install sufficient sound insulation.	Comply with noise standards.	
1.5.3	Battery packs	SB no-break	Support	Specify weight of battery packs.	Floor of the services building must have sufficient load-bearing capacity.		
1.5.4	Battery packs	SB no-break	Limiting leakage	Indicate the location of batteries.	Area where the battery packs are stored must have a fluid-tight finish due to battery leaks.		
1.5.5	Battery pack set-up	SB no-break	Limitation of fire damage	Specify separation between the different arrangements.	Provide for fire separation.	Fire resistance between different arrangements, so that only one battery arrangement fails in the event of a fire.	
1.5.6	UPS room air extractor	SB no-break	Required space	Specify cutouts for extraction.	Provide a cutout in the UPS area for the installation of an air extraction vent.		
1.5.7	UPS room air extractor	SB no-break	Required space	Specify cutouts for air treatment.	Provide a cutout in the UPS room for the air handling duct.	UPS working temperature is 20 °C. Maintain temperature within manufacturer's specifications.	
1.5.8	UPS	SB no-break	Required space	Specify space required for UPS in the energy/services building.	Reserve space for the UPS.		
1.5.9	UPS	SB no-break	Required space	Specify dimensions with regard to maintenance.	Reserve space for maintenance.	Space requirements for maintenance.	
1.5.10	Battery packs	SB no-break	Maintaining function	Specify temperature range, air duct size.	Keep forced air cooling (air ducts) in mind. Battery operating temperature is 20°C.	If the UPS is installed in the services building, provide space for air treatment. 	
1.5.11	Battery packs	SB no-break	Fire-proofing	Specify fire load and extinguishability.	Structural resistance to fire load, choose position in SB carefully.	Some types of battery packs pose a risk of unextinguishable fire.	
1.5.12	Battery packs	SB no-break	Environmental aspects	Specify the nature and characteristics of the chemical composition.	Structural design in accordance with chemical composition.	There will be various types of battery packs: are these suitable for application and should SB be set up accordingly?	

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
1.6.1	Transformer	SB high-voltage	Collecting oil	Oil-cooled transformers must be placed on a drip tray with a grid floor filled with gravel.	Drip tray for the oil-cooled transformer must be filled with gravel and have sufficient capacity to collect the oil from the transformer.		
1.6.2	Transformer	SB procurement area	Support	Weight of the transformer must not exceed X kg.	Floor in the transformer room must be able to support a load of X kg.	Weight to be determined.	
1.6.3	Transformer	SB	Maintainability	Specify transformer dimensions.	Ensure that transformer is replaceable.	Consider extra lifting devices, extra large doors and possible floor loads.	
1.6.4	Transformer	SB high-voltage	Reduction of noise emissions	As a minimum, the legal requirements with regard to noise production must be complied with.	Install sufficient sound insulation.		
1.6.5	Transformer	SB procurement area	Temperature control	Provide sufficient air supply and extraction so that the transformer remains within temperature limits.	Install grilles to outside or air ducts for forced cooling. 	Can apply to all transformers used. Technical room with space for air ducts for cooling and positive pressure. See also supplementary standard NEN 3840 - *Operation of electrical installations - Additional Dutch regulations for high-voltage installations*. 	
1.6.6	High-voltage equipment room	E-area in tunnel	Provision of access and transport within tunnel	Specify dimensions in a timely manner.	Allow for sufficient space for the transportation of transformers and distributors to the technical room in the tunnel.	Transport options in service corridors and/or hatches in road surface. E-spaces in tunnels are combined spaces for high-voltage equipment, distributors, UPS and low-voltage equipment. 	
1.6.7	High-voltage equipment room	CTT	Location	Specify the position of any transformers or distributors along the route.	Include enough conduits for the power supplies to the distributor circuit.	Conduits.	

1.6.8	High-voltage equipment room	CTT	Location	Specify the position of any transformers or distributors along the route.	Space for cable routes and ducts for the power supplies to the distributor circuit.	Cable routes.	
1.6.9	High-voltage distributor	SB high-voltage	Support	Specify distributor weight.	Floor of the services building must take the weight of the distributors into account.		
1.6.10	High-voltage distributor	SB high-voltage	Limitation of fire damage	Specify fire separation requirements.	Services building must comply with the requirements for fire barriers between installations.		
1.6.11	High-voltage equipment room	E-area in tunnel	Required space	Specify space requirements for equipment installed in the technical room.	Allow for sufficient space for incoming supply circuit.		
1.6.12	Air grille	SB high-voltage	Required space	Specify cutouts for airflow to cool transformers.	Allow for an air grille cutout.		
1.6.13	High-voltage installation	Various	Required space	Specify other cable cutouts and conduit requirements.	Allow for the placement of conduits and cutouts.		
1.6.14	Transformer	SB high-voltage	Required space	Specify space requirements for transformer in the services building.	Take dimensions of transformer into account.		
1.6.15	Transformer	SB high-voltage	Required space	Specify space requirements with regard to transformer maintenance.	Take maintenance dimensions of transformer into account.		

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
2.1.1	Profile of clearance	TT	Traffic guidance	Lighting fittings, including mounting hardware, that are attached to the ceiling of the tunnel have a maximum gross height of X mm.	Space for LTTI between upper limit of clearance and tunnel sealing is at least X mm.	For example 400 mm.	
2.1.2	Tunnel wall	TT	Lighting intensity	For the reflectance factor, it must be taken into account that the walls and ceiling consist of material X with reflectance factor of Y.	Tunnel walls are finished with material X with reflection factor Y.		
2.1.3	Tunnel wall	TT	Lighting intensity	Research into the optimal balance between reflection and lighting intensity.	Indicate civil engineering's influence on reflection.		
2.1.4	Tunnel wall	Various	Connectivity	Specify position and conduits for tunnel lighting.	Allow for embedded conduits for tunnel lighting.		
2.1.5	Tunnel wall	TT	Required space	Lighting is always installed perpendicular to the centre line on the ceiling. Where there are three lanes there will be two rows of lighting. Where there are two lanes there will only be one row of lighting. In the longitudinal direction of the tunnel, the position of lighting is a determining factor for counter-beam lighting. The same conduit may be used for rows of lights and counter-beam lighting. The spacing (centre to centre) must be determined separately for both.	Openings are made with Ø 63x55.8 mm HDPE pipes.	 	
2.1.6	Tunnel wall	Divers	Connectivity	Specify position and conduits for tunnel lighting.	Allow for embedded conduits for tunnel lighting.	Give special attention to the fire resistance of service mounted conduits. What are the consequences of a conduit burning through? 	
2.1.7	Fittings	TT	Connectivity	If necessary: specify cutouts for the fittings.	Allow for any cutouts for lighting fittings into account.		
2.1.8	Fittings	TT	Required space	Specify size of frames/anchor rails to be embedded.	Allow for embedded frames for tunnel lighting.		
2.1.9	Fittings	TT	Location	Specify drilling positions for lighting fittings.	Allow for drilling positions for lighting fittings.	Take standard section lengths into account.	

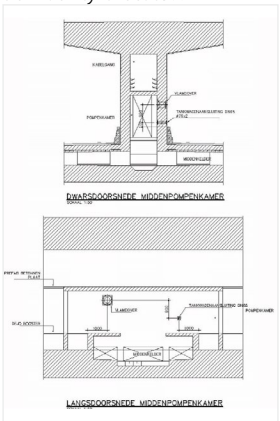
2.1.10	Fittings	TT	Required space	Indicate space requirements and position on tunnel roof.	Allow for lighting fittings on the tunnel roof.		
2.1.11	Tunnel wall	TT	Illumination intensity	Specify the maximum degree of pollution.	Robustness of solution against pollution, cleaning possibilities.	Prevent wall pollution in the long term.	
2.1.12	Tunnel ceiling	TT	Support cables and fixtures	State the nature and size of cables and cable ducts (and any fixtures) for attachment to tunnel ceiling.	Take into account the profile of clearance, if necessary. Embed pipes and anchors.	When cable ducts are applicable.	
2.1.13	Tunnel ceiling	TT	Mount fixtures	Specify way of mounting fixtures.	Come up with a solution that prevents having to drill holes again for replacements.	Over the years, a lot of drilling has been done in concrete, especially at the entrance. Prevent drilling damage and weakening construction.	

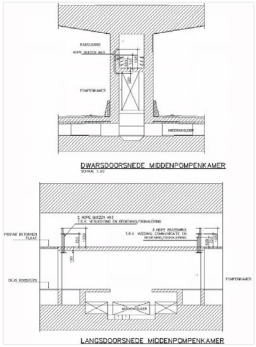
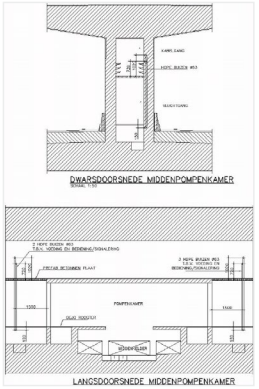
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
2.2.1	Tunnel wall	TT	Lighting intensity	Research into the optimal balance between reflection and lighting intensity.	Indicate civil engineering's influence on reflection.	Reach agreement on the type of finish and thus the reflection.	
2.2.2	Tunnel wall	TT	Lighting intensity	Research into the optimal balance between reflection and lighting intensity.	Indicate civil engineering's influence on reflection.	Reach agreement on the type of finish and thus the reflection. For example: only the first part with tiles, the rest of the tunnel with sprayed concrete. 	
2.2.3	Escape route lighting	CTT	Required space	Indicate space requirements and position in the central tunnel tube.	Allow for lighting fittings on the roof of the central tunnel tube.	Consider the height of people, at least 2 metres vertical clearance incl. equipment. 	
2.2.4	Escape route lighting	CTT	Connectivity	Specify the position of the escape route lighting.	Allow for embedded conduits for the power supply.		
2.2.5	Escape route lighting	Cross-con-nection	Required space	Indicate space requirements and position in the central tunnel tube.	Allow for clearance for lighting fittings on the service tunnel roof.	Bore tunnel.	
2.2.6	Escape route lighting	Cross-con-nection	Connectivity	Specify the position of the escape route lighting.	Allow for embedded conduits for the power supply.	Bore tunnel.	
2.2.7	Evacuation lighting	CTT	Connectivity	Specify the position of the evacuation lighting.	Allow for conduits for the power supply.		
2.2.8	Evacuation lighting	Cross-con-nection	Connectivity	Specify the position of the evacuation lighting.	Allow for conduits for the power supply.	Bore tunnel. 	
2.2.9	Traffic guidance lighting	TT, Access roads	Connectivity	Specify the position of the traffic guidance lighting.	Allow for embedded conduits for the power supply.		
2.2.10	Fittings	TT	Location	Specify drilling positions for fittings.	Allow drilling positions for fittings.		
2.2.11	Fittings	TT	Required space	Specify dimensions of various fittings.	Allow for the installation of fittings.		

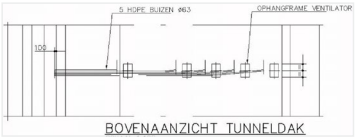
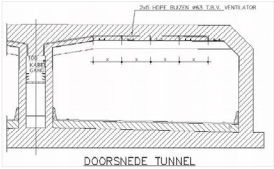
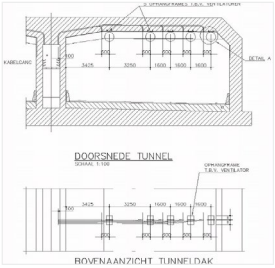
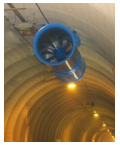
2.3 Site

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
2.3.1	Light towers	Access roads	Security	Specify method of crash protection.	Install crash protection.		
2.3.2	Light towers	Access roads	Maintainability	Put maintainable parts in accessible places. Coordinate locations.	Room must be available for possible maintenance.		
2.3.3	Light towers	Access roads	Support	Specify light towers on engineering structures with associated foundations and anchors.	Allow for foundations and anchors for the installation of light towers on engineering structures.		
2.3.4	Light towers	Access roads	Connectivity	Specify light towers with corresponding cable routes and conduits.	Fitting conduits to engineering structures and ground strips.		

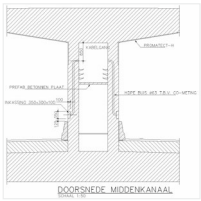
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
3.1.1	Pump system control cabinet	SB pump room	Location	Water drainage system control cabinet must be installed in the space reserved for it in the TTI pump room.	A space of at least X*Y mm must be reserved for the drainage system control cabinet.	Standard control cabinet: 1200*800.	
3.1.2	Water sump	SB pump room	Specify pump head	Minimum static head of the road tunnel pumping facility is Y m.	Bottom level of the water sump including the sunken pump is not deeper than Amsterdam Ordnance Datum level X m.		
3.1.3	Water sump	SB pump room	Required space	Pumping capacity of the road tunnel pumping facility must be matched to the capacity of the water sump.	Water storage capacity of the water sump is at least X m³ (including emergency storage of X m³).	For example 585 m³.	
3.1.4	Water sump	SB pump room	Required space	Contaminated water must be pre-cleaned before it can be discharged.	Allow for extra space due to e.g. a pleated filter, sand traps, flange diameters and bends.	Only applicable if local environmental requirements make this so. 	
3.1.5	Water sump	Tunnel pump sumps	Required space	Pumping capacity of the road tunnel pumping facility must be matched to the usable water storage capacity of the water sump.	Capacity of the water sump is at least X m³.	Only a leak water bore tunnel, several small pump sump.	
3.1.6	Water sump	SB pump room	Depth and pumps correspond	Water sump will be equipped with Y pumps with a maximum surface area of X m²/pump.	Surface of the sunken area where the pumps are located is at least Y*X m².	For example: 3 pumps and 3 m²/pump. A sunken location is efficient because pumps are usually not allowed to run dry. Due to a deeper location, more efficient use can be made of the rest of the water sump.	
3.1.7	Tanker connection	SB	Required space	Discharge any hazardous liquid present in the water sumps to an alternative container, road tanker or tanker located outside the tunnel by means of a permanent provision on the pump system, preferably by means of a Storz connection to the pump system's main discharge pipe. In this situation an earthing point for earthing the road tanker or tanker must be present.	Provide cutouts for the disposal of contaminated water.		

3.1.8	Tanker connection and flame arrestor	SB	Required space	Flame arrestor is fitted to the aeration/de-aeration tube between the tunnel and the central pump room. The tanker connection is inserted in the wall between the tunnel and the central pump room.	Tanker connection is inserted in the wall between the tunnel and the central pump room. It is a Ø76 steel pipe with two flanges.	Flame arrestor ensures that no flame penetration can take place where the central pump room de-aeration/aeration facility is located.  A hose can be connected to the tanker connector so that fluids can be drained to a tanker which may not be pumped to the main water sump.	
3.1.9	Discharge point	Infiltration zone	Provide sufficient discharge capacity	Discharge point must have a capacity of at least X m³/h for the discharge from the water sump.	Maximum discharge capacity from the road tunnel's water sump is X m³/h.	380 m³/h.	
3.1.10	Submersible pumps	SB pump room	Maintainability	Submersible pumps within a water tank do not need to be repaired on site but must be replaceable.	Submersible pumps within a water tank must be accessible from above via cutouts and/or access hatches.	See photo below: on the left hand side there are two guide pipes along which the submersible pumps can sink/rise. The orange cables are power cables and on the left you can see another hoisting cable. 	
3.1.11	Submersible pumps	SB pump room	Maintainability	Submersible pumps within a water tank do not need to be repaired on site but must be replaceable.	Submersible pumps within a water tank must be able to be lifted by means of a lifting beam.		
3.1.12	Access hatches	SB pump room	Facilitate placement of pumps.	In the pump room, hatches must be taken into account with regard to placement of the pumps. One hatch per pump and cutouts with a clear width of X mm by Y mm.	Cutouts with a clear width of X mm by Y mm are made between the pump room and the pump room.	Example of a common clear width: 1200 x 800 mm.	

3.1.13	Pump room	SB pump room	Gas tightness	Hatches and ducts between the pump room and the water sump must be closed tightly and without any gap.	Do not install unnecessary conduits between the pump room and the water sump.	Also applies to level sensor duct. 	
3.1.14	Central pump room	CTT	Connectivity	Conduits run from the central pump room to the cable duct.	Conduits are made with Ø 63x55.8 mm HDPE pipes.		
3.1.15	Dry pump set-up	SB pump room	Maintainability	It must be possible to dismantle the dry pump arrangement on site.	Dry pump installation area must be sufficiently large so that the pumps can be dismantled on site.	Required size depends on type; follow factory specifications.	
3.1.16	Ventilation point	SB pump room	Connectivity	Cutout in the floor of the pump room must be equipped with a Ø X mm de-aeration and aeration pipe.	Provide a Ø Y mm cutout in the floor of the pump room.	Diameter should be dimensioned to the maximum inflow of rainwater or maximum pump flow. For example Ø 200 mm for the pipe if the hole is Ø 250 mm. As the inflow increases, so does the venting.	
3.1.17	Pump well	CTT	Connectivity	Conduits run from the bilge pump to the cable duct.	Conduits are made with Ø 63x55.8 mm HDPE pipes.		
3.1.18	Water evacuation pipe	SB pump room	Connectivity	Cutout in the floor of the pump room must be equipped with a Ø X mm water evacuation pipe.	Provide a Ø Y mm cutout in the floor of the pump room.	For example Ø 50 mm for the pipe if the hole is Ø 75 mm.	

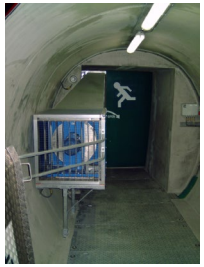
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
3.2.1	Fan	TT	Required space	Reversible fan, including mounting bracket, has a maximum gross height of X mm.	Space for the reversible fan between the top of the clearance and the tunnel sealing has to be at least X mm.		
3.2.2	Fan	TT	Required space	Fan has a maximum gross length of up to Y mm.	Reserve at least X mm for the fan including the descending parts.	For example, reserve a length of 8 metres, and 14 metres.	
3.2.3	Fan 	TT	Connectivity	Specify location of conduits.	The Ø63x55.8 mm HDPE pipes are placed deep into the tunnel roof due to space and pre-stressed tendons. Number of pipes depends on the number of fans, however use one double pipe per fan.		
3.2.4	Fan frame	TT	Required space	Specify the dimensions of the mounting frame.	Suspension frame is incorporated into the structural concrete and sits above the heat-resistant cladding on the roof.		
3.2.5	Fan	TT	Location	Indicate the location of the fans. For example, record by means of: the fans must be placed at a distance of X meters with a bandwidth of +/- x meters in relation to the tunnel entrance Y.	Provide space for the installation of fans. Possibly use a camel hump. The fans/ camel hump grille must be placed at a distance of X meters with a bandwidth of +/- Z meters in relation to the tunnel entrance Y.	Tolerance in the bandwidth is often quite wide, for example about +/- 10 meters.	
3.2.6	Fan	TT	Location	Indicate the locations of the fans.	Embed the conduits and take the position of the fans into account.	Sufficient space available in the upper part of the bored tunnel. Take clearance and fan diameter into account. 	
3.2.7	Entrance fans	TT	Required space	Entrance fans push the air into the tunnel at not too steep an angle.	Design of the entrances must be such that the positioning and the flow profile of the entrance fans are not obstructed.		
3.2.8	Fan	TT	Connectivity	Specify desired embedded conduits, suspension structure and location.	Embed the conduits and take the position of the fans into account.		
3.2.9	Chimney	TT	Required space	Specify chimney size, position, accessibility for maintenance and energy supply.	Install a chimney that meets the specified requirements.	If a chimney is included in the design: the larger the dimensions of the tunnel (length, lanes) in combination with the tunnel category, the larger the chimney for the extraction of air.	

3.3 Monitoring of C, CO, visibility and hydrocarbon

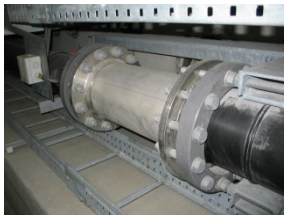
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
3.3.1	Visibility sensor	TT	Visibility monitoring	Visibility monitoring system, including mounting hardware, which is attached to the ceiling of the tunnel have a maximum gross height of X mm.	Space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.	For example 400 mm.	
3.3.2	Wind speed sensor	TT	Measurement of air velocity in tunnel tube	Wind speed sensors, including mounting hardware, which are attached to the ceiling of the tunnel have a maximum gross height of X mm.	Space for TTI between the top of clearance and the underside of the tunnel roof is at least X mm.	For example 400 mm.	
3.3.3	CO monitor	TT	Connectivity	Specify embedded conduits to be positioned.	The Ø63x55.8 mm HDPE pipe for the CO monitoring system is embedded in three places in a tunnel. One at the deepest point of the tunnel and the other two at about 100 m before the beginning and the end of the closed section of the tunnel respectively. Where the pipe leaves the tunnel, a 350x300x100 cut-out is made. After laying the cables and pipes, seal the pipes with PU foam for a distance of approx. 50 mm.	Monitor the concentration of carbon monoxide (CO) in both tunnel tubes. Based on the measured CO values, the tunnel ventilation system can be activated or not. 	

3.4 Positive pressure ventilation of (pump) rooms

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
3.4.1	Positive pressure fan	SB pump room	Required space	Ceiling of the pump room must provide surface area for the pressure relief fan.	Pressure relief fan must be attached to the ceiling of the pump room.	For example 800*800.	
3.4.2	Air duct positive pressure fan	SB pump room	Connectivity	Air duct from the pressure relief fan must be connected to a cutout in the front wall of the pump room.	Front wall of the TTI pump room must have a cutout for positive pressure ventilation.		
3.4.3	Air duct grille	SB pump room	Required space	Cutout in the front wall of the TTI pump room must be fitted with a grille on the outside to prevent the ingress of rain.	Cutout in the front wall of the TTI pump room must be suitable for fitting a rain-proof grille on the outside.		
3.4.4	Entrance door	SB pump room	Air loss limitation	A gap of X mm should be taken into account around the entrance door to the TTI pump room.	There must be a maximum space of X mm between the entrance door and the frame.	For example 2 mm.	
3.4.5	Entrance door	SB pump room	Air loss limitation	Entrance door to the pump room must open inwards and be fitted with a door closer.	Frame of the door to the pump room must be designed in such a way that the door opens inwards and is fitted with a door closer.	Pump room must be pressurised because of the danger of explosion in the event of a release of gases from vehicles.	
3.4.6	Fan	SB pump room	Required space	Specify desired embedded conduits, suspension structure and location.	Embed the conduits and take the position of the fans into account.		

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
3.5.1	Escape route positive pressure ventilation	SB	Ease of opening	Pressure relief fan must not create more than X bar of positive pressure.	Opening force of the escape door may not exceed X newton with the escape route positive pressure ventilation switched on.	X = 60 N	
3.5.2	Fan	SB	Required space	Specify desired embedded conduits, suspension structure and location.	Embed the conduits and take the position of the fans into account.		
3.5.3	Cross-connection positive pressure ventilation	TT	Required space	Cross-connection between the tunnel tubes must be pressurised in the event of an emergency.	Embed the conduits and take the position of the positive pressure system into account.	Gases/smoke released from the road tunnel cannot enter the cross-connection; not even with the door open. 	
3.5.4	Escape route positive pressure ventilation	TT	Ease of opening	Pressure relief fan must not create more than x bar of positive pressure.	Opening force of the escape door may not exceed X Newton with the escape route positive pressure ventilation switched on.	X= 60 N; use sliding doors.	
3.5.5	Service corridor positive pressure ventilation	SB	Required space	Service corridor under the road surface must be pressurised.	Embed the conduits and take the position of the positive pressure system into account.	Gases released from the road tunnel cannot enter the service corridor (WST: space of 5 x 20 m excluding air ducts to service corridor on both sides of the tunnel). 	
3.5.6	Positive pressure ventilation escape route	TT, CTT	Generate positive pressure	Specify the maximum permitted loss due to leakage.	Take measures to prevent unnecessary air loss.		

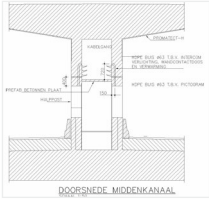
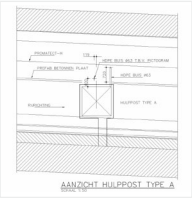
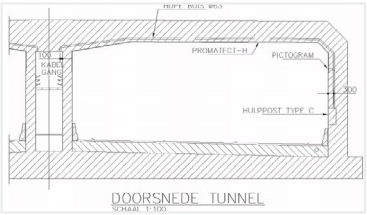
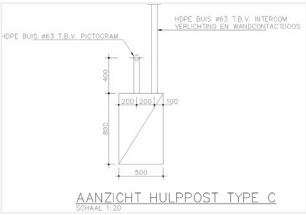
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
4.1.1	Fire hose	TT	Firefighting	Fire hose is of the type DN X.	Reserve space in the tunnel's cable duct for a DN X pipe.	For example DN 150. Material GRE or hot-dip galvanised steel PE, depending on the application.	
4.1.2	Fire extinguishing water tank vent	SB	Ventilation	A DN X vent pipe must be attached from the fire water tank to the front of the service building in order to vent the extinguishing water tank.	The various floors and the front of the service building must be fitted with DN X ducts to ventilate extinguishing water tank.	For example DN 80.	
4.1.3	Bilge pump in extin-guisher pump room	SB extin-guishing pump room	Keep extin-guisher pump room dry	Bilge in the extinguisher pump room is equipped with a bilge pump.	Bilge of the dimensions X * Y * Z meters must be provided in the extinguisher pump room.	For example 0.5 m x 0.5 m x 0.5 m.	
4.1.4	Extinguisher pump room floor	SB extin-guishing pump room	Keep extinguisher pump room dry	Sloped floor must be taken into account.	Floor of the extinguisher pump room shall be laid at a slope so that it drains into the bilge.		
4.1.5	Fire extinguishing water filling point	SB outside	Type and conduit	A filling point with [number] [type] con-nections for the fire brigade will be pro-vided outside the east service building.	North façade of service building east is to be provided with a conduit for a filling point for the fire brigade.	For example 3 Storz connections.	
4.1.6	Fire extinguishing water filling point	SB outside	Required space	Filling points for the fire brigade are installed in cutouts in the facades of the service buildings.	Façade of the service buildings must have a cutout in which filling points are installed for the filling points for the fire brigade in the services buildings.		
4.1.7	Fire hose in cable duct	TT	Required space	Fire hose must be inserted in the cable duct/sand trap.	Space must be reserved in the cable duct/sand trap for a fire hose of up to DN200.	Lowest pipe. 	
4.1.8	Fire hose in cable duct	TT	Maintaining function	Conduits from the service corridor to the emergency station must be taken into account.	Fire hose conduit must be run from the service corridor to the emergency station.	Fire hose is DN150. 	

4.1.9	Fire hose in cable duct	TT	Maintaining function	Fire hose must safeguard functionality in the event of a fire in service corridor.	Space must be reserved in the cable duct for a fire hose of up to DN X.		
4.1.10	Fire extinguishing pump	SB extin-guishing pump room	Required space	Extinguisher pumps are located in the service building.	A space of at least X m² per fire extinguisher pump must be reserved in the services building.	For example 5 m² for a 90 kW pump depend-ing on length of both sides of tunnel. 	
4.1.11	Fire extinguishing water tank	SB extin-guishing pump room	Required space	Extinguishing water tank is located in the service building.	A space of at least X m³ must be reserved in the services building for the water tank.	For example 120 m³. The extinguishing water tank can also be constructed below the access road.	
4.1.12	Fire extinguishing system	CTT	Required space	Coordinate space requirements, conduits, extinguisher pump set-ups and pipe runs in the central tunnel tube.	Provide space, embedded conduits, extinguisher pump set-up room and pipe run in the central tunnel tube.		
4.1.13	Fire safety systems	TT	Required space	Coordinate space requirements for fire doors for compartmentalisation of service corridors.	Each km must be provided with fire doors, fireproof conduits for cables and pipes.	Prevents economic damage to equip-ment in service corridor and service rooms in the event of a fire in service corridor and/or fire in a tunnel tube.	

4. FIRE SAFETY

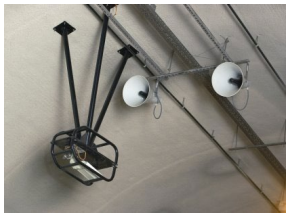
4.2 Tunnel fire detection

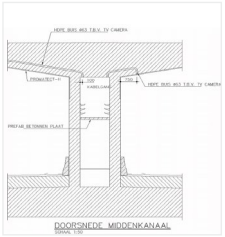
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
4.2.1	Means of detection	TT	Required space	Fire detection system, including mount-ing hardware, that is attached to the ceiling of the tunnel have a maximum gross height of X mm.	Space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.	For example 400 mm. 	

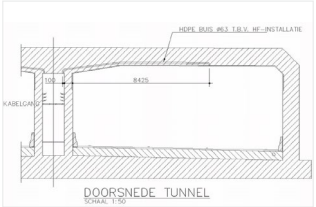
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
4.3.1	Emergency station sign	TT	Promote self-rescue	Emergency station cabinet must have a cutout for the cable conduit to the sign.	A cable conduit must be provided X mm above each emergency station for the supply cable to the emergency station signs.	Cable conduit for emergency station sign.	
4.3.2	Emergency station	TT	Required space	An emergency station type B has be installed in the tunnel must fit in a X * Y * Z mm cutout.	Outer walls of the closed section of the road tunnel are to be provided with cut-outs with the dimensions X * Y * Z mm for type * emergency stations.	Emergency station types in accordance with safety guidelines. For example: 1000 x 1000 x 350 mm for a type B emergency station or 800 x 500 x 260 mm for type F emergency stations.	
4.3.3	Emergency station sign	TT	Required space	Emergency station cabinet must have a cutout for the cable conduit to the sign.	A cable conduit must be provided at least X mm above each emergency station for the supply cable to the emergency station signs.	For example 20 cm. 	
4.3.4	Emergency stations	TT	Required space	Coordinate space requirements, conduits, supporting structure and incorporation into the tunnel wall and connection to the fire hose.	Meet space requirements in the tunnel wall, supporting structure, embedded conduits.	Centre-to-centre distance e.g. 50 m.	
4.3.5	Emergency stations TYPE A	TT	Connectivity	Specify cable routing and conduits to be positioned.	Two Ø 63x55.8 mm HDPE pipes are embedded per emergency station. After laying the cables and pipes, seal the pipes with PU foam for a distance of approx. 50 mm. 	See 'emergency station frame and door' and 'emergency station rear seal'. Electrical cabling for the sign in the tunnel tube. Electrical cabling for the intercom, the lighting, a wall socket and the electric heating for emergency station. 	
4.3.6	Emergency stations TYPE C	TT	Connectivity		Two Ø 63x55.8 mm HDPE pipes are embedded per emergency station. 	Electrical cabling for a sign. Electrical cabling for the intercom, the lighting, and anwall socket. 	

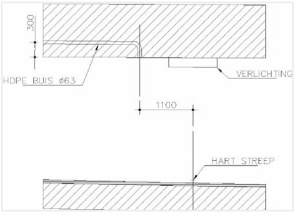
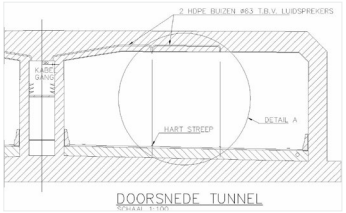
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
5.1.1	Various components	SB	Support	Installations must not exceed the maximum floor load of X kg in room Y.	Main supporting structure of the services building Road must be dimensioned for the following floor loads: X kg in room Y.	Clear widths not specified.	
5.1.2	Various components	SB	Maintainability	Equipment to be set up in the services building fits through X * Y mm doors.	Doors fitted in the services building must have an opening of X * Y mm.	Clear widths should be coordinated with TTI. 	
5.1.3	Various components	TT	Maintainability	Equipment which is to be installed in the service corridors of the tunnel fits through X * Y mm doors.	Doors fitted in the service corridors must have an opening of X * Y mm.	Clear widths should be coordinated with TTI.	
5.1.4	Doors	SB	Position notification	Door positions must be transmitted to the access control system and the intrusion detection system.	Doors in the service building must be equipped with position monitoring.	Installation measurements of cabinets are often 60 or 80 cm deep and 200 cm high. It must be possible to get these into the technical room via service corridors. 	
5.1.5	Escape hatches from service area to road	TT	Position notification	Positions of hatches must be transmitted to the control system.	Escape hatches that lead from the service areas to the road surface must be equipped with position monitoring.		
5.1.6	Fire doors to compart-mentalise the service corridor	TT	Position notification	Positions of doors must be transmitted to the control system.	Doors in the service corridors must be equipped with position monitoring.	Doors in pressure equalisation rooms, service cor-ridors determine sufficient pressure and partitioning in the event of fire; use partitioning in service corridors. 	
5.1.7	Climate control system	SB HVAC	Required space	Indicate dimensions.	Reserve space in the services building for air-conditioning.		

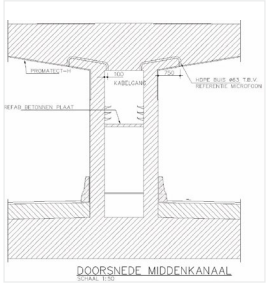
5.1.8	Climate control system	SB HVAC	Required space	Indicate dimensions.	Reserve space in the services building for separate air-conditioning for the service corridors.	Depending on availability and reliability, double the installation on both sides of the tunnel. 	
5.1.9	Climate control system	SB HVAC	Support	Indicate weight of air-conditioning system.	Provide sufficient load-bearing capacity.		
5.1.10	Various components	SB	Preservation	Indicate maximum dust load of the service building.	Restrict dust dispersion in services building.	Spaces in which technical installations are set up, with a coating on roof, floor and walls (cement dust is disastrous for electronics). 	
5.1.11	Gas extinguishing system	SB	Maintaining function	Gas extinguishing system in technical rooms.	Specify cutouts for air inlets (closable).		
5.1.12	Fire resistant conduits	SB	Maintaining function	All cable and pipe conduits must be fire resistant.	Fine tune the dimensions of the conduits (take fire proofing agents into account).		
5.1.13	Fire resistant conduits	SB	Maintaining function	Installing fire resistant conduits at cable routes (horizontal and vertical).	Specify fire compartmentation.	Check fire compartments and prevent chimney operation.	

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
6.1.1	CCTV cameras	TT	Required space	CCTV cameras, including mounting hardware, that are attached to the ceiling of the tunnel have a maximum gross height of X mm.	The space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.	For example 400 mm.	
6.1.2	CCTV cameras	TT	Required space	Speed detection CCTV cameras, including mounting hardware, that are attached to the ceiling of the tunnel above the lanes have a maximum gross height of X mm.	The space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.	For example 600 mm. Centre-to-centre distance is camera dependent. 	
6.1.3	CCTV cameras	TT	Connectivity	Specify required conduit cameras in cross-connections.	Embed conduits.	Monitor cross-connections during evacuation.	
6.1.4	CCTV cameras	TT	Connectivity	Mount brackets for the mounting of cameras in cross-connections.	Ensure that the tunnel wall is suitable for mounting of brackets for the CCTV cameras.	Monitor cross-connections during evacuation.	
6.1.5	CCTV cameras	TT	Connectivity	Specify required conduits.	Embed conduits.	For example Ø 50 mm.	
6.1.6	CCTV cameras	TT	Connectivity	Mount brackets for the mounting of cameras.	Ensure that the tunnel wall is suitable for mounting of brackets for the CCTV cameras.	Fine-tune anchoring mode.	
6.1.7	CCTV cameras	Access roads	Required space	CCTV camera for the access roads should be placed on a mast.	Reserve space for a camera mast for the CCTV access routes.		
6.1.8	CCTV cameras	TT	Required space	Specify camera dimensions.	Reserve space for the CCTV cameras on the wall.	Concerns tunnel wall in the tunnel, central tunnel tube, access roads, internal and external services buildings.	
6.1.9	CCTV equipment	SB	Required space	Specify dimensions of central equipment.	Reserve space for central CCTV equipment.		
6.1.10	CCTV cameras	Access roads	Required space	Specify cable routing, in terms of digging ducts.	In the trench, take CCTV conduits into account.		
6.1.11	CCTV cameras	Access roads	Security	Specify mast locations and method of crash protection.	Provide crash protection.		
6.1.12	CCTV cameras	Access roads	Required space	Fine tune possibilities for using portals to attach cameras.	Provide clearance on portals.		

6.1.13	CCTV cameras	TT	Required space	Before assembly of the CCTV installation is commenced, the correct camera locations must be detailed using quality and visibility measurements. CCTV cameras in the tunnel are not mounted in a rotatable manner. Depending on the alignment (possible bends) of the tunnel, it may be necessary to install cameras on the opposite outer wall.	Camera position in the outer wall is the same as for the inner wall. The centre-to-centre spacing of the cameras is determined by the alignment of the tunnel. Conducts are made with Ø 63x55.8 mm HDPE pipes. After laying the cables and pipes, seal the pipes with PU foam for a distance of approx. 50 mm.	CCTV installation is installed in order to observe the traffic in the tunnel. The CCTV system is automatically switched on at the relevant location in specific situations such as activation of the height sensors, the stationary vehicle alarm or an open emergency station. 	
6.1.14	Hazardous substances identification system	TT	Required space	Specify position and method of mounting cameras in the tunnel.	Take space requirements and method of mounting cameras in tunnel into account.		
6.1.15	Hazardous substances identification system	SB	Required space	Specify space in service building.	Reserve space for central equipment for identifying hazardous substances.		
6.1.16	Hazardous substances identification system	Access roads	Connectivity	Take into account the method of mounting to portals.	Specify method of camera mounting to portals.		

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
6.2.1	Various communications media	TT	Required space	All communications media, including mounting hardware, that are attached to the ceiling of the tunnel have a maximum gross height of X mm.	Space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.	For example 400mm (Noordtunnel). 	
6.2.2	Sound installation STI value	TT	Intelligibility	A reflection factor X for the tunnel walls and ceiling must be used as a basis for the STI calculation.	Tunnel walls and ceiling may have a maximum reflection factor of X.	Safety guidelines prescribe speech intelligibility requirements (STI) for tunnels. Fine-tuning must take place in the design phase to meet these requirements.	
6.2.3	Sound installation STI value	TT	Intelligibility	A reflection factor X for the floor must be used as a basis for the STI calculation.	Floor may have a maximum reflection factor of X.	Safety guidelines prescribe speech intelligibility requirements (STI) for tunnels. Fine-tuning must take place in the design phase to meet these requirements.	
6.2.4	HF system	CTT	Required space	Specify dimensions of coaxial cable and clearance in tunnel, central tunnel tube and the services building.	Reserve space for installing HF coax in tunnel, central tunnel tube and services building.		
6.2.5	HF system	TT	Connectivity	Specify required conduits.	Embed conduits.		
6.2.6	HF system	TT	Earthing	Specify earthing facility.	Embed earthing facilities.		
6.2.7	HF system	TT	Connectivity	Fine tune mounting options, drilling locations.	Facilitate mounting of HF system.	Take the fixed section lengths and anchoring depths of the assembly into account.	
6.2.8	HF system	Access roads	Support	Specify locations of camera masts.	Provide foundations for camera masts.		
6.2.9	HF system	TT	Connectivity	High-frequency and radio communications systems must be installed at the mouth and the end of the tunnel. 	Conduits are made with Ø 63x55.8 mm HDPE pipes.	High-frequency and radio communications installation is intended for the radiotelephone and walkie-talkie communications from mobile units inside and outside the tunnel, as well as for the reception of radio transmitters and voice communication using radio frequencies within the enclosed tunnel section.	
6.2.10	Telephone and intercom system	TT	Connectivity	Specify required conduits.	Embed conduits.		
6.2.11	Telephone and intercom system	CTT	Required space	Specify position and dimensions of the intercom equipment.	Provide space in the central tunnel tube for the intercom system.		

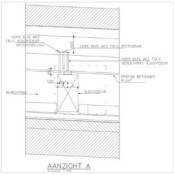
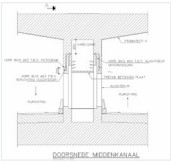
6.2.12	Telephone and intercom system	Access roads	Required space	Specify position and dimensions of the intercom pillars along service access routes.	Reserve space in central tunnel tube for phone mounts.		
6.2.13	Telephone and intercom system	Access roads	Security	Specify positions and types of crash protection for intercom pillars.	Install intercom pillar crash protection on service buildings access roads.		
6.2.14	Telephone and intercom system	Access roads	Maintainability	Specify space requirements for maintainability of the intercom pillar.	Take clearance around the intercom pillar into account.		
6.2.15	Telephone and intercom system	Access roads	Required space	Specify quantity and type of cables to be routed in cable ducts.	Reserve space in the cable ducts along roads.		
6.2.16	GSM	TT, access roads, service areas and corridors	Connectivity	Specify required conduits.	Embed conduits.	For longer (>1 km) and bored tunnels: make GSM communications possible in service areas and corridors.	
6.2.17	Public address system	TT	Intelligibility	Specify required minimum attenuation to civil infrastructure.	Tunnel wall cladding attenuation determines design of public address system.		
6.2.18	Public address system	TT	Intelligibility	Specify required minimum attenuation to civil infrastructure.	Tunnel wall cladding attenuation determines the design of the public address system.	Due to the use of spray concrete, the attenuation is relatively high. 	
6.2.19	Public address system	TT	Connectivity	Specify required conduits.	Embed conduits.		
6.2.20	Public address system	TT	Connectivity	Align with civil engineering department with regard to preconditions for installation in/on tunnel roof.	Mount brackets for suspension speakers in tunnel.		
6.2.21	Public address system	TT	Required space	Specify position of loudspeakers in tunnel.	Reserve space on tunnel wall.		
6.2.22	Loudspeakers	TT	Required space	Loudspeakers are always installed perpendicular to the centre line on the ceiling. Where there are three lanes there will be two rows of loudspeakers. Where there are two lanes there will be just one row of loudspeakers. The spacing (centre to centre) must be determined separately for both.	Conduits are made with Ø 63x55.8 mm HDPE pipes.  		
6.2.23	Public address system	CTT	Required space	Specify position of loudspeakers in the central tunnel tube.	Reserve space in central tunnel tube.		
6.2.24	Public address system	CTT	Required space	Specify the position of loudspeakers in cross-connections.	Reserve space in cross-connection. 		

6.2.25	Public address system	SB	Required space	Specify dimensions of equipment for services building.	Reserve space for public address equipment in services building.		
6.2.26	Public address system	Access roads	Required space	Specify specific loudspeaker locations, such as service access roads.	Reserve space at specific locations for the public address system.		
6.2.27	Public address system	Access roads	Required space	Specify the quantity and type of cables to be routed in cable ducts.	Reserve space in the cable ducts along roads.		
6.2.28	Public address system	Access roads	Maintainability	Specify dimensions with regard to the maintainability of the system.	Take clearance around public address system equipment into account.		
6.2.29	Public address system	Access roads	Security	Specify crash protection with regard to public address system masts.	Provide crash protection.		
6.2.30	Reference microphone	TT	Required space	Design and configure the speaker system in such a way that persons on the tunnel approach or inside the tunnel, outside or inside a vehicle, can clearly understand a spoken message. The reference microphone must be installed in a protective structure. The centre-to-centre distances and the number should be specified.	Conduits are made with Ø 63x55.8 mm HDPE pipes. After laying the cables and pipes, seal the pipes with PU foam for a distance of approx. 50 mm.	Sound system must be installed so that tunnel users can be instructed from the central control room in the event of a breakdown or accident. 	
6.2.31	Digital image storage system	SB	Required space	Specify dimensions of image storage system.	Provide space for the image storage system.		

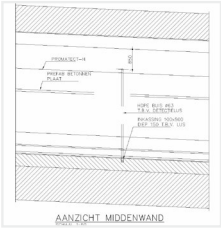
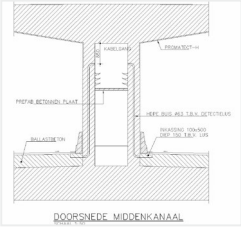
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
7.1.1	Simulation system	SB control room	Required space	Specify dimensions of simulation system.	Provide space for the simulation system.		
67.1.2	Decision support system (DSS)	SB control room	Required space	Specify dimensions of DSS.	Provide space for the DSS.		
7.1.3	Instruction and training system	SB control room	Required space	Specify dimensions of space and training system.	Provide space for the instruction and training system.		
7.1.4	Servers for PLC	SB control room	Required space	Specify dimensions of server systems.	Provide space for central servers.		
7.1.5	Internal transmission network	SB	Connectivity	Specify required conduits.	Embed conduits.		
7.1.6	Internal transmission network	CTT	Required space	Specify required space and position of fibre-optic equipment in CTT.	Provide space in the central tunnel tube for fibre-optic equipment.		
7.1.7	Internal transmission network	SB control room	Required space	Specify dimensions of system cabinets for the internal transmission network in the services building.	Provide space for the internal transmission network in the services building.		
7.1.8	Internal transmission network	Access roads	Required space	Specify conduits in cable ducts along the roads.	Provide space in cable ducts along roads for the internal transmission network.		
7.1.9	External transmission network	SB control room	Required space	Specify dimensions of system cabinets for the internal transmission network in the services building.	Provide space for the internal transmission network in the services building.		
7.1.10	Servers for PLC	SB control room	Maintaining function	Sufficient air supply and extraction must be ensured so that the systems remain within temperature limits.	Install grilles to outside or air ducts for forced cooling.		
7.1.11	PLC controllers	SB	Required space	Specify required space for local control PLC.	Provide space for PLC cabinets.	In longer and bored tunnels there is a technical room with local controls and distributors, transformers, etc. every 500 metres.	
7.1.12	PLC controllers	TT	Required space	Specify required space for local control PLC.	Provide space for PLC cabinets.	In longer or bored tunnels there is a technical room with local controls, and distributors, trans-formers, etc. every 500 metres. 	

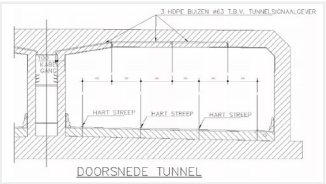
#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
7.2.1	Local controls	SB	Required space	Specify required space for local operation.	Fulfil space requirements in services buildings.		
7.2.2	Local controls	SB	Human factors	Considerations of occupational health and safety requirements for the workplace	Provide workspace according to health and safety guidelines.	Daylighting, climate control, lighting, furniture, care	

8. ESCAPE FACILITIES

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
8.1.1	Escape door lock	TT	Locking	Unlocking of the escape doors must be controlled electrically.	Escape door must be equipped with an electrical locking mechanism.		
8.1.2	Escape door alarm	TT	Position notification	Position of the escape doors must be reported to the controller.	Escape door must be provided with a a means for attaching a position sensor.		
8.1.3	Escape door	TT	Required space	Specify conduits to be positioned. 	Escape door slides to deepest point of the tunnel. Above the door there is an opening to facilitate the installation of a lighting fitting. The sign is located directly above the door in closed position. The release is on the lock side. Three Ø 63x55.8 mm HDPE pipes are embedded per escape door. After laying the cables and pipes, seal the pipes with PU foam for a distance of approximately 50 mm.	Associated details and data: see 'Escape door and frame'. Electrical cabling for the sign in the tunnel. Electrical cabling for escape door lighting. Electrical cabling for the escape door release. 	
8.1.4	Escape door lock	TT	Locking	Opening of an emergency escape route that is closed in normal situations must be performed centrally.	Escape doors must be suitable for the installation of central locking.		
8.1.5	Escape door	TT	Promote self-rescue	Escape doors must be equipped with LED edge lighting.	Reserve space for installation and for conduits.		
8.1.6	Escape door sound beacon system	TT	Intelligibility	Specify required minimum attenuation to civil engineering department.	Tunnel wall cladding attenuation determines design of public address system.		
8.1.7	Escape door sound beacon system	TT	Required space	Reserve space above escape doors, possibly specify size of cutout.	Take space for fitting the escape door beacon into account.		

#	Component	Interface location	Interface function	TTI	Civil engineering	Pointers	Notes
9.1.1	Various installations: ESC, barriers, special signs, traffic control cabinets	Access roads	Support	Installation should be positioned on a sufficiently solid surface.	Verge must have sufficient space and load-bearing capacity to lay the foundations for the installations.		
9.1.2	Various installations in the tunnel	TT	Required space	All traffic systems, including mounting hardware, that are attached to the ceiling of the tunnel have a maximum gross height of X mm.	Space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.	For example 400 mm.	
9.1.3	Various installations in the tunnel	TT	Required space	All traffic systems, including mounting hardware, that are attached to a portal in the tunnel have a maximum gross height of X mm.	Space for TTI between the top of the clearance and the underside of the tunnel roof is at least X mm.		
9.1.4	Traffic signalling/ traffic detection	TT	Connectivity	Specify conduits and desired position for traffic signals/detection.	Embed conduits to traffic signals/detection.		
9.1.5	Traffic signalling/ traffic detection	TT	Connectivity	Specify the type of mounting to the tunnel wall.	Provide means of fixing traffic signals/ detection to tunnel wall.		
9.1.6	Traffic signalling/ traffic detection	TT	Required space	Indicate space requirement for signalling devices/detectors.	Provide space for signal devices/ detectors in tunnel.	In tunnel.	
9.1.7	Traffic signalling control cabinet	CTT	Required space	Indicate space requirements for traffic signalling control cabinet in CTT.	Provide space for control cabinet signal emitters in central tunnel tube.	Service tunnel.	
9.1.8	Traffic signalling system	SB traffic system	Required space	Indicate space requirement for traffic signalling system in service building.	Provide sufficient space for traffic signalling system in services building.	Service building.	
9.1.9	Traffic signalling	Access roads	Connectivity	Specify necessary conduits that cross roads.	Run conduits that intersect with roads.	Conduits under roads.	
9.1.10	Roadside cabinets	Access roads	Security	Specify the position of roadside cabinets and crash protection.	Provide crash protection at roadside cabinets.		
9.1.11	Roadside cabinets	Access roads	Maintainability	Indicate clearance around roadside cabinets.	Provide sufficient space around the roadside cabinet for maintenance.	For example 1000 mm.	
9.1.12	Roadside cabinets	Access roads	Support	Indicate the weight of the roadside cabinets.	Provide sufficient load-bearing capacity for the roadside cabinet.		
9.1.13	Traffic signalling/ traffic detection	Access roads	Connectivity	Specify installation requirements for signalling devices/detectors on portals.	Meet installation requirements for signalling devices/detectors on portals.		
9.1.14	TCS	Access roads	Connectivity	Specify intersecting of conduits with roads for TCS.	Provide conduits under roads.		
9.1.15	TCS	Access roads	Connectivity	Specify the size of the ducts for cable routes.	Provide ducts for cable routes.		

9.1.16	TCS	Access roads	Security	Indicate position of TCS cabinets and level of crash protection.	Provide crash protection for TCS cabinets.		
9.1.17	TCS	Access roads	Maintainability	Indicate clearance around TCS cabinet.	Sufficient space around the TCS cabinet for maintenance.	For example 1000 mm.	
9.1.18	TCS	Access roads	Support	Indicate the weight of the TCS cabinet.	Provide sufficient load-bearing capacity for the TCS cabinet.		
9.1.19	Induction loops	TT	Connectivity	Indicate facilities to be embedded. 	A cutout of 100x150x500 mm has to be made for the accommodation of the cabling to the detection loops in the road surface. From here a Ø 63x55.8 mm HDPE pipe is embedded through the middle wall to the central tunnel tube. Align the positioning of the tubes to the positioning of the loops in the road surface. After laying the cables and pipes, seal the pipes with PU foam for a distance of approx. 50 mm.		
9.1.20	Height detection system	Access roads	Connectivity	Specify intersecting of conduits with roads for height detection.	Provide conduits under roads.		
9.1.21	Height detection system	Access roads	Connectivity	Specify size of the ducts for cable routes.	Provide ducts for cable routes.		
9.1.22	Height detection system	Access roads	Security	Indicate position of cabinets, masts and level of crash protection.	Provide crash protection for cabinets and masts.		
9.1.23	Height detection system	Access roads	Maintainability	Indicate clearance around cabinet.	Allow for sufficient space around the cabinet for maintenance.	For example 1000 mm.	
9.1.24	Barriers	Access roads	Connectivity	Specify necessary conduits that cross roads.	Run conduits that intersect with roads.		
9.1.25	Barriers	Access roads	Connectivity	Specify size of the ducts for cable routes.	Provide ducts for cable routes.		
9.1.26	Barriers	Access roads	Security	Indicate position of barrier control cabinets and level of crash protection.	Provide crash protection for barrier control cabinets.		
9.1.27	Barriers	Access roads	Support	Indicate weight of barrier control cabinets.	Provide sufficient load-bearing capacity for the barrier control cabinets.		
9.1.28	MG	Access roads	Connectivity	Specify size of the ducts for cable routes.	Provide ducts for cable routes.		
9.1.29	MG	Access roads	Security	Indicate position of MG.	Provide crash protection for MG.		
9.1.30	MG	Access roads	Support	Indicate weight of MG.	Provide sufficient load-bearing capacity for MG.		
9.1.31	ESC	Access roads	Connectivity	Specify necessary conduits that cross roads.	Run conduits that intersect with roads.		
9.1.32	ESC	Access roads	Connectivity	Specify the size of the ducts for cable routes.	Provide ducts for cable routes.		
9.1.33	ESC	Access roads	Security	Indicate position of MG.	Provide crash protection for MG.		
9.1.34	ESC	Access roads	Required space	ESC must be positioned in a location where it fits in terms of road design.	The road design must be tailored to the installation of an ESC.		
9.1.35	ESC	Access roads	Support	Indicate weight of MG.	Provide sufficient load-bearing capacity for the barrier control cabinets.		

9.1.36	Special signs	Access roads	Connectivity	Specify necessary conduits that cross roads.	Run conduits that intersect with roads.		
9.1.37	Special signs	Access roads	Connectivity	Specify the size of the ducts for cable routes.	Provide ducts for cable routes.		
9.1.38	Special signs	Access roads	Security	Indicate position of special signs.	Provide crash protection for special signs.		
9.1.39	Special signs	Access roads	Support	Indicate weight of special signs.	Provide sufficient load-bearing capacity for the special signs.		
9.1.40	Matrix signalling devices	TT	Connectivity	Matrix signal devices is always positioned on the ceiling perpendicular to the centre of the lane or emergency lane. In the longitudinal direction of the tunnel, the centre-to-centre distance from the matrix signalling devices is approximately 150 metres. Depending on the alignment, a longer centre-to-centre distance can be adopted.	Conduits are made with Ø 63x55.8 mm HDPE pipes.		
9.1.41	Access road metering system	Access roads	Connectivity	Specify necessary conduits that cross roads.	Run conduits that intersect with roads.		
9.1.42	Access road metering system	Access roads	Connectivity	Specify size of the ducts for cable routes.	Provide ducts for cable routes.		
9.1.43	Access road metering system	Access roads	Security	Indicate position of the access road metering system.	Provide crash protection for the access road monitoring system.		
9.1.44	Access road metering system	Access roads	Support	Indicate weight of access road metering system.	Provide sufficient load-bearing capacity for the access road metering system.		

Colophon

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Interfaces TTI-civil engineering

Overview of interfaces between tunnel installations and the tunnel structure

In order to use a tunnel safely, both a good structure and effective technical installations are required. It is therefore important during construction or renovation that the disciplines civil engineering and installation engineering are coordinated. This checklist provides an overview of important interfaces.

The COB project Identity the risks, as part of the tunnel programme, focused on preventing surprises during a tunnel renovation; inspections and preliminary research do not always provide sufficient insight. Among other things, the working group found that where tunnel-technical installations (TTI) and the tunnel structure meet, risks often arise. That is why these interfaces have been inventoried per (sub) system and component, with pointers for harmonizing the two aspects.

www.cob.nl/identifytherisks

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