



Gemeente
Amsterdam

System Specification Traction Power Switchgear Substation

Z109A07AC63*

Validation and authorisation

Document	System Specification Traction Power Switchgear Substation		
Prepared by	Croes, Brittany / Schaap, Jan		
Dossier JOIN	CEB - 20639	Item No.	
Feature JOIN	CEB\OVG\26033		
Document version	5.1		
Status	Final		
Date	25-6-2021		

Version changes

Description and explanation	Date	Version
Initial version - General	13-12-2019	1.0
Adjustments in accordance with System Specification GS v5.0	27-03-2020	2.0
Adjustments in accordance with System Specification GS v6.0	31-07-2020	3.0
Adjustments in accordance with System Specification GS v7.0	28-08-2020	4.0
Adjustments in accordance with System Specification GS v8.0	21-04-2021	4.1
Textual adaptations and annexes	14-05-2021	5.0
Layout cleaned up and ready for publication	25-06-2021	5.1

Authorisation

Name	Function	Date	Signature
n.a.			

Contents

Contents	3
List of images	4
1 Introduction	5
1.1 Abbreviations	5
1.2 Binding documents	7
1.3 Standards	8
1.3.1 DC distribution system	8
1.3.2 Low-voltage supply	9
1.3.3 Miscellaneous	9
2 Traction power switchgear substation	11
2.1 System description	11
2.2 Functional description of the system	11
2.3 Traction power switchgear substation implementation	15
3 Requirements	16
3.1 Definition of requirements	16
3.2 Requirement tables	17
1.1 Unique Requirement Number	17
3.3 Verification	19
4 Traction power switchgear substation	20
4.1 Top requirements	20
4.1.1 Functional Metro	20
4.1.2 Aspect requirement: Maintainability	20
4.1.3 Aspect requirement: Reliability	21
4.1.4 Aspect requirement: Future-proofing	22
4.1.5 Aspect requirement: Availability	22
4.1.6 Aspect requirement: Nuisance	22
4.1.7 Aspect requirement: Safety	22
4.2 GVI	23
4.2.1 General	23
4.2.2 High speed circuit breakers	26
4.3 Protection	27
4.3.1 General	27
4.3.2 Emergency off	28
4.3.3 GVI	28
4.3.4 Frame short circuit protection	31
4.3.5 Minus earth potential (rail-to-ground voltage)	31
4.3.6 Carrier circuit	32
4.4 Internal wiring	32

4.5 Local/central control of installations (CBI)	33
4.5.1 Control (Station automation)	33
4.5.2 HMI	35
4.6 Low-voltage connection Grid operator	40
4.7 LVI	40
4.7.1 Low-voltage distributor	40
4.7.2 Auxiliary voltage	42
4.8 Building-related installations	45
4.8.1 Climate	45
4.8.2 Lighting & WCD	46
4.8.3 Firefighting facilities	48
4.8.4 Fire alarm	48
4.9 Internal cabling, cables and cable ducts	49
4.10 Construction	52
4.11 Cables & Pipelines External	52
4.12 Plus connections Metro (Third Rail)	53
4.13 Minus connection Metro	53
4.14 Connection CBI Metro	54
5 List of requirements	55

List of images

Figure -21 - Function tree	12
Figure -22 - Object tree	14

1 Introduction

This document describes the technical specifications and functional backgrounds for newly built and commissioned traction power switchgear substations of GVB and Metro and Tram.

The specification describes the requirements for the traction power switchgear substation with the relevant technical specifications.

Finally, it is a requirement that compatibility between the substation and the components installed is guaranteed. This compatibility ensures the correct operation of the components in the substation supplied; particularly with regard to providing safety, maintenance, reliability and life expectancy/lifetime.

This specification is generic for metro traction power switchgear substations.

1.1 Abbreviations

A full list of Metro and Tram abbreviations and acronyms used is included as an appendix (see section 1.2).

Abbreviation	Meaning
A	Amps
AN	Air Natural
AWI	Auto-reclose
BLVC	Accessibility, Livability, Safety and Communication
CAB	Central remote control
CBI	Central control of installations
dB	Decibel
DC	Direct Current
DO	Final Design
EBH	Electrotechnical operations manual of GVB
EBT	Auxiliary transformer
EKS	Erd Kurzschluss Schalter (Electronic short-circuit switch)
AND	European Standard
FIT	Factory Integration Test
FO	Functional Design
GOOSE	Generic Object Oriented Substation Event
GS	Traction power substation
GVI	DC switchgear assembly
HMI	Human Machine Interface
HS	High-voltage
HVI	High-voltage distribution system
Hz	Hertz
IAC	Internal Arc Classification
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device

Abbreviation	Meaning
IO	Input Output
IP	International Protection Marking
kPa	Kilo Pascal
kV	Kilovolt
kWh	Kilo Watt hour
LVI	Low-voltage switchgear
MTTF	Mean Time To Fail
MTTR	Mean Time To Repair
MVA	Mega Volt Ampère
Ni-Cad	Nickel Cadmium
NSA	Emergency power unit
OG	Client
ON	Contractor
OR	Overview Retour
PLC	Programmable Logic Controller
SA	Station Automation System
SAT	Site Acceptance Test
SCADA	Supervisory Control And Data Acquisition
SF6	Sulphur hexafluoride
SIT	Site Integration Test
(S)IV	(Strategic) Installation Manager
SS	Traction Power Switchgear Substation
SSI	Sectional switchgear
TO	Technical Design
UO	Implementation design
V	Volt
VLD	Voltage Limiting Device
WCD	Socket

1.2 Binding documents

Title	Document number	Version	Date
Afkortingen en acroniemen	CEB\OVG\19462	1.0.0.0	15-7-2019
Elektrotechnisch Bedrijfsvoering Handboek voor Railinfrastructuur Metro en Tram Amsterdam	WLS\OVG\18867	3.2	10-7-2018
Netcode Elektriciteit	https://wetten.overheid.nl/BWB-R0037940/2021-02-13		13-2-2021
VB AMS 053 Areaaldecompositie en codering van locaties, installaties, objecten en kabels	CEB\OVG\20507	3.0	20-5-2019
Eenlijnschema typical Schakelstation	CEB\OVG\25947	1.0.2.0	21-4-2021
Opstellingstekening installaties Schakelstation	CEB\OVG\25948	1.0.2.0	21-4-2021
Schakelmatrix Schakelstation	CEB\OVG\26035	0.1.0.0	3-5-2021
Tripmatrix Schakelstation	CEB\OVG\25952	1.0	27-3-2020
Blokschema CBI Metro	CEB\OVG\25957	1.0	11-2-2020
Template I/O-lijst Schakelstation	CEB\OVG\25956	3.0	31-7-2020
Overzicht RAMS grenswaarden	CEB\OVG\24071	0.3	03-09-2020
Principe-ontwerp Minus-Aarde potentiaalbewaking volgens EN50122-1	CEB\OVG\25763	1.0	21-12-2020
TKF 630 mm ² kabelspecificatie	CEB\OVG\25764	-	-
Aansluitvoorwaarden NMA definitief	CEB\OVG\21512	1.0	08-10-2019
NMA Device specification form template	CEB\OVG\21512	1.0	08-10-2019-
NMA Switchpoortaanvraag template	CEB\OVG\21512	1.0	08-10-2019
Operationele scenario's Gelijkrichterstation Metro	CEB\OVG\23093	2.7	23-4-2020
Schakeltoestanden Metro	CEB\OVG\26115	0.4.0.0	7-5-2021

1.3 Standards

This section provides an overview of relevant standards and guidelines.

The deliveries must comply with the Dutch laws and regulations and the Buildings Decree. In addition, the deliveries must meet all common requirements that can be set for the systems at the current state of the art. In addition, the delivery must comply with all the applicable standards, regulations and directives listed below in the prevailing order:

1. NEN (Dutch Standards)
2. GVB/MeT Specific Rules
3. EN (European Standards) and European Harmonisation Documents (HD)
4. IEC (Standards of the International Electrotechnical Commission)
5. NPR (Dutch Practice Guidelines)
6. EnergieNed Guidelines
7. VDE (guidelines of the German Association of Electrical Engineering, Electronics and Information Technology)
8. ATEX (European Directives on the danger of explosion)

The list of standards is not intended to be exhaustive. The Contractor shall include additional and/or replacement standards that are applicable in the work.

1.3.1 DC distribution system

NEN-EN 50123	Railtoepassingen – Gelijkstroomschakelinrichtingen voor vaste opstellingen
NEN-EN 50526	Spoorwegen en soortgelijk geleid vervoer – Overspanningsafleiders en spanningsbegrenzers voor gebruik met gelijkspanning
NEN-EN 50124-1	Spoorwegtoepassingen - Isolatiecoördinatie
NEN-EN 50123-1	Railtoepassingen - Gelijkstroomschakelinrichtingen voor vaste opstellingen - Deel 1: Algemeen (en)
NEN-EN 50123-2	Railtoepassingen - Gelijkstroomschakelinrichtingen voor vaste opstellingen - Deel 2: Gelijkstroomschakelaars
NEN-EN 50123-3	Railtoepassingen - Gelijkstroomschakelinrichtingen voor vaste opstellingen - Deel 3: Gelijkstroomscheiders en lastscheiders voor binnenopstelling
NEN-EN 50123-4	Railtoepassingen - Gelijkstroomschakelinrichtingen voor vaste opstellingen - Deel 4: Gelijkstroomlastscheiders, scheiders en gelijkstroomaarders voor buitenopstelling
NEN-EN 50123-6	Railtoepassingen - Gelijkstroomschakelininstallaties voor vaste opstellingen - Deel 6: Gelijkstroomschakelinrichtingen
NEN-EN 50123-7-1	Railtoepassingen - Gelijkstroomschakelininstallaties - Vaste opstellingen - Deel 7-1: Meet-, beheers- en beveiligingsinrichtingen voor specifiek gebruik in gelijkstroomtractiesystemen - Leidraad voor de toepassing
NEN-EN 50123-7-2	Railtoepassingen - Gelijkstroomschakelininstallaties voor vaste opstellingen - Deel 7-2: Meet-, beheers- en beveiligingsinrichtingen voor specifiek gebruik in gelijkstroomtractiesystemen - Isolerende stroomomzetters en andere ampèremeters
NEN-EN 50123-7-3	Railtoepassingen - Gelijkstroomschakelininstallaties voor vaste opstellingen - Deel 7-3: Meet-, beheers- en beveiligingsinrichtingen voor specifiek gebruik in gelijkstroomtractiesystemen - Isolerende spanningsomzetters en andere voltmeters
NEN-EN 50526-1	Spoorwegen en soortgelijk geleid vervoer - Overspanningsafleiders en spanningsbegrenzers voor gebruik met gelijkspanning - Deel 1: Overspanningsafleiders

NEN-EN 50526-2	Spoorwegen en soortgelijk geleid vervoer - Vaste installaties - Overspanningsafleiders en spanningsbegrenzers voor gebruik met gelijkspanning - Deel 2: Spanningsbegrenzers
NEN-EN 50526-3	Spoorwegen en soortgelijk geleid vervoer - Vaste installaties - Overspanningsafleiders en spanningsbegrenzers voor gebruik met gelijkspanning - Deel 3: Richtlijn voor de toepassing

1.3.2 Low-voltage supply

NEN 1010	Veiligheidsbepalingen voor laagspanningsinstallaties (complete versie)
----------	--

1.3.3 Miscellaneous

NEN-EN 50122-1	Spoorwegen en soortgelijk geleid vervoer – Vaste installaties – Elektrische veiligheid, aarding en retourstromen – Deel 1: Eisen in verband met bescherming tegen elektrische schok.
NEN-EN 50122-2	Spoorwegen en soortgelijk geleid vervoer - Vaste installaties - Elektrische veiligheid, aarding en retourstromen - Deel 2: Maatregelen tegen de effecten van zwervstromen veroorzaakt door met gelijkspanning gevoede tractiestelsels
NEN-EN 50124-1	Spoorwegtoepassingen - Isolatie-coördinatie – Deel 1: Basiseisen – Slagwijdten en kruipwegen voor alle elektrische en elektronische uitrusting.
NEN-EN 50124-2	Spoorwegtoepassingen - Isolatie-coördinatie – Deel 2: Overspanningen en bijbehorende bescherming.
NEN-EN 50160	Spanningskarakteristieken in openbare elektriciteitsnetten
NEN-EN 50163	Railtoepassingen – Voedingsspanningen van tractiesystemen
NEN-EN 50388	Spoorwegen en soortgelijk geleid vervoer - Energievoorziening en rollend materieel - Technische criteria voor de coördinatie tussen energievoorziening (onderstations) en rollend materieel om interoperabiliteit te bereiken.
NEN 3140	Bedrijfsvoering van elektrische installaties – Aanvullende Nederlandse bepalingen voor laagspanningsinstallaties.
NEN 3840	Bedrijfsvoering van elektrische installaties – Aanvullende Nederlandse bepalingen voor hoogspanningsinstallaties.
NEN 8012	Keuze van het leidingtype met als doel het beperken van schade als gevolg van brand van en via elektrische leidingen met inbegrip van glasvezelleidingen
NEN 3207	Geïsoleerde leidingen voor sterkstroom - Systemen voor de aanduiding van leidingtypen
NEN-EN 50110	Bedrijfsvoering van elektrische installaties – Algemene bepalingen.
NEN-EN 50522	Aarding van hoogspanningsinstallaties van meer dan 1 kV wisselspanning.
NEN-EN-IEC 61936-1	Sterkstroominstallaties met meer dan 1 kV wisselspanning – Deel 1: Algemene bepalingen.
NEN 5152	Technische tekeningen - Elektrotechnische symbolen.
IEC 60146-1-1	Halfgeleideromzetters – Algemene eisen en omzetters met netcommutatie – Deel 1-1: Specificatie van basiseisen.
IEC 61850	Communicatienetwerken en – systemen in substations
IEC 60909	Short-circuit calculation in three phase a.c. systems.
IEC 60038	IEC Standard Voltages
IEC 60050	International Electrotechnical Vocabulary

NEN-EN-IEC 60529	Degrees of protection provided by enclosures (IP Code)
EnergieNed	Richtlijnen voor toelaatbare harmonische stromen.
NEN-EN-IEC 60228	Geleiders van geïsoleerde elektrische leidingen
NEN-EN-IEC 61914	Kabelzadels voor elektrische installaties
NPR 3626	Kabels geïsoleerd met vernet polyetheen (XLPE) voor spanningen van 6 kV tot en met 30 kV - Continu toelaatbare stroom en thermisch toelaatbare kortsluitstroom.

2 Traction power switchgear substation

2.1 System description

The traction power switchgear substation subsystem is primarily designed to distribute electrical energy to the consumer, the electrical rolling stock. In addition, power can be supplied to the installations in the traction power switchgear substation via a connection to the electricity grid.

2.2 Functional description of the system

The system traction power switchgear substation (SS) fulfils the desired functions within the system boundaries. The desired functions are shown in Figure 2-1. Table 1 contains a functional description of the SS system.

A traction power switchgear substation improves the voltage management: the metros run at a higher voltage and the power is distributed to the surrounding traction power substations. In addition, selectivity will be safeguarded by using high speed circuit breakers in the traction power switchgear substation.

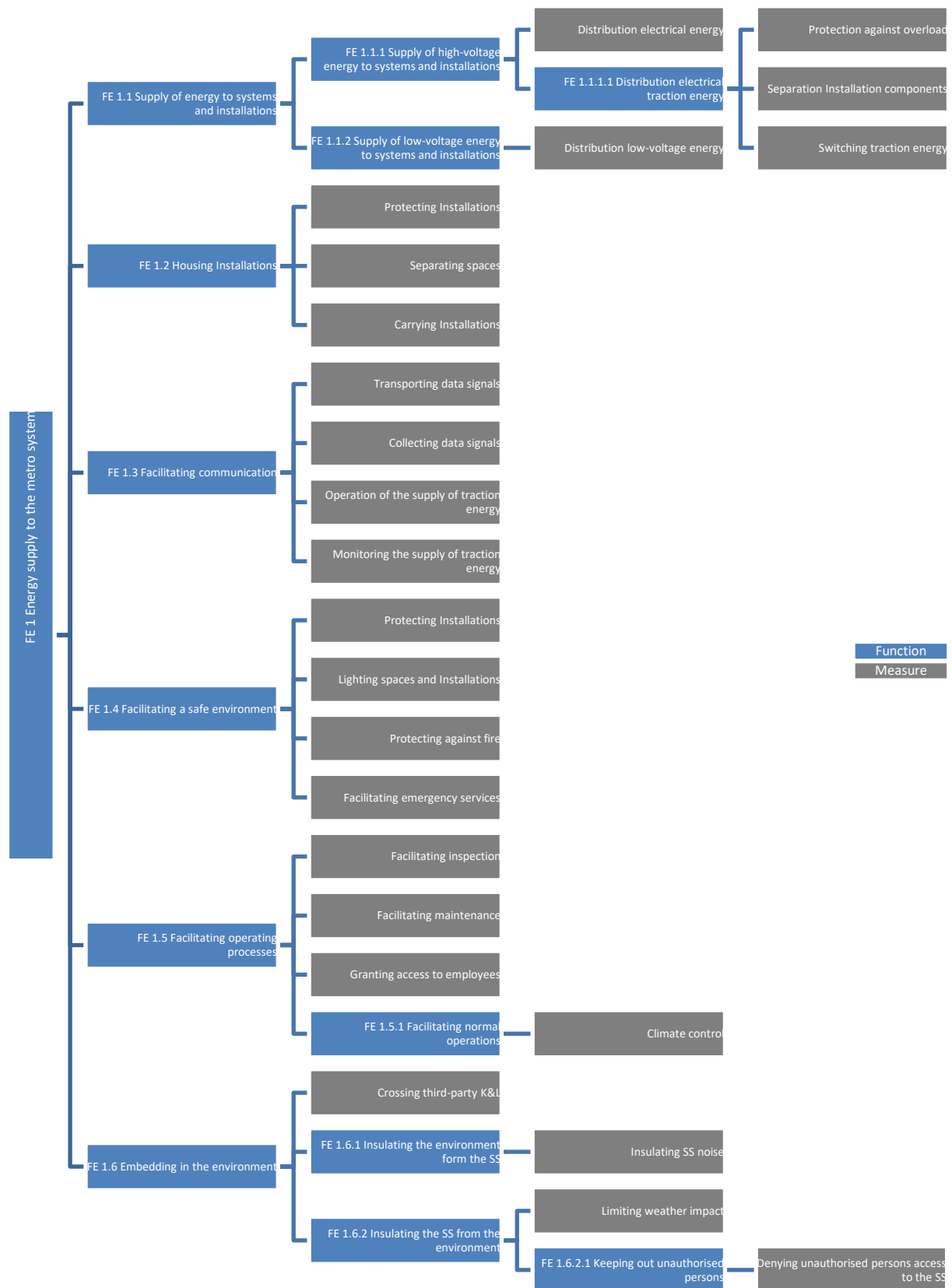


Figure 2-1 - Function tree

ID	Position	Function description
FE 1	Supplying energy to the metro system.	Supplying energy to the metro system.
FE 1.1	Supply of energy to systems and installations.	Supply of low-voltage energy to systems and installations.
FE 1.1.1	Supply of high-voltage energy to systems and Installations.	Distribution and supply of electrical energy.
FE 1.1.1.1	Distribution electrical traction energy	Securing against overload, separation of installation components, switching traction energy.
FE 1.1.2	Supply of low-voltage energy to systems and Installations.	Supply of low-voltage energy to systems and installations.
FE 1.2	Housing Installations	Protecting and carrying the installations. Separating the spaces.
FE 1.3	Facilitating communication	Collecting and transporting data signals. Operating and monitoring the supply of traction energy.
FE 1.4	Facilitating a safe environment	Protecting installations, lighting spaces and installations, protecting against fire and facilitating access for emergency services.
FE 1.5	Facilitating operating processes	Facilitating inspection and maintenance of the installation and systems by employees of the manager. Granting access to employees.
FE 1.5.1	Facilitating normal operation	Facilitating normal operations by means of climate control.
FE 1.6	Embedding in the environment	Embedding the SS in the environment. Crossing cables and pipes owned by third parties. Insulating the environment and the SS.
FE 1.6.1	Insulating the environment form the SS	Avoiding impact of the SS on the environment such as noise and other nuisance.
FE 1.6.2	Insulating the SS from the environment	Limiting the impact of the weather on the SS and keeping out unauthorised persons.
FE 1.6.2.1	Keeping out unauthorised persons.	Denying unauthorised persons access to the SS.

Table 1 - Functional analysis - System Traction power switchgear substation.

Based on the functional analysis, an object tree was created for the system "SS". The objects in the object tree thus provide an initial interpretation of the required functions. The desired objects for "Traction Switchgear Station" are shown in Figure 2-2.

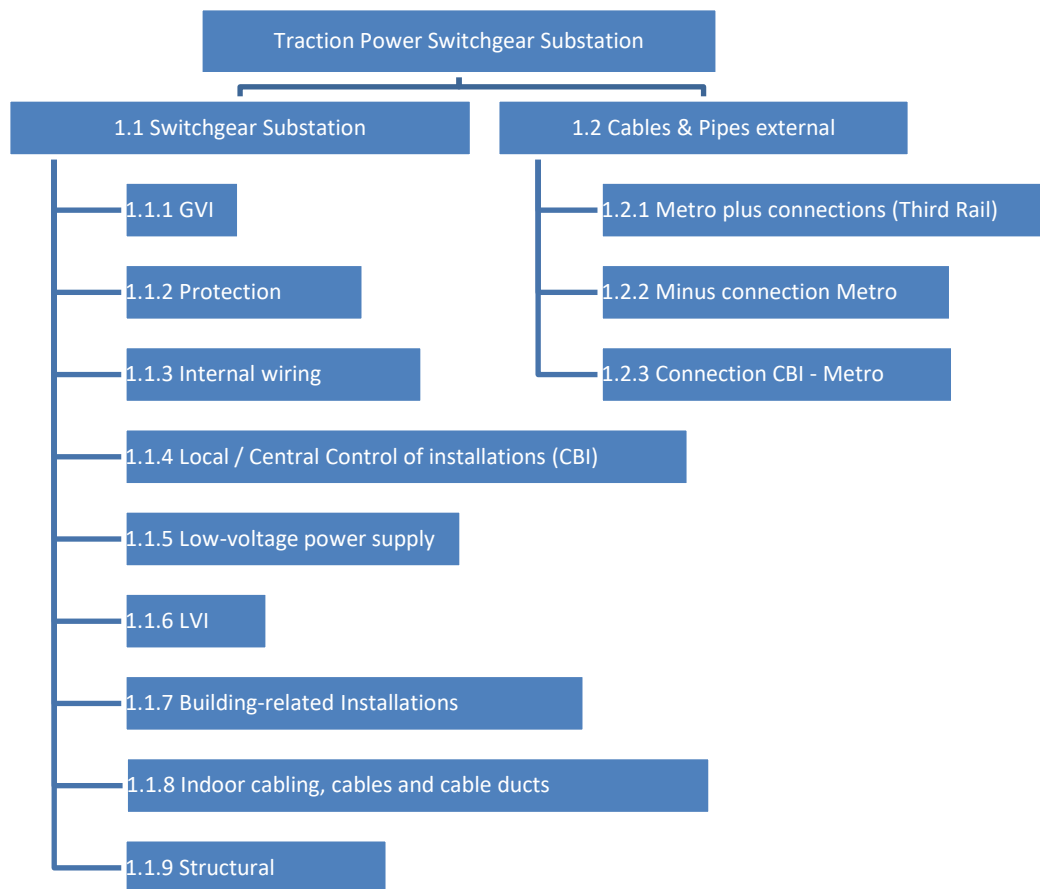


Figure 2-2 - Object tree

Table 2 shows a cross-reference table, indicating per object which functions are fulfilled by the object.

Object Function		FE 1.1 Supplying energy to systems	FE 1.2 Housing Installations	FE 1.3 Facilitating communication	FE 1.4 Facilitating safe environment	FE 1.5 Facilitating business processes	FE 1.6 Embedding in the environment
1.1.1	GVI	X					
1.1.2	Security				X		
1.1.3	Internal wiring	X		X		X	
1.1.4	CBI			X		X	
1.1.5	Low-voltage supply	X				X	
1.1.6	LVI	X				X	
1.1.7	Building-related installations	X					
1.1.8	Internal cabling, cables and cable ducts	X		X		X	
1.1.9	Construction		X		X	X	X
1.2.1	Plus connections Metro (3rd Rail)	X					X
1.2.2	Minus connection Metro (rail)	X					X
1.2.3	Connection CBI - Metro			X		X	X

Table 2- Relationship between Functions and Objects

2.3 Traction power switchgear substation implementation

This specification uses the structure for the traction power switchgear substation as shown on the single-line diagram and the installation drawing. These drawings are included as an appendix (see section 1.2). These concern principle drawings and not site specific drawings, depending on the location deviations are provided. The starting point, however, is compliance with the typical drawings; deviations should be submitted to OG for approval, stating the reasons.

3 Requirements

The classification of the requirements in this specification is based on the object tree. Requirements have been set for each object. The requirements are linked to the objects named in Chapter 2.

3.1 Definition of requirements

Characteristic of this specification is the classification into various types of requirements and the relationship between the requirements. The requirements are divided into the following types:

- Functional requirements.
- Aspect requirements.
- Interface requirements.
- Realisation requirements.

Table 3 provides a definition for each type of requirement.

Type of requirement		Note
Functional Requirements		Functional requirements are requirements for the primary function or performance of the system and the objects of which the system is composed.
Aspect requirements	Reliability	The probability that the required function is performed under given conditions during a given time interval.
	Availability	The probability that the required function can be performed at a given arbitrary time under given conditions. This corresponds to the fraction of time that the required function can be performed under given conditions.
	Maintainability	Requirements concerning the necessary management and maintenance effort of the system or objects to be realised and the ease and speed with which a system can be restored to an operational status after failure.
	Safety	Requirements concerning the safety of the system to be realised or the objects during the usage phase, for both the user and the environment.
	Design	Requirements for the aesthetic appearance of the system or objects to be realised.
	Lifetime	Requirements regarding the required lifetime of the system or objects to be realised.
	Future-proof	Requirements for making the system suitable for future use.
Realisation requirements		During the implementation phase, the system should meet the requirements and preconditions as described in the "BLVC framework".
Interface requirements	External interface	Requirements for interfaces of the system with the (future) environment on the outside of the system boundaries
	Internal interface	Requirements for interfaces within the system related to systems/objects to be designed or realised by third parties or for the interaction between different objects within the system.

Table 3- Requirement types definition

3.2 Requirement tables

The requirements in this System Specification are presented in accordance with the format of Table 4.

ID Title of the claim	
Demand text	
Explanation (optional)	
Verification method (optional)	Prescription/Standards (optional)

Table 4- Requirement format.

	:	Supplier of engineering and components (is also indicated by the letter L in the requirement number).
	:	Installer (is also indicated by the letter I in the requirement number).
ID	:	Unique Requirement Number.
Title of the claim	:	Short description of the requirement with keywords.
Requirement text	:	Description of the requirement.
Explanation (optional)	:	Explanation of requirement included for information.
Verification method (optional)	:	Prescribed verification method.
Requirement (optional)	:	Description of verification method.

1.1 Unique Requirement Number

The unique Requirement Number is composed of 9 characters, W-XX-YY-ZZZ. Whereby the characters represent the following:

W	L or I	Coding requirement applies to the supplier (L) or to the installer (I)
XX	M, T or MT	Code requirement applies to M=Metro, T=Tram or MT=Metro and Tram
YYY	000-999	Coding for system group, see Table 5.
ZZZ	001-999	Coding of requirement within system group

System group code YYY	Group name
000	General
001	Functionality
002	Test protocols
003	1-line diagram
004	Object Architecture
005	Contact list
006	Civilian Requirements/Designs
010	HVI
011	Metering
020	Traction Transformer
021	Auxiliary transformer
022	Station energy supply transformer
030	Rectifier

System group code YYY	Group name
031	Recovery Unit
040	GVI general
041	GVI high speed circuit breaker
043	GVI-Plus-/mine circuit breaker
044	GVI Circuit breaker Recovery
045	Sectional switchgear (SSI)
046	Track circuit breaker
050	Low voltage general
051	Low-voltage switchgear
052	Low-voltage UPS
060	General protection
061	Protection-HVI
062	Protection-Traction Transformer
063	Protection Auxiliary transformer
064	Protection-Rectifier
065	Protection-GVI
066	Interlocks-SSI
070	Cabling general
071	Cable paths
072	Cabling-internal
073	Cabling-external
074	Cabling - fibre optic network
075	Wiring 61850
076	Connection CBI Metro
077	Connection CBI Tram
080	General controls
081	Control-CBI Metro
082	Control-CBI Tram
083	HMI operation
084	Emergency off circuit
090	Building-related installations
091	Project management
092	Interface management
093	Designs
094	Implementation
095	Testing
096	Verify/Validation
097	Completion/Delivery
098	Education/Training
099	Project Control and Project Support
100	Aftercare
101	Warranty

System group code YYY	Group name
102	Parts supply
103	Service and maintenance

Table 5 - Coding system group

3.3 Verification

The verification method is filled in in the requirements tables. The contractor must elaborate this verification through a verification and validation plan. The interpretation of the verification method in this specification should be seen as a conceptual proposal which the contractor should complete, detail, work out and specify further.

This specification distinguishes between the following verification methods:

- Document assessment Design: In this verification method, the design must provide an explicit description, substantiation of how the requirement is implemented. It is up to the contractor how this is worked out.
- Document review Design Drawing: In this verification method, the design should provide an explicit description, substantiation of how the requirement is implemented. A specific design drawing is explicitly required.
- Document review Design Calculation: In this verification method, the design should provide an explicit description, substantiation of how the requirement is implemented. A specific design calculation is explicitly required (example: short circuit calculation).
- Document review Design specification: In this verification method, the design must provide an explicit description, substantiation of how the requirement is implemented. A specification from, for example, a supplier is explicitly required (e.g. a control circuit diagram of a high speed circuit breaker field).
- Testing/inspection report visual: In this verification method, an explicit substantiation must be provided visually of how the requirement has been implemented. This should be recorded in a report. (For example, an inspection of the cable ducts).
- Testing/functional: In this verification method, a functional test should provide evidence that the requirement has been implemented. This should be recorded in a report (e.g. an IO test).
- Testing/measurement and report: In this verification method, a measurement should provide evidence that the requirement has been implemented. This must be laid down in a report (e.g. a measurement of the frame-earth insulation).

It should be noted that tests are normally divided into FAT, SAT and iSAT tests. It is up to the contractor to give further substance to this. The above enumeration forms a basis for this.

4 Traction power switchgear substation

This specification is generic for metro traction power switchgear substations.

4.1 Top requirements

4.1.1 Functional Metro

I-M-001-001 Traction power switchgear substation system - Metro 3rd rail/Minus	
The SS should supply power to Rail traffic via a connection to the third rail.	
Explanation: Requirement applies if the contact line network is third rail. See Single-line diagram (section 1.2)	
Verification method Document review Design drawing	Requirement: The ON must demonstrate the connection by means of a circuit diagram.

4.1.2 Aspect requirement: Maintainability

I-M-000-001 System traction power switchgear substation - SS maintainability	
The SS shall be suitable for maintenance by the operator. The explanatory notes specify the operating aids and special tools.	
Explanation: Per traction power switchgear substation: Number of outgoing plus fields x 1-pole grounding kit. 1x earth stick. Number of outgoing plus fields x "NIET SCHAKELEN" sign. Number of outgoing plus fields x "GEAARD" sign. Locks to lock switches. Wall rack for hanging the earthing sets. Single Line on the wall.	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

L-M-000-002 Traction power switchgear substation system - SS accessibility	
The SS must be accessible to maintenance personnel by means of an access road and path.	
Explanation: Specific requirements for the access road and path are laid down in the System Specification Gelijkrichterstation - CIVIEL.	
Verification method Document review Design Testing/inspection report visual	Prescription: System specification Gelijkrichterstation - CIVIEL

L-M-000-003 Traction power switchgear substation system - Platform power section Metro	
The SS shall arrange the feed sections according to the circuit diagram, so that each platform track has a separate feed section. The circuit diagram is included in the sPvE.	
Explanation: Requirement applicable if Traction power switchgear substation Metro. For metro, each platform track has in general its own power supply section. With such an arrangement, each platform track can be taken out of service and/or de-energised separately. See Schedule for the circuit diagram to be used.	
Verification method Document review Design drawing	Prescription/Standards

L-M-000-006 System traction power switchgear substation - SS disconnectable	
It must be possible to independently switch off and maintain the electrical installations (GVI) of the SS.	
Explanation (optional)	
Verification method Document review Design drawing	Norm: NEN-EN 50123

L-M-000-007 System traction power switchgear substation - Installation housing	
All components and parts of the traction installations in the SS shall be placed in metal-enclosed cabinets where accessibility for maintenance shall be maintained in accordance with NEN-EN 50123. The DC distribution system shall be installed insulated from earth.	
Explanation (optional)	
Verification method Document review Design specification Testing/inspection report visual Testing/measurement and report	Norm: NEN-EN 50123

L-M-000-008 Traction power switchgear substation system - Clearance for maintenance of switchgear	
The location of the switchgear in the SS must allow for the switchgear to be driven out and for (maintenance-) work to be carried out safely in front of, in and on the equipment-.	
Explanation (optional)	
Verification method Document review Design	Prescription/Standards

4.1.3 Aspect requirement: Reliability

L-M-000-009 Traction power switchgear substation system - SS design life	
The SS shall have a design life of at least 30 years, or otherwise if so specified in referenced documents or in this demand specification. Exception for PLCs and protective relays, for which the minimum design life is 15 years. For batteries, a design life of 10 years should be applied.	
Explanation (optional)	
Verification method Document review Design specification	Prescription/Standards

L-M-000-010 System traction power switchgear substation - SS operation in existing climate	
The SS must function undisturbed in the Dutch climate. A moderate sea climate should be assumed.	
Explanation (optional)	
Verification method Document review Design specification	Prescription/Standards

L-M-000-011 System traction power switchgear substation - SS ambient temperature	
The SS should be suitable for an ambient temperature of -10°C to +40°C.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design specification	

4.1.4 Aspect requirement: Future-proofing

L-M-000-012 Traction power switchgear substation system - Components to be supplied	
The supply of applied components must be guaranteed for at least 10 years.	
Explanation (optional)	
Verification method	Prescription/Standards
Testing/inspection report visual	

4.1.5 Aspect requirement: Availability

L-M-000-013 System traction power switchgear substation - SS Group separation	
The SS shall continue to supply power to the other power sections when one power section is switched off.	
Explanation: Each feed section contains its own feed quick switch.	
Verification method	Requirement: ON must demonstrate group separation by means of the circuit diagram.
Document review Design drawing	

4.1.6 Aspect requirement: Nuisance

L-M-000-014 Traction power switchgear substation system - SS noise level	
The external sound level of SS shall not exceed 55dB(A) [LpA] at a distance of 10 m.	
Explanation (optional)	
Verification method	Prescription/Standard:
Testing/measurement and report in accordance with IEC 6007610	Noise Pollution Act 01-05-2017 IEC 6007610

4.1.7 Aspect requirement: Safety

L-M-000-015 System traction power switchgear substation - SS protections	
The SS installations must be protected against internal faults, overloads and short-circuits.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Security concept design & selectivity	

I-M-000-016 System traction power switchgear substation - SS Cable type	
The cables and wiring used in the SS must be halogen-free and flame-resistant.	
Explanation (optional)	
Verification method	Norm:
Document review Design specification	
	NEN 8012

4.2 GVI

4.2.1 General

L-M-040-001 System traction power switchgear substation - GVI Outgoing fields Metro	
The GVI of the SS shall have outbound (plus) fields. The project-specific circuit diagram included in the sPvE is leading in the number of outbound fields.	
Explanation: The number of outgoing fields and configuration must be determined from the project-specific circuit diagram.	
Verification method Document review Design drawing	Prescription/Standards

L-T-040-005 System traction power switchgear substation - GVI Installation	
It must be possible to install the GVI directly against the wall. It must be possible to carry out all maintenance from the front.	
Explanation: When replacing in existing traction power substations, space is often at a premium, so a free-standing arrangement is not possible.	
Verification method Document review Design drawing Testing/inspection report visual	Prescription/Standards

L-M-040-007 Traction power switchgear substation system - GVI Minus field	
The GVI must be equipped with a minus field to which the return cables must be connected.	
Explanation: For traction, a minus connection at a traction power switchgear substation is in principle not necessary. However, the outbound plus fields need a reference minus for the line test functionality and undervoltage protection. Therefore, a minus connection must be provided nonetheless. This can be done with a smaller diameter compared to minus connections for traction power substations.	
Verification method Document review Design drawing Testing/inspection report visual	Prescription/Standards

L-M-041-001 Traction power switchgear substation system - GVI switching carriages	
The high speed circuit breakers must be placed on switch carts.	
The switch cars must be equipped with a test position in which the main contacts are broken. When the switch car is deployed, it shall be possible to test the switch for proper functioning (switching on, off, trips) using normal electrical operation.	
Explanation (optional)	
Verification method Document review Design drawing Testing/inspection report visual Testing/functional	Prescription/Standards

L-M-041-002 Traction power switchgear substation system - GVI ground balls	
The GVI must be equipped with earth balls on the plus, minus and earth rail.	
Explanation: For securing the installation during maintenance.	
Verification method Document review Design drawing Inspection report visual	Prescription/Standards

I-M-040-010 System traction power switchgear substation - GVI insulated arrangement	
The GVI must be completely isolated from water earth. The system is connected to water earth via the system short-circuit protection, which detects the fault current in the event of a short-circuit from the DC circuit to the system. The system short-circuit protection must be demonstrably short-circuit proof.	
Explanation (optional)	
Verification method Document review Design drawing Document review Design Calculation Testing/measurement and report Testing/functional	Prescription/Standards

I-M-040-011 System traction power switchgear substation - GVI blind diagram	
The GVI must have a single-line blind diagram on the panel.	
Explanation: The blind diagram must be site-specific, with the correct coding and section names.	
Verification method Document review Design drawing Testing/inspection report visual	Prescription/Standards

L-M-040-012 Traction power switchgear substation system - GVI Version

Operation and monitoring of the DC distribution system shall comply with:

- All controls, measurements and signalling must be carried out at the front of the cabinet.
- All local and remote controls and position transmitters must be carried out with double poles.
- The status reports of all switches and disconnectors and the current and voltage measurements must be easy to read, both on the front panel and on the HMI.
- Switching on and off of high speed circuit breakers has to be done by means of push buttons on the field or on the protection unit.
- It must be possible to switch the high speed circuit breaker on and off manually in the field at any time, even in the absence of auxiliary power.
- The disabling of the blocking of the on-switching must be carried out by means of a field reset.
- When the high speed circuit breaker is tripped, it shall be possible to read which protection has been activated and at what time.
- The trip history shall be stored up to at least 50 trips and be easily readable.
- The controls and signalling to and from the traction power switchgear substation must be in accordance with the IO list.

Explanation (optional)

Verification method

Document review Design specification

Prescription/Standards

L-M-040-013 Traction power switchgear substation system - GVI protection type

The GVI shall be equipped with (modern) safety relays that enable interconnection and linkage to station automation systems on the basis of IEC61850/GOOSE. The components must support version 2.0.

Explanation:

Trip notifications, status and stand notifications will be linked to CBI via fibre optic connections. No hardware links will be used.

Verification method

Document review Design specification

Norm:

IEC61850/GOOSE

L-M-040-014 System traction power switchgear substation - GVI control version	
The GVI high speed circuit breakers can be operated in three ways: • Local. This refers to the control in the traction power switchgear substation at the GVI itself. • Remote. This means operation from the HMI in the traction power switchgear substation. • Remote control. This means the operation from the CVL/Switchman. The selection between operation "Local", "Remote" or "Distant" must be made by means of a selector switch in the relevant field. The selector switch must be implemented as a key switch. The selector switch shall be a three-position switch with the following design: • In the "Local" mode, only locally issued commands are to be executed on the GVI. • In the remote mode, only the commands issued from the HMI must be executed. • In the "remote control" mode, only the commands given by the CVL/Switchman shall be executed. The position of the selector switches must be signalled in the field, on the HMI and to the switchman. Switching the selector switch must not cause a change of state in the field concerned.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

4.2.2 High speed circuit breakers

L-M-041-004 Traction power switchgear substation system - GVI activation and deactivation of contact line system	
The switch-on and switch-off of the voltage in the contact line network is carried out by means of the high speed circuit breakers. For this purpose, the high speed circuit breakers must be equipped with protection devices that cut off the power supply to the contact line network in the event of an excessive current load.	
Explanation: For each section of the contact line network, a direct current circuit breaker (high speed circuit breaker) is included in the switching and distribution device.	
Verification method	Prescription/Standards
Document review Design	

L-M-041-005 System traction power switchgear substation - GVI high speed circuit breaker per section	
One DC circuit breaker (high speed circuit breaker) per section of the contact line system shall be installed in the switch and distribution unit.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	

L-M-041-006 System traction power switchgear substation - GVI high speed circuit breaker specifications	
The high speed circuit breakers must be capable of carrying the nominal operating current that occurs and also of switching on and off the short-circuit currents that occur.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design Calculation	
Document review Design specification	

L-M-041-007 System traction power switchgear substation - GVI high speed circuit breakers	
The high speed circuit breakers must be equipped with a fast cut-off unit (shunt trip, capacitor cut-off with thyristor and additional tripping coil on the high speed circuit breaker).	
Explanation: This is in order to be able to switch off the high speed circuit breaker extra quickly (less than 20 ms).	
Verification method Document review Design specification	Prescription/Standards

4.3 Protection

4.3.1 General

L-M-060-001 Traction power switchgear substation system - Selectivity study	
ON shall carry out a selectivity study and submit it to OG for approval. The selectivity study must include at least the following aspects: - Expected maximum operating and design flows (DC side) - Short-circuit calculations DC side - Safety settings DC side - Thermal and dynamic short-circuit resistance of cables and installation parts in relation to short-circuit currents and tripping times should also be considered. - The above must be explained and described in a separate report.	
Explanation: Collecting and retrieving the necessary input data to elaborate the above is part of the job.	
Verification method Document review Design Calculation	Prescription/Standards

L-M-060-002 System traction power switchgear substation - Trip functionality	
The trip function of all protection devices must be realised in accordance with the appendix to this specification Trip matrix Traction power switchgear substation.	
Explanation (optional) See section 1.2 Traction power switchgear substation trip matrix.	
Verification method Document review Design Testing/functional	Prescription/Standards

4.3.2 Emergency off

L-M-060-003 System traction power switchgear substation - Emergency off SS	
An emergency off button should be installed on the inside of the SS at each access door, which can switch off the entire SS.	
Explanation (optional) The purpose of this emergency off is to promote the safety of personnel, and to switch off immediately if a fire is detected. All high speed circuit breakers switch off.	
Verification method	Prescription/Standards
Document review Design drawing	
Testing/functional	

4.3.3 GVI

4.3.3.1 Protection plus fields

L-M-065-001 System traction power switchgear substation - Protection devices GVI	
The outbound (plus) fields (high speed circuit breakers) must be equipped with the following protection devices: • I> mechanical: directly on the high speed circuit breaker, should work without auxiliary voltage • I> electronic: via protective relay in combination with shunt trip/ capacitor trip • I thermal (pre-alarm): alarm at 80% via protection relay • I thermal (trip): via protective relay in combination with shunt trip/ capacitor trip • dI/dt (trip): via protection relay • Cable protection: via protection relay • External trip (see relevant section) • Line test functionality	
The protection relay shall have the possibility of automatically switching between two settings/ parameter sets (high and low settings) with regard to the maximum current time (I>) protection.	
Explanation: A distinction is made between trips with Auto-reclose (AWI) and without (see section 4.3.3.2 Auto-reclose).	
Verification method	Prescription/Standards
Document review Design	
Document review Design specification	
Testing/inspection report visual	

4.3.3.2 Auto-reclose

L-M-065-002 System traction power switchgear substation - Auto-reclose (AWI)	
The outgoing (plus) fields (direct current circuit breakers) must be equipped with Auto-reclose, AWI applies to the following trips: • I > mechanical • I > electronic • I thermal (trip) (after cooling below 80%) • di/dt	
Explanation: When a trip with automatic reset occurs, the reset procedure may be activated a maximum number of times (1 to 10 times). This procedure means that the switch receives an IN command after which the line test is started. If the line test is successful, the switch is re-entered and the counter is reset. If the line test is not successful, the procedure is started again. If the settable number of times has been reached and the switch has still not entered, it shall be blocked against switching on. It shall be possible to reset the lock on remote control (switching watch).	
Verification method Document review Design Document review Design specification Testing/inspection report visual	Prescription/Standards

4.3.3.3 Line test

L-M-065-003 System traction power switchgear substation - Line test functionality	
The outbound (plus) fields (DC high speed circuit breakers) shall be provided with line test functionality. The line test should work both ways. The key current shall be adjustable, as well as the number of attempts before the switch locks.	
Explanation: After an IN command for an outgoing plus field, the line test must be performed. With a line test, the resistance of the circuit to be fed is measured. The line test must work both ways to prevent switching on from a live busbar to an earthed plus busbar in the GVI. When the current is too high (e.g. a short circuit) the line test is unsuccessful and the switch will not come on. When the current is sufficiently low, the switch is switched on. If there is already voltage on the power section when switching on, do not test. A pause must be maintained between tests to prevent the heat dissipation of the test resistors from becoming too great.	
Verification method Document review Design Document review Design specification Testing/inspection report visual	Prescription/Standards

4.3.3.4 External trips

L-M-065-004 System traction power switchgear substation - external trips	
The outgoing (plus) fields (DC high speed circuit breakers) must be equipped with external trip functionality.	
Explanation: External trip means a trip of the high-speed switch not by its "own" protection relay but by trips of protection relays of other installations or by protection of neighbouring traction power substations. As with "internal" trips, a distinction is made for external trips: • External trip without AWI • External trip with AWI <u>The external trips without AWI are:</u> • Trip surge arrester device • Trip Minus Earth Potential Monitoring • Trip surge arrester device of neighbouring importing GS • Trip cable protection of neighbouring importing GS • Line test error of neighbouring importing GS <u>The external trips with AWI are:</u> • I> trip of neighbouring importing GS • dl/dt trip of neighbouring importing GS In this context, neighbouring feeder refers to the high speed circuit breaker feeders that feed into the same supply section. <u>The external trips are received and transmitted from/to the neighbouring GS via the so-called "carrier circuit" circuit. This is done via the Central Control of Installations (CBI).</u>	
Verification method	Prescription/Standards
Document review Design	
Document review Design specification	
Testing/functional	

4.3.3.5 Anti-pump protection

L-M-065-005 System traction power switchgear substation - Anti-pump protection	
The outgoing (plus) fields (high speed circuit breakers) must be equipped with anti-pump protection.	
Explanation: The control circuit of the high-speed switch must be equipped with an anti-pump protection. The anti-pump protection prevents a switch from being switched on again if, within 1 second of being switched on, the switch is switched off again for any reason. This can occur, for example, during an automatic restart where the low-energy line test voltage does not detect an error and the switch is wrongly switched on. Subsequently, a trip of the fast-start switch will immediately take place, now that the error has manifested itself. The anti-pump protection then blocks the automatic reactivation, so that the high-speed switch remains switched off.	
Verification method	Prescription/Standards
Document review Design	
Document review Design specification	
Testing/functional	

4.3.4 Frame short circuit protection

L-M-065-006 Traction power switchgear substation system - Frame short circuit protection	
The DC distribution device shall be equipped with a lock-out protection.	
Explanation: The cabinets of the DC distribution system and other components of the DC traction power supply circuit must be installed in an insulated manner. The cabinets of these parts of the installation must be electrically interconnected and connected to earth via a single terminal box. In this way, closures between the DC installation and the cabinets are detected and eliminated. When the current through the side circuit breaker exceeds a certain adjustable value, it must send a trip command to all outgoing plus fields of the station. In addition, via the "take-out circuitry", all incoming plus fields from neighbouring traction power substations must be switched off.	
Verification method Document review Design Document review Design specification Testing/functional	Prescription/Standards

4.3.5 Minus earth potential (rail-to-ground voltage)

L-M-065-007 System traction power switchgear substation - Minus earth potential monitoring	
The DC distribution unit must be equipped with a minus earth potential monitoring device according to the binding document: Basic design of minus earth potential monitoring device.	
The minus earth potential signalling device must be installed in the traction power switchgear substation and be designed as a low-voltage limiting device between the minus rail and earth. The low voltage limiter shall ensure that an overvoltage on the minus rail is diverted to earth. The conducted current shall be monitored and signalled in the SCADA system with a pre-alarm and an alarm. The signals shall be automatically cancelled if the induced current falls below the monitoring levels. If the overvoltage has not dropped below the standard value after 1 second, the high speed circuit breakers of the outbound plus fields and the circuit breakers of the traction fields shall be switched off: - External trip outgoing plus field(s) GVI without automatic reset (AWI) Minus earth potential monitoring must be carried out with a VLD-O. The threshold values for the various reports are listed in the following table. Values must be in accordance with NEN-EN 50122: • Minus earth pre-alarm: 90V • Minus ground trip: 120V • Mini-rail current to earth alarm: 20A • Mini-rail current to earth alarm: 200A	
Explanation: The potential difference between minus and earth must always comply with the safety standard (the potential difference must not exceed the standard value). The minus earth potential monitoring monitors the minus earth potential and intervenes when the potential threatens to exceed the safety standard. The protective device has a response value for a pre-notification and a trip value.	
Verification method Document review Design Document review Design specification Testing/functional	Standards: NEN-EN 50122-1

4.3.6 Carrier circuit

L-M-065-009 Traction power switchgear substation system - Carrier circuit	
The external trips between the neighbouring traction power substations are to be communicated between the traction power switchgear substation and the traction power substations by the carrier circuit. This carrier circuit must be implemented via the Central Control of Installations (CBI).	
Explanation: The carrier circuit is intended to ensure that, in the event of a fault situation in a connected contact line network (feed section), such as a short circuit, whereby the high speed circuit breaker switches off as a result of the tripping of the current protection, the high speed circuit breaker of the connected traction power substation is also switched off via the CBI.	
Verification method Document review Design Document review Design specification Testing/functional	Prescription/Standards

4.4 Internal wiring

I-M-072-001 System traction power switchgear substation - Internal wiring	
Internal wiring must be halogen-free, low-smoke and flame-resistant.	
Explanation (optional)	
Verification method Document review Design specification	Prescription/Standards

I-M-072-002 System traction power switchgear substation - Coding	
Internal wiring must be coded.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards VB AMS 053 Area composition and coding of sites, installations, objects and cables JOIN: CEB/OVG/20507)

I-M-072-003 System traction power switchgear substation - Internal wiring sleeves filling degree	
Internal wiring should be housed in flame-retardant and halogen-free ducts. Fill level should not exceed 60%.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-072-004 Traction power switchgear substation system - Internal wiring sleeves covers	
The lids of the wiring sleeves must be easy to remove and replace.	
Explanation (optional)	
Verification method Testing/inspection report visual	Prescription/Standards

I-M-072-005 Traction power substation system - Wiring connection	
The installation of two or more wires under one terminal is not permitted.	
Explanation (optional)	
Verification method Testing/inspection report visual	Prescription/Standards

I-M-072-006 System traction power substation - 600/750 VDC cabling	
For 600 VDC and 750 VDC cables, double-insulated special wire should be used and placed in separate conduits where no other wires run.	
Explanation (optional)	
Verification method	Prescription/Standards
Testing/inspection report visual	

I-M-070-001 System traction power switchgear substation - Mechanical protection	
When wiring is connected to parts that are movable in relation to the fixed part, this wiring must be bundled and flexible and mechanically protected.	
Explanation (optional)	
Verification method	Prescription/Standards
Testing/inspection report visual	

4.5 Local/central control of installations (CBI)

4.5.1 Control (Station automation)

As the requirements for the SS in particular show, the various protection relays will be interconnected according to the standard IEC61850/GOOSE. The intelligence will be implemented as much as possible in the decentralised safety relays (IED). However, there are functions that should be realised from a more centralised IED. In addition, a central unit must be provided with which the link with the Central Control of Installations can be realised. This concerns the local control (the station automation unit of the SS). The coupled components must support version 2.0 of the IEC61850 standard.

L-M-080-001 System traction power switchgear substation - Station automation unit SS	
The SS shall be equipped with a local station automation unit that provides the necessary control interfaces between the various installations, plus the interface to the GVB Central Control of Installations (CBI). The local station automation unit shall be an industrial PLC. ON may offer alternatives at the discretion of OG.	
It is required that the local control unit is housed in a separate cabinet.	
A site-specific block diagram specifying the various interfaces is a required part of the design.	
Modern IEC61850 connections must be used for station automation. ON will take measures with regard to cybersecurity. ON may make proposals to that effect and must discuss and agree them with OG.	
Explanation. Coordination with party for interface with CBI is part of the work and scope ON.	
Verification method Document review Design	Prescription/Standards

L-M-080-002 Traction power switchgear substation system - Switching power sections on/off	
Each traction power section of the SS must be able to be disconnected locally (at installation level), remotely (from the HMI) and by remote control (via the CBI) and, if required, put back into operation.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-080-003 System traction power switchgear substation - CBI	
The SS must be equipped with remote control and signalling, for all commands, position transmitters, alarms and measurements necessary for correct operation. This information should be transmitted to the CAB of the GVB. A connection to the existing CBI system must be realised.	
Explanation: This is based on the site-specific IO list approved by OG, which must be prepared by ON based on the template IO list (see section 1.2).	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-080-004 System traction power switchgear substation - IO list	
ON shall submit a site-specific IO list for approval in the UO. The IO list should be made location specific based on the template IO list.	
Explanation: See the template IO list (section 1.2).	
Verification method	Prescription/Standards
Document review Design	

I-M-081-001 System traction power switchgear substation - Local control SS	
ON must install a local control box (Control SS) in the SS. The local control box must facilitate the specific IO list and described functionality prepared by ON.	
For the basic principle, see the block diagram "Blok-schema CBI Metro" (see section 1.2).	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	

L-M-081-002 System traction power switchgear substation - Block diagram	
ON should make the block diagram "Blok-schema CBI Metro" in the Annex specific and up to date and develop it further as part of the design process.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	

L-M-081-003 System traction power switchgear substation - Interface underlying installations	
The local control box must be connected to the underlying installations on the basis of the interfaces indicated in "Blok-schema CBI Metro" in the appendix.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	
Testing/functional	

L-M-081-004 System traction power switchgear substation - Track controller interface	
The local control box must be connected to the higher-level track controller (BC) based on the interface specified in "Blok-schema CBI Metro" in the appendix. The reconciliation of the interface, specific IO list with the party providing the operations with the track controller is part of the scope of this specification. The track controller itself, the interface to the NMA network and all related work on the SCADA system are not part of the scope of this specification.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

I-M-081-005 Traction power switchgear substation system - Space reservation	
ON should take into account space reservation in the SS for the following components: - Third-party installation of Track Controller - Installation of a wall cabinet (60x60cm) for network connection A Track Controller will not be placed in the SS in all cases. ON must specifically request this from the client.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	
Testing/inspection report visual	

4.5.2 HMI

L-M-083-001 System Traction power switchgear substation - HMI Remote Control	
Operation and monitoring of the traction power switchgear substation should be possible at three levels: • Local service • Local Remote control • Remote control	
Explanation: • Local control refers to control and monitoring on the installations/panels themselves. This can be done via push buttons on the panel, status lights, but also via operation and reading of (touch) screens of safety relays. For the purpose of local operation, the panels must be provided with up-to-date blind diagrams on the panels. • Local Remote control refers to the operation and monitoring of the traction power switchgear substation via a display system installed centrally in the traction power switchgear substation. Only the traction power switchgear substation where the display system is located can be operated and monitored. • Remote control means: operation and monitoring of the traction power switchgear substation via the CVL/Central remote control.	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-083-002 System Traction power switchgear substation - HMI Remote Control -- Status Indication	
The status of all switches (outgoing plus fields) must be indicated: • Open • Closed • Carry out (GVI) It must not be possible to override locks in the primary circuit via remote control or remote operation.	
Explanation (optional)	
Verification method Document review Design Testing/functional	Prescription/Standards

L-M-083-003 System Traction power switchgear substation - HMI Remote Control -- Operation	
It must be possible to operate the following components (after taking over operation of the room): • Switching on and off outbound plus fields • Resetting of error messages / acknowledgement of alarms	
Explanation (optional)	
Verification method Document review Design Testing/functional	Prescription/Standards

L-M-083-004 System Traction power switchgear substation - HMI Remote Control - Analogue values	
The following analogue values shall be displayed: • Voltage on the DC rail • Minus earth voltage • Current per outgoing plus field (both positive and negative)	
Explanation: Although the traction power switchgear substation has a minus cable, no current runs through it in normal operation. The minus cable only serves as a reference for measuring traction voltage and minus earth voltage.	
Verification method Document review Design Testing/functional	Prescription/Standards

L-M-083-005 System traction power switchgear substation - HMI remote control - signalling/alarms

The following signals/alarms must be readable:

- Error messages/alarms of protective relays outbound plus fields including at least:
 - Line test failed;
 - I_{max};
 - di/dt;
 - Cable jacket fault.
- Frame short circuit protection
- Short-circuit switch
- Error message/alarm high minus earth potential
 - High minus earth potential alarm;
 - Trip high minus-earth potential.
- Emergency off
- Take-off (external trip)

The signalling/alerting must be visualised in an alarm list which is logged.

Explanation (optional):

Error messages/alarms from the transformer and rectifier are not relevant for a traction power switchgear substation.

Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-083-006 System Traction power switchgear substation - HMI Remote Control - General

Display visualisation after activating the screen.

Access to control functions should only be possible after login with user name and password of switching authorised persons.

Explanation:

After activating the screen, due to burn-in / service life / energy consumption.

Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-083-007 System traction power switchgear substation - HMI access rights

The HMI should have different authorisation levels:

- Basic level: Visualisation of the status of switches and disconnectors as well as error messages/alarms is available to anyone who has access to the traction power switchgear substation without a user name/password;
- Second level: Access to control and reset functions should only be possible after login with user name and password by switchgear authorised persons;
- A third level gives access under a (different) user name/password to change parameters/settings.

Explanation:

After activating the screen because of burn-in/life expectancy/energy consumption.

Verification method	Prescription/Standards
Document review Design	
Testing/functional	

I-M-083-008 System traction power switchgear substation - HMI placement	
The hardware of the HMI consists of a screen that is built into a control panel; preferably the panel that also houses the traction control of the traction power switchgear substation to avoid unnecessary wiring.	
Explanation (optional):	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-083-009 System traction power switchgear substation - HMI screen	
Schermeisen: • Touchscreen; • Colour TFT screen minimum 15 inches (widescreen); • Resolution at least 1024×768. Displays should switch off after a settable period of time due to burn-in / service life / energy consumption. Switch on by touching the touch screen.	
Explanation: After activating the screen because of burn-in/life expectancy/energy consumption.	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

L-M-083-010 System traction power switchgear substation - HMI screen layout

It must be possible to display various images on the screen, including at least:

- A login screen;
- A single-line diagram of the installation in the traction power switchgear substation showing the current status of the switches;
- An overview of the supply sections fed by the traction power switchgear substation;
- An overview of the last 50 error messages and alarms.

If a component is in an alarm/error situation, this must be made visible on the screen for the component:

- Alarm: Orange;
- Fault: Red.

Operation (for level 2 and 3 users):

- Switching of disconnectors and switches via touch screen and after answering an additional confirmation question;
- Resetting of error messages / acknowledgement of alarms.

Parameters:

- Clicking on a component opens a frame with the set values (for all login levels);
- Changing parameters only by level 3 users.

Logging of parameter change:

- The logging indicates when, by whom and the change in the parameter.

The symbols on the screen must be in accordance with NEN 5152/IEC 60617 'Graphical symbols for diagrams'. Display switches as switch symbols and not as green or red squares due to lack of standardisation.

Explanation:

After activating the screen because of burn-in/life expectancy/energy consumption.

Verification method	Prescription/Standards
Document review Design	
Testing/functional	

I-M-083-011 System traction power switchgear substation - HMI placement

The HMI should be placed in the DC voltage & low voltage area.

Explanation:

See typical arrangement drawing in annex (par. 1.2). This does not concern a location-specific building arrangement.

Verification method	Prescription/Standards
Document review Design	
Testing/functional	

4.6 Low-voltage connection Grid operator

The low-voltage connection from the grid operator supplies the low-voltage power for the substation's own operation, which includes lighting, WCDs, secondary DC auxiliary voltages for relays, etc. The low-voltage connection feeds a low-voltage distribution unit (LVI), which provides further distribution to the underlying consumers. The LVI must be equipped with the possibility of feeding in an external emergency power generator in the event of a failure of the low voltage connection of the Grid Operator.

I-M-050-001 System traction power switchgear substation - LS power balance	
A site-specific LS power balance must be drawn up to determine the power of the grid connection.	
Explanation: All consumers should be included in the LS balance sheet, taking into account realistic simultaneity factors.	
Verification method Document review Design Calculation	Prescription/Standards

I-M-050-002 System traction power switchgear substation - LS connection class	
The SS must have a low-voltage connection (3x25A) with the grid operator Liander.	
Explanation (optional)	
Verification method Document review Design	Prescription/Standards

I-M-050-003 System traction power switchgear substation - LS connection request	
The low-voltage connection must be requested from the grid operator Liander by ON.	
Explanation (optional)	
Verification method N/A	Prescription/Standards

4.7 LVI

4.7.1 Low-voltage distributor

L-M-051-001 System traction power switchgear substation - LVI	
The SS must be equipped with a low-voltage installation 230/400 V.	
Explanation (optional)	
Verification method Document review Design	Prescription/Standards

L-M-051-002 System traction power switchgear substation - LVI kWh metering	
A low-voltage distribution with kWh meter must be installed in the DC voltage & low-voltage room.	
Explanation: See installation drawing in the appendix (see section 1.2). This is not a site-specific building arrangement.	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

L-M-051-003 System traction power switchgear substation - LVI emergency power connection option	
The LVI must be fitted with a connection option for an external power supply. For connecting an NSA.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

L-M-051-004 System traction power switchgear substation - LVI Specifications	
The low-voltage distributor must comply at least with the following points:	
1. In accordance with NEN-EN-IEC 61439 parts 1 and 2. 2. Construction form 2b. 3. Operating voltage 400/230 V - 50 Hz. 4. Earthing regime: TN-S. 5. External protection class IP 54. 6. Insulation value class II. 7. Design: surface-mounted wall mounting. 8. Connection type: top side with screw terminals. 9. Enclosure material: Galvanised sheet steel of at least 1.5 mm thickness. 10. Outside lying doors. 11. Locking system (if casing is used): three-point espagnolette. 12. Lock: handle/lever to be operated without key or tools. 13. Surface treatment: powder coating. 14. Colour: standard manufacturer-dependent (light grey/greyish white or equivalent). 15. Plastic gland plates with membranes.	
Explanation (optional)	
Verification method	Standards: NEN-EN-IEC 61439 part 1 and 2 / NEN1010
Document review Design specification	

L-M-051-005 System traction power switchgear substation - LVI protection and reserve	
All necessary equipment is connected to the low-voltage distribution. The end groups must be protected by circuit breakers. The low-voltage distribution should also be equipped with 20% built-in reserve groups.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	

L-M-051-006 System traction power switchgear substation - LVI control and signalling	
The controls and signalling to and from the traction power switchgear substation must be in accordance with the IO list.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

4.7.2 Auxiliary voltage

L-M-052-001 System traction power switchgear substation - Auxiliary power balance	
The DC auxiliary power supply must be able to provide sufficient power to supply all consumers with the corresponding autonomy time.	
Explanation: All consumers must be included in the power balance, taking into account realistic simultaneity factors. It must be demonstrated that the rectifiers and batteries used are sufficiently dimensioned in relation to autonomy time and rectifier failure. This involves total capacity, base load and peak load.	
Verification method Document review Design Calculation	Prescription/Standards
L-M-052-002 System traction power switchgear substation - Auxiliary power supply	
In order for the various protection, control and transmission devices in the station to operate independently of mains voltage, a battery buffered auxiliary power supply 48VDC must be present in the SS. The emergency lighting should also be powered from the energy supply. Autonomy time: 4 hours.	
Explanation: The emergency lighting must be powered if no emergency lighting with built-in batteries is used. The autonomy time of 4 hours is based on the assumption that all switches can also be switched once within this period.	
Verification method Document review Design	Prescription/Standards
L-M-052-003 System traction power switchgear substation - Auxiliary power supply	
The auxiliary power supply must be supplied by a separate 3 phase group from the low voltage distribution system (LVI).	
Explanation (optional)	
Verification method Document review Design	Prescription/Standards
L-M-052-004 System traction power switchgear substation - Auxiliary power supply devices	
The housing (one piece) of the auxiliary power supply must accommodate two rectifiers for indoor installation and is the connecting link between rectifiers, battery and consumer(s). Switches and fuse-switch disconnectors must be included in the housing in order to be able to switch, separate and protect the various parts of the installation. The rectifiers must be able to operate independently of each other; in the event of a defective rectifier, the other must be able to supply the entire load while retaining its autonomy.	
Explanation (optional)	
Verification method Document review Design specification	Prescription/Standards
L-M-052-005 System traction power switchgear substation - Housing construction	
The construction of the cabinet and rack on which the batteries are placed must be resistant to battery leakage.	
Explanation (optional)	
Verification method Document review Design specification	Prescription/Standards

L-M-052-006 System traction power switchgear substation - Auxiliary power supplies

The auxiliary power supply shall be provided:

- Equipped with earth fault detection relay: adjustable between 0 and 100 kΩ.
- For each outbound group, a fuse with a signal contact must be included in both the plus and the minus side.
- Plus and minus rails are shielded with marked shielding that must be made of transparent flame extinguishing material.

Explanation (optional)

Verification method	Prescription/Standards
Document review Design specification	

L-M-052-007 System traction power switchgear substation - Cooling auxiliary power supply

The auxiliary power supply must be provided with natural cooling; forced cooling is not permitted.

Explanation (optional)

Verification method	Prescription/Standards
Document review Design specification	

L-M-052-008 System traction power switchgear substation - Power supply requirements auxiliary voltage

The auxiliary power supply must meet the following power supply requirements:

- Input voltage: 400V AC/ 3 phase
- System: TN-S
- Frequency: 50 Hz
- Voltage and frequency variation: according to NEN-EN-50160
- Tolerances: according to ACM Netcode Elektriciteit

Explanation (optional)

Verification method	Standards:
Document review Design specification	NEN-EN-50160

L-M-052-009 System traction power switchgear substation - Auxiliary output voltage

The auxiliary power supply must meet the following values as a minimum:

- Rated output voltage 48VDC
- Output voltage limits +/-15%
- Spare capacity: 20%.

Explanation (optional)

Verification method	Prescription/Standards
Document review Design specification	

L-M-052-010 System traction power switchgear substation - Power supply without batteries

The rectifiers must be laid out in such a way that the load can also be supplied without batteries without exceeding the required tolerances.

Explanation (optional)

Verification method	Prescription/Standards
Document review Design specification	
Testing/functional	

L-M-052-011 Traction power switchgear substation system - Auxiliary power reserve groups

The size of the distributor required must be determined by the contractor, taking into account at least 20% reserve groups for future expansion.

Explanation:

The Contractor shall determine the arrangement of the auxiliary power supply groups according to the specific situation.

Verification method	Prescription/Standards
Document review Design Calculation	

L-M-052-012 System traction power switchgear substation - Auxiliary voltage controller	
The auxiliary power supply must be equipped with a controller for protection, monitoring, signalling, operation and service/maintenance. This controller monitors the busbar voltage, controls the charging voltage and current of the rectifiers.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	
L-M-052-013 Traction power switchgear substation system - Selectivity auxiliary voltage	
The tripping of monitoring and protection relays in the auxiliary voltage supply must not lead to a tripping of the automatic circuit breakers.	
Explanation (optional)	
Verification method	Prescription/Standards
Testing/functional	
L-M-052-014 Traction power switchgear substation system - Selectivity of auxiliary power protection	
The protective devices used must be selective with the upstream and downstream protection devices. The protective devices used must be suitable for detecting and switching off DC fault currents.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design Calculation	
L-M-052-015 System traction power switchgear substation - Auxiliary power batteries	
The batteries of the auxiliary power supply must comply with the following points:	
- Ni-Cad - Maintenance-free - Time period during which full operability and accessibility should be ensured (calculation to be added): 4 hours. - Guaranteed lifetime: 10 years. - Capacity should be determined from the installed power balance.	
Explanation:	
In 2021, we will assume Ni-Cad. Batteries with better characteristics for this application may be available in the future. The autonomy time of 4 hours is based on the assumption that all switches can also be switched once within this period.	
Verification method	Prescription/Standards
Document review Design specification	
Document review Design Calculation	

L-M-052-016 Traction power switchgear substation system - Room conditions auxiliary voltage	
It must be possible to place the auxiliary power supply in an indoor space with a temperature variation between 0 °C and 40 °C. The cabinet shall be provided with cooling/ventilation so that the 48VDC No-break installation is not adversely affected by too high an internal temperature caused by a room temperature of no more than 40 °C.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design specification	

L-M-052-017 Traction power switchgear substation system - Indication and signalling of auxiliary voltage	
The auxiliary power supply must be equipped with messages for the CBI. The following messages must be provided as a minimum, with local readout also possible on the auxiliary power supply:	
• Rectifier malfunction • AC voltage failure • Low DC voltage • DC voltage too high • Ground fault	
Explanation: See the template IO list (section 1.2). Readout of messages on local HMI and CBI.	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

4.8 Building-related installations

4.8.1 Climate

I-M-090-001 System traction power switchgear substation - Climate control	
The building's mechanical systems must control and regulate the climate in the SS.	
Explanation: Climate control means ventilating, cooling and heating the building to ensure the required climatic conditions in the rooms. For the cable cellar, only ventilation applies.	
Verification method	Prescription/Standards
Document review Design Calculation	

I-M-090-002 System traction power switchgear substation - Room thermostat	
The climate control system in the SS should be controlled by a room thermostat in the DC voltage & low voltage room.	
Explanation: Climate control means ventilating, cooling and heating the building to ensure the required climatic conditions in the rooms.	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

I-M-090-003 System traction power switchgear substation - Air conditioning application	
The use of air conditioning is only permitted if cooling by means of ventilation is not sufficient.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design Calculation	

I-M-090-004 Traction power switchgear substation system - Climatic conditions	
In connection with the operation of various components of the equipment to be installed, the climatic conditions should be	
- Maximum room temperature +40 °C - Average room temperature over a period of 24hrs < +35 °C - Minimum room temperature +5 °C - Average relative humidity over 24hr period not more than 90%.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	

I-M-090-005 System traction power switchgear substation - Heating	
The SS must be equipped with electric heating. It must be possible to keep the inside temperature above 5°C at all times.	
Explanation (optional)	
Verification method:	Prescription/Standards
Location-specific heat load calculation, with the heat loads of the applied system components as input.	

I-M-090-006 System traction power switchgear substation - Ventilation method	
The SS must have mechanical ventilation to keep the interior temperature below 40°C at all times.	
Explanation:	
Mechanical ventilation applies to the DC voltage & low voltage area.	
Verification method:	Prescription/Standards
Location-specific heat load calculation, with the heat loads of the applied system components as input.	

4.8.2 Lighting & WCD

I-M-090-007 Traction power switchgear substation system - Lighting installation	
A lighting system should be provided that can be used in every room of the SS.	
Explanation (optional):	
Verification method	Prescription/Standards
Document review Design Calculation	

I-M-090-008 System Traction power switchgear substation - Illuminance	
The illuminance should be at least 400 lux at 80 cm above floor level.	
Explanation (optional)	
Verification method	Standards:
Document review Design Calculation	NEN-EN 12464-1
Testing/measurement and report	

I-M-090-009 Traction power switchgear substation system - Lighting version	
The lighting should be carried out with LED lighting.	
Explanation: Application of energy-efficient lighting.	
Verification method Document review Design specification Testing/inspection report visual	Prescription/Standards

I-M-090-010 System traction power switchgear substation - Lighting switches	
Each room of the SS should have separately switchable lighting.	
Explanation: A light switch must be installed on the lock side of each entrance door.	
Verification method Document review Design drawing Testing/inspection report visual	Prescription/Standards

I-M-090-011 System traction power switchgear substation - WCD	
Each individual room must be equipped with at least two double wall sockets.	
Explanation (optional)	
Verification method Document review Design drawing Testing/inspection report visual	Prescription/Standards

I-M-090-012 System traction power switchgear substation - Emergency lighting	
Emergency lighting should be installed in all rooms. The emergency lighting should be powered from the auxiliary power supply.	
Explanation: The emergency lighting must be powered from the auxiliary power supply if emergency lighting with built-in batteries is not used.	
Verification method Document review Design drawing Testing/inspection report visual	Regulations and Standards: Emergency lighting systems - Central power supply systems: NEN-EN 50171; Emergency lighting (projection, cabling and equipment): NEN-EN1838; Escape route lighting (projection, cabling and equipment): NEN-EN1838, NEN-EN 50172 and NPR 2576;

I-M-090-013 System traction power switchgear substation - Escape route indication	
The SS should be fitted with escape route pictograms.	
Explanation: The escape route pictograms are part of the emergency lighting.	
Verification method Document review Design drawing Testing/inspection report visual	Regulations and Standards: Escape route lighting (projection, cabling and equipment): NEN-EN1838, NEN-EN 50172 and NPR 2576; Escape route symbols: NEN-6088 and NEN-EN1838.

I-M-090-014 System traction power switchgear substation - Lighting control cabinets	
Control cabinets must be fitted with cabinet lighting.	
Explanation: The cabinet lighting switches on when the control cabinet door is opened.	

I-M-090-014 System traction power switchgear substation - Lighting control cabinets	
Verification method	Prescription/Standards
Document review Design drawing	
Testing/inspection report visual	

I-M-090-015 System Traction power switchgear substation - Cable Cellar Lighting	
The cable cellar must be equipped with sufficient working lighting: 10 lux for the crawlspace lighting. The switch for the lighting shall be located in the switch room, near the access hatch, and shall be equipped with a light indicator showing that the lighting in the cellar is on.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	
Document review Design Calculation	
Testing/inspection report visual	
Testing/measurement and report	

I-M-090-016 Traction power switchgear substation system - Shading/replacement	
In order to avoid shadows and to simplify replacement of elements, lighting fixtures should not be placed above appliance cabinets.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design drawing	
Testing/inspection report visual	

I-M-090-017 Traction power switchgear substation system - Door position indicator	
All entrance doors should be equipped with door position indicators for reporting to the CBI. The door position indicator must only respond to the actual opening of the door in question, and not to movement of the door due to wind, vibration, etc. See Appendix Template IO List Traction power switchgear substation (section 1.2).	
Explanation: This concerns all access doors to the SS and the individual rooms of the SS.	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

4.8.3 Firefighting facilities

I-M-090-018 System traction power switchgear substation - Fire extinguishers	
The rooms of the Traction power switchgear substation shall be equipped with portable fire extinguishers.	
Explanation (optional)	
Verification method	Standards: NEN-EN2 / NEN-EN3/NEN4001
Document review Design	
Testing/inspection report visual	

4.8.4 Fire alarm

I-M-090-019 System traction power switchgear substation - Fire detection	
The rooms in the SS must be equipped with fire alarms.	
Explanation: The fire detectors must not be located above live parts of the traction installation.	

I-M-090-019 System traction power switchgear substation - Fire detection	
Verification method	Prescription/Standards
Document review Design drawing	
Testing/functional	

I-M-090-020 System traction power switchgear substation - Fire alarms group notification	
The various fire detectors must generate a collective alarm that is connected to the SCADA system.	
Explanation: This means that only one message must be provided to the SCADA.	
Verification method	Prescription/Standards
Document review Design	
Testing/functional	

I-M-090-021 System traction power switchgear substation - Fire alarms projection	
The fire detectors shall be installed in such a way (against the ceiling) that they can be serviced and/or replaced without disconnecting parts of the (traction) system.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

4.9 Internal cabling, cables and cable ducts

I-M-071-001 System traction power switchgear substation - Cableways	
In the traction power switchgear substation, all cables should be enclosed in cable ducts, cable racks, ladderways or cableways or a combination of these.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

I-M-071-002 Traction power switchgear substation system - Cable tray design	
The cable ducts of the cable ways shall be made of galvanised steel.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

I-M-071-003 Traction power switchgear substation system - Equipotential bonding	
The steel cable routing systems are connected to each other by means of potential equalisation. They must also be connected to the water earth.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

I-M-071-004 System traction power switchgear substation - Electrical connection	
A cable tray consisting of several parts must be electrically unified. The parts should be electrically connected with an earth wire of sufficient diameter and green/yellow insulation.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Standards: NEN 1010

I-M-071-005 System traction power switchgear substation - Fixing	
The cable routes in the traction power switchgear substation must be mounted on the ceiling, the wall and/or in the cellar compartment.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-071-006 System traction power switchgear substation - Sharp edges	
Cable paths may not have any sharp edges that could cause damage to cables and/or pipes. The edges should have a protective rubber that does not come loose when cables are removed or installed.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-071-007 System traction power switchgear substation - Disconnection	
The cable routes should be provided with a separation between power cables and signal cables, which will limit the influence as much as possible.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-071-008 Traction power switchgear substation system - Fill level	
Cable roads should have a maximum fill rate of 60%.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-071-009 Traction power switchgear substation system - Internal wall penetrations	
Cable entries must be made permanently watertight and fire-resistant. It must be possible to make changes at a later date.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-071-010 Traction power switchgear substation system - external wall penetrations	
Cable passages through an outer wall must be permanently sealed. It must be possible to make changes later.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-071-011 System traction power switchgear substation - Cable blocks	
Traction cables should be mounted in cable blocks in the SS cable cellar. The cable blocks should ensure short-circuit proof mounting of the relevant cables.	
Explanation (optional)	
Verification method Document review Design Calculation Testing/inspection report visual	Norm: NEN-EN-IEC61914

I-M-071-012 Traction power switchgear substation system - Cable blocks Version	
The cable blocks must be made of plastic. In addition, the material should be non-combustible and low-smoke.	
Explanation: Wooden cable blocks are not allowed.	
Verification method Document review Design specification Testing/inspection report visual	Norm: NEN-EN-IEC61914

I-M-071-013 Traction power switchgear substation system - Low voltage cables	
The low-voltage cables must be laid and anchored in the cable ducts provided.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-072-007 System traction power switchgear substation - Cable joints	
The use of cable joints in the SS is not permitted.	
Explanation (optional)	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-072-008 Traction power switchgear substation system - Low voltage cables	
Low-voltage cables must be UV-resistant, low-smoke, flame-retardant and halogen-free.	
Explanation (optional)	
Verification method Document review Design specification Testing/inspection report visual	Prescription/Standards

I-M-072-009 Traction power switchgear substation system - Shielding low voltage cables	
Low voltage cables (control cables) must be shielded.	
Explanation (optional)	

I-M-072-009 Traction power switchgear substation system - Shielding low voltage cables	
Verification method	Prescription/Standards
Document review Design specification	
Testing/inspection report visual	

I-M-072-010 System traction power switchgear substation - Low voltage cables	
Low-voltage cables must be labelled per metre with a sheathing stamp. Labels should be provided at the ends of low voltage cables and on both sides of wall penetrations.	
Explanation: The sheathing stamp for the indication: "cable type", "cross-section", "voltage".	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

L-M-072-011 Traction power switchgear substation system - Coding and numbering	
All wiring in cabinets must be coded. All components must be provided with component coding.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

L-M-072-012 Traction power switchgear substation system - Coding and numbering of cabinets	
All control boxes, traction boxes must be provided with a unique box code.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

4.10 Construction

I-M-006-001 Traction power switchgear substation system - Construction	
There is a separate contract document for the construction aspects.	
Explanation (optional)	
Verification method	Prescription/Standards
Document review Design	
Testing/inspection report visual	

4.11 Cables & Pipelines External

Not applicable

4.12 Plus connections Metro (Third Rail)

I-M-073-002 Traction power switchgear substation system - Connection third rail	
Every descending fast switch field for supplying the third rail must be connected to the third rail (in accordance with the circuit diagram) using the following type of cable BMz1Kas 1x630 mm ² Cu, conductor class 5, earth shield 70 mm ² . The sPvE is leading for the number of cables.	
Explanation: The cable specifications are included in the appendix (see section 1.2). See Schedule for the number of plus connections to be laid.	
Verification method Document review Design drawing Testing/measurement and report	Prescription/Standards

I-M-073-003 Traction power switchgear substation system - Demarcation	
Scope of work for plus cables is described in the sPvE.	
Explanation: See sPvE for scope demarcation.	
Verification method N/A	Prescription/Standards

4.13 Minus connection Metro

I-M-073-004 System traction power switchgear substation - Minus connection	
The minus field has to be connected to the track for voltage reference.	
Explanation: Voltage reference is required for line test functionality and undervoltage monitoring. A minus connection is also required for the minus earth potential monitoring.	
Verification method Document review Design Testing/inspection report visual	Prescription/Standards

I-M-073-005 Traction power switchgear substation system - connection of Minus field	
The minus field for return shall be connected to the track by the following type of cable BMqK 1x150 mm ² Al or 120 mm ² Cu. The sPvE is leading for the number of cables.	
Explanation: ON should request the OR sheets from OG.	
Verification method Document review Design drawing Testing/measurement and report	Standards: NEN 3207

I-M-073-007 Traction power switchgear substation system - Demarcation	
Scope of work for return cables is described in the sPvE.	
Explanation: See sPvE for scope demarcation.	
Verification method N/A	Prescription/Standards

4.14 Connection CBI Metro

I-M-076-001 Traction power switchgear substation system - NMA connection	
The SS should provide a connection to the NMA (Network Metro Amsterdam) fibre optic network of Metro and Tram. The NMA connection conditions have been included as an appendix (par. 1.2). The connection to the NMA network is realised via the Track Controller and is not part of the scope of this specification.	
Explanation: Coupling in the nearest fibre optic coupling point	
Verification method Document review Design Testing/functional	Prescription: 21512_1 - Connection conditions NMA v1.0 final

5 List of requirements

I-M-000-001 System traction power switchgear substation - SS Maintainability	20
L-M-000-002 Traction power switchgear substation system - SS accessibility	20
L-M-000-003 Traction power switchgear substation system - Platform power section Metro	21
L-M-000-006 System traction power switchgear substation - SS disconnectable	21
L-M-000-007 System traction power switchgear substation - Installation housing	21
L-M-000-008 Traction power switchgear substation system - Clearance for maintenance of switchgear	21
L-M-000-009 Traction power switchgear substation system - SS design life	21
L-M-000-010 System traction power switchgear substation - SS operation in existing climate	21
L-M-000-011 System traction power switchgear substation - SS ambient temperature	22
L-M-000-012 Traction power switchgear substation system - Supply of components	22
L-M-000-013 Traction power switchgear substation system - SS Group separation	22
L-M-000-014 Traction power switchgear substation system - SS noise level	22
L-M-000-015 System traction power switchgear substation - SS protections	22
I-M-000-016 System traction power switchgear substation - SS Cable type	22
I-M-001-001 Traction power switchgear substation system - Metro 3rd rail/Minus	20
I-M-006-001 Traction power switchgear substation system - Construction	52
L-M-040-001 System traction power switchgear substation - GVI Outgoing fields Metro	23
L-MT-040-005 System traction power substation - GVI Installation	23
L-M-040-007 Traction power switchgear substation system - GVI Minus field	23
I-M-040-010 System traction power switchgear substation - GVI insulated arrangement	24
I-M-040-011 System traction power switchgear substation - GVI blind diagram	24
L-M-040-012 Traction power switchgear substation system - GVI Version	25
L-M-040-013 Traction power switchgear substation system - GVI protection version	25
L-M-040-014 System traction power switchgear substation - GVI control version	26
L-M-041-001 Traction power switchgear substation system - GVI switching carriages	24
L-M-041-002 Traction power switchgear substation system - GVI ground balls	24
L-M-041-004 Traction power switchgear substation system - GVI switching on and off contact line network ..	26
L-M-041-005 System traction power switchgear substation - GVI high speed circuit breaker per section	26
L-M-041-006 System traction power switchgear substation - GVI high speed circuit breaker specifications ...	26
L-M-041-007 System traction power switchgear substation - GVI high speed circuit breakers	27
I-M-050-001 System traction power switchgear substation - LS power balance	40
I-M-050-002 System traction power switchgear substation - LS connection connection class	40
I-M-050-003 System traction power switchgear substation - LS connection request	40
L-M-051-001 System traction power switchgear substation - LVI	40
L-M-051-002 System traction power switchgear substation - LVI kWh metering	40
L-M-051-003 System traction power switchgear substation - LVI emergency power connection option	41
L-M-051-004 System traction power switchgear substation - LVI Specifications	41
I-M-051-005 System traction power switchgear substation - LVI protection and reserve	41
L-M-051-006 System traction power switchgear substation - LVI control and signalling	41

L-M-052-001 System traction power switchgear substation - Auxiliary voltage power balance	42
L-M-052-002 System traction power switchgear substation - auxiliary power supply	42
L-M-052-003 System traction power switchgear substation - auxiliary power supply	42
L-M-052-004 System traction power switchgear substation - auxiliary power supply devices	42
L-M-052-005 Traction power switchgear substation system - housing construction	42
L-M-052-006 System traction power switchgear substation - auxiliary power supplies	43
L-M-052-007 System traction power switchgear substation - Cooling auxiliary power supply	43
L-M-052-008 System traction power switchgear substation - Power supply requirements auxiliary voltage ...	43
L-M-052-009 System traction power switchgear substation - auxiliary output voltage	43
L-M-052-010 System traction power switchgear substation - Power supply without batteries	43
L-M-052-011 Traction power switchgear substation system - auxiliary power reserve groups	43
L-M-052-012 System traction power switchgear substation - auxiliary voltage controller	44
L-M-052-013 Traction power switchgear substation system - selectivity auxiliary voltage	44
L-M-052-014 Traction power switchgear substation system - Selectivity of auxiliary power protection	44
L-M-052-015 System Traction power switchgear substation - Batteries auxiliary voltage	44
L-M-052-016 Traction power switchgear substation system - room conditions auxiliary voltage	45
L-M-052-017 Traction power switchgear substation system - Indication and signalling of auxiliary voltage	45
L-M-060-001 Traction power switchgear substation system - Selectivity study	27
L-M-060-002 System traction power switchgear substation - trip functionality	27
L-M-060-003 System traction power switchgear substation - emergency off SS.....	28
L-M-065-001 System traction power switchgear substation - Protection devices GVI	28
L-M-065-002 System traction power switchgear substation - Auto-reclose (AWI)	29
L-M-065-003 System traction power switchgear substation - Line test functionality	29
L-M-065-004 System traction power switchgear substation - external trips.....	30
L-M-065-005 System traction power switchgear substation - Anti-pump protection	30
L-M-065-006 Traction power switchgear substation system - Frame short circuit protection	31
L-M-065-007 System traction power switchgear substation - Minus earth potential monitoring.....	31
L-M-065-009 Traction power switchgear substation system - Carrier circuit	32
I-M-071-001 System traction power switchgear substation - Cableways	49
I-M-071-002 Traction power switchgear substation system - cable tray design	49
I-M-071-003 Traction power switchgear substation system - equipotential bonding	49
I-M-071-004 System traction power switchgear substation - electrical connection	50
I-M-071-005 System traction power switchgear substation - fixing	50
I-M-071-006 System traction power switchgear substation - Sharp edges	50
I-M-071-007 System traction power switchgear substation - Disconnection.....	50
I-M-071-008 Traction power switchgear substation system - fill level.....	50
I-M-071-009 Traction power switchgear substation system - internal wall penetrations.....	50
I-M-071-010 Traction power switchgear substation system - openings outside wall	51
I-M-071-011 System traction power switchgear substation - Cable blocks.....	51
I-M-071-012 Traction power switchgear substation system - Cable blocks Version	51
I-M-071-013 Traction power switchgear substation system - low voltage cables	51
I-M-072-001 System traction power switchgear substation - internal wiring	32
I-M-072-002 System traction power switchgear substation - coding	32

I-M-072-003 System traction power switchgear substation - internal wiring sleeves filling degree	32
I-M-072-004 Traction power switchgear substation system - internal wiring sleeves covers.....	32
I-M-072-005 Traction power substation system - Wiring connection.....	32
I-M-072-006 System traction power substation - 600/750 VDC cabling	33
I-M-072-007 System traction power switchgear substation - cable joints	51
I-M-072-008 System traction power switchgear substation - low voltage cables	51
I-M-072-009 Traction power switchgear substation system - shielding low voltage cables.....	51
I-M-072-010 System traction power switchgear substation - low voltage cables	52
L-M-072-011 Traction power switchgear substation system - coding and numbering	52
L-M-072-012 Traction power switchgear substation system - Coding and numbering of cabinets.....	52
I-M-073-002 Traction power switchgear substation system - Connection third rail.....	53
I-M-073-003 Traction power switchgear substation system - demarcation.....	53
I-M-073-004 System traction power switchgear substation - Minus connection	53
I-M-073-005 Traction power switchgear substation system - connection minus field	53
I-M-073-007 Traction power switchgear substation system - demarcation	53
I-M-076-001 Traction power switchgear substation system - NMA connection	54
L-M-080-001 System traction power switchgear substation - Station automation unit SS.....	33
L-M-080-002 Traction power switchgear substation system - taking power sections into/out of operation	34
L-M-080-003 System traction power switchgear substation - CBI.....	34
L-M-080-004 System traction power switchgear substation - IO list	34
I-M-081-001 System traction power switchgear substation - local control SS	34
L-M-081-002 System traction power switchgear substation - block diagram	34
L-M-081-003 System traction power switchgear substation - Interface underlying installations	34
L-M-081-004 System traction power switchgear substation - Track controller interface	35
I-M-081-005 Traction power switchgear substation system - space reservation	35
L-M-083-001 System Traction power switchgear substation - HMI Remote Control	35
L-M-083-002 System Traction power switchgear substation - HMI Remote Control -- Status Indicator	36
L-M-083-003 System Traction power switchgear substation - HMI Remote Control -- Operation	36
L-M-083-004 System traction power switchgear substation - HMI remote control - Analogue values	36
L-M-083-005 System traction power switchgear substation - HMI remote control - signalling/alarms	37
L-M-083-006 System Traction power switchgear substation - HMI Remote Control - General	37
L-M-083-007 System traction power switchgear substation - HMI access rights	37
I-M-083-008 System traction power switchgear substation - HMI placement	38
L-M-083-009 System traction power switchgear substation - HMI screen.....	38
L-M-083-010 System traction power switchgear substation - HMI screen layout	39
I-M-083-011 System traction power switchgear substation - HMI placement	39
I-M-090-001 System traction power switchgear substation - climate control.....	45
I-M-090-002 System traction power switchgear substation - room thermostat	45
I-M-090-003 System traction power switchgear substation - Air conditioning application	46
I-M-090-004 Traction power switchgear substation system - climatic conditions	46
I-M-090-005 System traction power switchgear substation - heating	46
I-M-090-006 System traction power switchgear substation - ventilation method	46

I-M-090-007 Traction power switchgear substation system - lighting installation	46
I-M-090-008 System Traction power switchgear substation - Illuminance	46
I-M-090-009 Traction power switchgear substation system - Lighting version.....	47
I-M-090-010 System traction power switchgear substation - Lighting switches	47
I-M-090-011 System traction power switchgear substation - WCD	47
I-M-090-012 System traction power switchgear substation - emergency lighting	47
I-M-090-013 Traction power switchgear substation system - Escape route indication.....	47
I-M-090-014 Traction power switchgear substation system - Lighting control cabinets	47
I-M-090-015 Traction power switchgear substation system - Cable cellar lighting	48
I-M-090-016 Traction power switchgear substation system - Shading/replacement	48
I-M-090-017 Traction power switchgear substation system - door position indicator	48
I-M-090-018 System traction power switchgear substation - Fire extinguishers.....	48
I-M-090-019 System traction power switchgear substation - Fire detection.....	48
I-M-090-020 System traction power switchgear substation - fire alarms group notification.....	49
I-M-090-021 System traction power switchgear substation - fire alarms projection	49