VERGABEUNTERLAGEN
Qualifizierungssystem

Qualifizierungssystem (Sektorenverordnung)

2018001641 − CABLE PREQUALIFICATION SYSTEM FOR USE BY VATTENFALL AB

AUFTRAGGEBER
Vattenfall AB
Evenemangsgatan 13 C, 16956 Solna, Schweden

27.04.2018

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VERFAHRENSINFORMATIONEN
Qualifizierungssystem

Verfahren: 2018001641 − CABLE PREQUALIFICATION SYSTEM FOR USE BY VATTENFALL AB

INFORMATION PREQUALIFICATION SYSTEM

The EU− Prequalificationsystem was published at xx.xx.xxxx of xxxxxxxxxxxxxxx under the EU−Supplement−Number xxxxxxxxxx.

The Publication informed about the Prequalificationsystem (based on the derective Sektorenverordnung− SektVO 2016, §37).

Number

INFORMATIONS

GENERALLY

Number	2018001641
Header Titel	B07 − Breunung
Titel	CABLE PREQUALIFICATION SYSTEM FOR USE BY VATTENFALL AB
Project Info	Pre−Qualification for: − low voltage cable (0,6/ 1 kV), − medium voltage cable (6−24/ 36 kV) and − high voltage/ sea cablesystem (> 36 kV − 110/ 145 kV)

Procedure

Principal	Vattenfall AB
Sponsor	Sektorenauftraggeber
Place of Deleivery	
Activity Type	Lieferauftrag
Awarding Type	Qualifizierungssystem (Sektorenverordnung)

CLASSIFICATION

CLASSIFICATION

Code	Bezeichnung
31321200−4	Nieder− und Mittelspannungskabel
31321300−5	Hochspannungskabel
31321400−6	Seekabel

Elecrtonoical

APPLICATION OF PARTICIPATION

Electronical Types	Die Einreichung der Angebote/ Teilnahmeanträge darf nur elektronisch erfolgen
URL for electronical Participations	https:// portal. deutsche− evergabe. de

APPOINTMENT

GENERALLY

Advanced Information	Nein
Special Priority	Nein

PUBLICATION

Publication	04.05.2018
Advanced Information	

PARTICIPATION AND ASSESSMENT

Bidding Period	Unbegrenzte Laufzeit
Bidding Period (time)	

ELECTRONICAL PARTICIPATION

Please used the Publicationplattform under
https:// portal. deutsche− evergabe. de
with your username and your password.

If you did not registrated, please login yourself at the plattform. The registation and all processes are did not cost anything for you.

After the registation you can start to look after the publication prequalification cable.

QUESTIONS OF BIDDERS

Questions of bidders − timeline o´clock. After the Period it is not possible to answered of your questions. More Information in appendix : Document General Information.

Please use dor your questions the question−/ answerforum at the eVergabe https:// portal. deutsche− evergabe. de. Question per email or telefon we can not answered.

CABLE PRE QUALIFICATION SYSTEM FOR USE BY VATTENFALL AB

Ref to announcement in

e-Vergabe: 2018001641

(Ver 1. 26th of April 2018)

1. BACKGROUND

Vattenfall AB (Vattenfall) is a leading European energy company, that for more than 100 years has electrified industries, supplied energy to people's homes and modernized our way of living through innovation and cooperation.

In order to operate this business and provide electricity to app 3,290,000 electricity network and app 6,450,000 electricity customers in: Sweden, Germany, the Netherlands, Denmark, the UK and Finland - Vattenfall Group has among other initiatives decided upon a common strategy to enable the cable supply.

Vattenfall Group´s annual spend of distribution and transmission power land cables (LV, MV) in total is app 500 MSEK. This is mainly covered through Framework agreements, created by public tendering.

Huge part of this volume is also called off through Vattenfall´s own contracted contractors or bought through a technical prequalification model, where the contractors are the direct commercial part to the cable supplier(s).

Vattenfall´s annual spend of subsea power cables (MV, HVAC and HVDC) in total is approx. 470M MSEK. This is mainly covered through project agreements, created by (public) tendering (depending on EU-tendering exceptions where windfarm are planned to will be build).

The spend of transmission cables (land and subsea) vary, depending on the investment plans.

2. SCOPE

Vattenfall AB includes any and all of its subsidiaries, affiliates and other companies and business units that are part of Vattenfall group that are entitled to use this PQS.

Prequalified (PQ) status means that the supplier´s factory is entitled to receive all cable tenders/RFQ for Vattenfall AB (as long as the PQ status is uphold).

This Pre-Qualification System´s (PQS) aim is to prequalify supplier(s) to Vattenfall AB of:

- Qualification for delivery low voltage (0,6/1kV) ,
- Qualification for delivery medium voltage (6 – 24/36kV) and
- Qualification of application for the delivery and installation high/ sea cable (> 36 kV – 110/ 145kV) with conductor material of Copper or Aluminum, all corresponding to Vattenfall´s technical specifications.

The qualification will be granted individually for the different Vattenfall areas in respect of specific product lines as of voltage level, insulation and construction. A qualification for single cable types of the delivery scale is possible.

3. ADMINISTRATIONAL DESCRIPTION

Only applicants with clearly provable compliance and capability can be qualified. For this reason a questionnaire has to be answered and patterns of specific cable types have to be provided by every applicant.

3.1 Methodology for the qualification-system:

1) The Application for participation to be sent to e-Vergabe

2) The Applicant has to answer a pre-qualification questionnaire (PQQ) provided by Vattenfall.

3) Vattenfall analyses the answers in the returned questionnaire; analyzing the fulfilment of the technical specification.

4) Further documents and patterns have to be made available on request of Vattenfall.

5) Factory audit by Vattenfall

6) Qualification decision by Vattenfall

7) Notification of qualification status will be a public information

Qualified manufactories will be admitted into a prequalification list (PQL) expressing the qualification status in respect of site of manufacturing, type of cable and to respective Vattenfall areas/ business units/ areas.

This PQL / prequalification will be:

a) basis for next Framework agreement competition
b) in some Vattenfall areas be provided to Vattenfall´s contactors for supply of cables.

4. PQ PROCESS

Description of the PQS-process for:

A) Becoming a PQ supplier;

B) Maintaining/upholding - or losing PQ status over time.

4.1 A) Becoming a PQ Supplier

4.1.1 Background:

The long term target of PQS is to establish a cable supplier base that meet (and can improve):

- general and technical requirements - quality aspects;

- the foreseeable demand profile from 2019 and on and thereby increasing the focus on long term supply and quality assurance.

Requirements for becoming PQ:

Only a company that has ownership of a factory that manufacture cable can apply and be awarded PQ status.

The process for PQ is based on individual factory audit to verify that factory/supplier meet mandatory requirements.

If one supplier/company wants to prequalify more than one factory, each factory will have it´s own PQ process as described below.

A factory that is approved through the described PQ process is given PQ status for the delivery of cable to Vattenfall.

PQ status means that factory is entitled to receive all cable tenders/RFQ to Vattenfall (as long as PQ status is uphold).

Non PQ suppliers, contrary, shall not be selected for tenders/RFQ (they can consequently not be awarded contract).

A supplier that lose PQ status during ongoing tender(s) will accordingly be rejected from tender(s).

If a supplier would lose PQ status during ongoing supply period, this shall be seen as "substantial breach" to prequalification terms.

4.1.3 Timeline:

Vattenfall intends to implement PQS during 2018.

The PQS will be released on eNotices in TED http://ted.europa.eu/TED/main/HomePage.do

in April 2018.

On 28th of May the PQS application will be freezed for evaluation, in order to use the result to the forthcoming tender of Framework Agreement process.

Any Applicants who has submitted the Questionnaire and been approved, will be receiving the RFQ for the tender.

4.1.4 The PQ process is structured as follows:

1) The questionnaire is sent to supplier by Vattenfall from e-Vergabe

2) Factory/supplier fills in the questionnaires and resends to Vattenfall according to instruction from e-Vergabe.

3) Vattenfall evaluates the answers in the submitted questionnaires.

4) If Vattenfall approves the answers on questionnaires, Vattenfall could request an on-site factory audit to verify answers to questionnaires and capability to meet technical requirements as set forth in the technical specifications.

5) For supply to Vattenfall Sweden the prequalified suppliers also need to be registered and approved in UNCE/ Sellicha for *AUCS 3.7.0 Cables and* Accessories, *manufacturers* in order to get full prequalification status.

http://corporate.vattenfall.com/about-vattenfall/supplier-relations/supplier-registration/

6) Based on Vattenfall approved final audit report, factory/ supplier is awarded PQ status.

7) If factory/supplier is located in "risk country", also Vattenfall approved on-site CSR audit is necessary for PQ status.

(as not static, eventual "risk country" status will be informed upon supplier application).

4.2 B) Maintaining/upholding - or loosing PQ status over time

Along with the implementation of the PQS, Vattenfall also implements a Quality Management System (QMS), also called the “Concept Quality Monitoring”.

All cable supply within the PQS will be subject to this QMS. The intention of QMS is to assure continuous improvements on the PQ supplier base. Supplier quality deviations will be measured and actions for improvement will be taken (Quality follow up).

A supplier that repeatedly have quality deviations and do not improve will eventually lose it´s PQ status (= "stopped/red" status) i.e becomes disqualified. Also, any single major quality deviation may lead to a re-audit of factory/supplier to verify that requirements on PQ supplier are meet.

5. AMNINISTRATIONAL DESCRIPTION OF THE QUESTIONNAIRE

Please answer all questions in PQ questionnaires and attach eventual requested information to support the reply.

A non-compliant answer on any question means that the manufacturer cannot assure the right:

- process, or

- product, or

- service, or

- establishment/ competence, or a combination of above to deliver to / meet the requested requirements of Vattenfall.

Any non-compliant answer will therefore mean "not prequalified status".

If all answers are compliant, it means that supplier is evaluated as capable to deliver to requested requirements.

6. Audit

The submitted answers in the questionnaire will be verified through an on-site factory audit on questions in PQ questionnaires and technical specifications through which Vattenfall intends to finally verify if factory/supplier meet the requirements.

If factory is approved through audit, factory/supplier will be awarded PQ status. PQ means that factory/supplier is entitled to receive all tenders/RFQ for Vattenfall (as long as PQ status is uphold). PQ status will be regularly checked by:

a) continuous quality follow up and

b) re-audit of factory

Periodically re-audits can take place to verify that PQ supplier meet the updated/new requirement(s) over time.

7. Important notice

Vattenfall AB reserves the right to update or introduce new requirements on the factories/suppliers within the PQS.

Following an updated/new requirement the PQS will be updated with the update/new requirement; and the PQ supplier is accordingly informed.

The consequence can accordingly be that a PQ supplier cannot meet updated/new requirement; if that is the case, supplier will lose it´s PQ status.

8. CONCEPT QUALITY MONITORING

CONCEPT OF QUALITY MONITORING		Quality status of supply				Related infromation from Vattenfall
Quality criteria	Sub-Criteria	Approved	Action plan	Escalation plan	Stopped	Note: If one category (=sub criteria) gets into "red" status, the supplier will immediately lose its general PQ-status. A new application fro pre-qualification is posible.
Technical	Deviation to technical specification					
	Deviation to technical specification influencing functionality of the cable or system.					Applicable only for HV & Sub Marine Cables
	Deviation to technical specification not influencing functionality of the cable or system.					Applicable only for HV & Sub Marine Cables
	Deviation during factory acceptance testing (FAT)					Applicable only for HV & Sub Marine Cables
	Deviation to type test setup					
	Deviation during testing (SAT)					
Logistics	Late delivery according to Purchase Order/ Project Time Plan (OTD)					
	Incorrect handling of cables/ drums/ goods					
	Incorrect packaging of cables/ drums/ goods					
	Damaged cables/ drums/ goods					
Execution	Deviation to SFT (specification to tenders) - Health & Safety					Applicable only for HV & Sub Marine Cables
	Deviation to SFT - Personnel					Applicable only for HV & Sub Marine Cables
	Deviation to SFT - Technical requirements and general regulations					Applicable only for HV & Sub Marine Cables
	Deviation to Documentation					Applicable only for HV & Sub Marine Cables
Commercial	Failures during guarantee time					
	Deviations in delivery statistics					
Other	Health & Safety Issues					
	Environmental Issues					
	Cooperation					

8.1 Quality follow up on Vattenfall Prequalification System (PQS) for cables

8.1.1 The PQ supplier gets a Quality Status given the number of claimed Quality Deviations and the supplier´s ability to improve and not repeat Quality Deviations.

A Quality Deviation claim is based on:

1) a specific Vattenfall requirement

2) the supplier´s acceptance of claim

8.1.2 Quality Deviation types and definitions

DT = Quality Deviation

FAT* = (factory acceptance test) = any deviation versus specification on FAT

SAT*/RFO (site acceptance test/ ready for operation) = any deviation versus specification/ supply agreement on SAT/ RFO

OTD (on time delivery) = any delivery delay to supply agreement OTD (=reday fro operation date)

G (product guarantee) = any deviation that is related to manufacturer´s product responsibility

8.1.3 Supplier Quality Status (QS) levels:

- approved (green or white for OTD, also means prequalified (PQ) status)

- action plan (yellow, also means prequalified (PQ) status))

- escalation plan (amber, also means prequalified (PQ) status)

- stopped (red, stopped status, also means loss of prequalified (PQ) status)

Supplier QS will be measured and monitored over time - and regularly reported to PQ suppliers.

The QMS might be updated/ improved over time and this will be the announced to PQ suppliers.

If the supplier within one year after loss of PQ status can show that requirement is met, supplier will get back the approved PQ status (all else equal).

If more than one year pass from loss of PQ status, supplier will have to re-apply to become prequalified and submit full PQ process again.

9. CONTACT PERSONS

Main contact person for this PQ-system and cable supply to Vattenfall Germany (LV, MV, HV):

marika.breunung@vattenfall.com

Contact person for cable supply to Vattenfall Sweden/ Nordic (LV, MV, HV, sea-cable):

jelica.djeke@vattenfall.com

ANNEXES

1. Prequalification Questionnaire
2. Technical Specifications for Vattenfall Sweden cable supply
3. Technical Specifications for Vattenfall Germany cable supply

Prequalification System Questionnaire with to reference to announcement in e-Vergabe nb 2018001641		
Prequalification System Questionnaire form	**SUPPLIER RESPONS**	**QUESTIONS RELATED INFORMATION FROM VATTENFALL**
1. Applicants information		
Company Name		
Postal Address		
Company Identification/ Registration Number		
Sales Tax Number		
Country		
Type of company structure		
Managing Director		
Date of application		
2. Applicant´s Production Site(s)´s Full Infomration: Name of the factory, Postal Adress, Company ID no and Contact Person		
For Low Voltage cable (LV)		
For Middle Voltage cable (MV)		
For High-Voltage cable-systems (HVS):		
For High Voltage Sub Sea (HVS SS) cables:		
3. Contact details during the pre-qualification period		
Applicant´s Contact Person		
Title		
Telephone		
E-mail Address		
Website		
4. Project organisation		
Representative		
Key Account Manager		
Environment Manager		
Quality Manager		
5. Certificate of incorporation		
Certificate of incorporation from "Bolagsverket" (the Swedish Companies Registration Office) or equivalent. "We hereby certify that the company is free of hindrances under the Swedish Public Procurement Act (SFS2007:1092) Chap 10. "		Applicable for cable supply to Vattenfall Nordic
Yes		
No		
Note		
1. General information		
A - 1.1 UNCE/ Vattenfall Supplier Bank/ Sellicha		Applicable for cable supply to Vattenfall Nordic
Please state your supplier-ID of the UNCE/ Sellicha provided by Achilles: http://www.achilles.com/en		Applicable for cable supply to Vattenfall Nordic
Note		
A - 1.2 Batches of the PQ-system		
Please select, which batch(es) you are applying for.		
Low Voltage cable (LV)		
Medium Voltage cable (MV)		
High Voltage cable-systems (HVS)		
High Voltage Sub Sea (HVS SS) cables		
Note		
A - 1.3 Local law		
For the purpose of drafting and processing any forthcoming commercial contract do you accept that local Swedish law and Public Procurement Act? (http://www.konkurrensverket.se/en/publications-and-decisions/swedish-public-procurement-act/)		Applicable for cable supply to Vattenfall Nordic
Yes		
No		
Note		
B - 1.4 PQ-status with other clients		
Is your company already prequalified as supplier for other clients/utilities as part of an official PQ-system?		
Yes		
No		
Note		
B - 1.5 Does your organisation subscribe or agree to the principles set out in the UN Global Compact, as described in http://www.unglobalcompact.org?		
Yes		
No		
Note		
A - 1.5 Key financial figures		
Please state the following key financial figures for last three business years (cable types as applicable).		
Turnover total:		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Turnover Low-Voltage cables		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Turnover Medium-Voltage cables		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Turnover High-Voltage cable-systems		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
High Voltage Sub Sea cable		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Turnover related services:		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Profit before taxes:		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Equity ratio:		
2015 (SEK)		
2016 (SEK)		
2017 (SEK)		
Note		
A - 1.6 My company is up to date with payment of all national, local and employee related taxes.		
Yes		
No		
Note		
A - 1.7 My company has met all legal requirements for the preparation, auditing and filing of its latest annual report and financial statements.		
Yes		
No		
Note		
A - 1.8 At the date of answering this questionnaire my company is not subject to debt recovery proceedings by its creditors and it is not subject to any formal insolvency procedures.		
Yes		
No		
Note		
1.9 - Is your company, or any of its representatives, the subject of any past convictions or current legal claims, court proceedings or arbitration proceedings?		
Yes		
No		
Note		
1.10 - Does your company have a Liability Insurance?		
Yes		
No		
Note		
1.10 - Does your company have a Liability Insurance?		
Yes		
No		
Note		
2. Organization		
A - 2. Organisational charts		
A - 2.1 General		
A - 2.1.1 Company total		Please attach the following organisational charts of your company as appendices.
A - 2.1.2 Company - local organisation in Sweden (if any) 1b		Please attach the following organisational charts of your company as appendices.
Production & Logistics		
A - 2.1.3 Production		Please attach the following organisational charts of your company as appendices.
A - 2.1.4 Logistics		Please attach the following organisational charts of your company as appendices.
Quality Assurance (QA)		

A - 2.1.5 Global QA-networking between your production locations 3a		Please attach the following organisational charts of your company as appendices.
A - 2.1.6 QA-organisation at respective production site to be prequalified for Vattenfall		Please attach the following organisational charts of your company as appendices.
R&D, Sales, Services		
A - 2.1.7 Research & Development		Please attach the following organisational charts of your company as appendices.
A - 2.1.8 Sales organisation within Sweden		Please attach the following organisational charts of your company as appendices.
A - 2.1.9 Technical service organisation		Please attach the following organisational charts of your company as appendices.
A - 2.1.10 Customer service organisation		Please attach the following organisational charts of your company as appendices.
Note		
B - 2.1 Swedish-speaking staff		Applicable for cable supply to Vattenfall Nordic
Please tell us how many Swedish-speaking staff you have employed for the following areas:		Applicable for cable supply to Vattenfall Nordic
Total number		
Client acquisition		
Technical sales and distribution		
Assenbling staff		Only applicable for HV-cable systems
Note		
A - 2.2 Swedish and/ or English-speaking staff		Applicable for cable supply to Vattenfall Nordic
Do you have Swedish speaking staff for managing the communication with Vattenfall and its suppliers?		Applicable for cable supply to Vattenfall Nordic
Yes		
No		In case of "No" the resonsible technical contact person must be able to communicate in the English language. For HV-projects, a Swedish-speaking contact person must be available at the construction site. Please state if you can ensure that.
Note		
B - 2.3 German-speaking staff		Applicable for cable supply to Vattenfall Germany
Please tell us how many Swedish-speaking staff you have employed for the following areas:		Applicable for cable supply to Vattenfall Germany
Total number		
Client acquisition		
Technical sales and distribution		
Assenbling staff		Only applicable for HV-cable systems
Note		
A - 2.4 German and/ or English-speaking staff		Applicable for cable supply to Vattenfall Germany
Do you have German speaking staff for managing the communication with Vattenfall and its suppliers?		Applicable for cable supply to Vattenfall Germany
Yes		
No		In case of "No" the resonsible technical contact person must be able to communicate in the English language. For HV-projects, a German-speaking contact person must be available at the construction site. Please state if you can ensure that.
Note		
3. Technical criteria		
B - 3.1 Launch of production		
Please state when the requested product group was first launched in your company.		
Low Voltage cable		
Date		
Medium Voltage cable		
Date		
High Voltage cable-systems (HVS)		
Date		
High Voltage Sub Marine (HVS SM) cables		
Date		
Note		
B - 3.2 Overall cable volume supplied per year (in km)		
Please state how many km of each product group have been supplied per year.		
In total		
B - 3.2.1 Low Voltage cable		
2015		
2016		
2017		
B - 3.2.2 Medium Voltage cable		
2015		
2016		
2017		
B - 3.2.3 High Voltage cable-systems (HVS)		
2015		
2016		
2017		
B - 3.2.4 High Voltage Sub Marine (HVS SM) cables		
2015		
2016		
2017		
B. 3.2.5 According to specification main cable types to Vattenfall		
Low Voltage cable		
2017		
Medium Voltage cable		
2017		
High Voltage cable-systems (HVS)		
2017		
High Voltage Sub Marine (HVS SM) cables:		
2017		
Note		
A - 3.3 Product description and documentation (local language)		
Please state if, in case of a contract, you will provide the product description and documentation in local language (Swedish and German).		
Yes		
No		
A - 3.4 Do you confirm all requirements for the cables according to Vattenfall´s technical specification?		In general, the specifications and standards shall be met. In case of improved design, the new design has to be approved by Vattenfall. The functional requirements (e.g. testing) shall be fulfilled.
Regarding Low Voltage cable (Ref DD-N-G008 for 1kV)		
Yes		
No		
Note		
Regarding Medium Voltage cable (Ref ND-G-00006 for 24kV)		
Yes		
No		
Note		
Regarding Medium Voltage, Covered Conductor (Ref ND-G-00007 for 24kV)		
Yes		
No		
Note		
Regarding High-Voltage cable-systems (HVS) (Ref VTR 14-01E for 36-170kV)		
Yes		
No		
Note		
Regarding High Voltage Sub Marine (HVS SS) cables (Ref VTR 14-04E Single Sub Marine fro 36-170kV)		
Yes		
No		
Note		
Regarding High Voltage Sub Marine (HVS SS) cables (Ref VTR 14-05E Sub Marine for 3-core 36-170kV)		
Yes		
No		
Note		
Regarding Low Voltage cable (Ref KG 4073 and appendix Germany)		
Yes		
No		
Note		
Regarding Medium Voltage cable (Ref KG 4073 and appendix Germany)		
Yes		
No		
Note		
Regarding High Voltage cable (Ref TD 3514 Germany)		
Yes		
No		
Note		
A - 3.5 Which components for a high-voltage-cable system can be provided and assembled by you? (For instance fittings, sealing ends, protection- and monitoring-systems, please name with type, description etc.)		
Note		Only applicable for HV-cable systems
A - 3.6 Which references are available for the HV- & Sub Marine cable system?		* There have to be projects that were conducted within the last 5 years. ** According to Vattenfall specifications
1) Project name		
2) Country		
3) Client (if not restricted)		
4) Year*		
5) Production site		
6) Voltage-level		
7) Cable (length, type, cross section**, conductor material)		
8) Fittings (type, number of junction straight-joints, sealing ends, plug connectors)		
Note		
A - 3.7 Can you provide general Product Data Sheet for the cables / components you may provide acc to the Vattenfall´s technical specification?		
Yes		
No		
Note		
4. Health & Safety		
B - 4.1 Do you have a certificate for Health & Safety (e.g. ISO 18 001 OHSAS)?		
Yes		If "Yes" please provide valid certificate. System shall be audited/ approved by third party accredited company

No		
Note		
B - 4.2 Are the test staff/ engineers fully conversant with the latest industry test standards (IEC, IEEE, etc) and customer specific test requirements?		
Yes		
No		
Note		
5. Environment		
A - 5.1 Environmental Management System		
A - 5.1.1 Do you have a certified environmental management system compliant to ISO 14001, EMAS etc?		
Yes		If "Yes" please provide valid certificate. System shall be audited/ approved by third party accredited company
No		
Note		
A - 5.1.2 Who is the environmental officer and to whom is he/she reporting to?		
Note		
A - 5.1.3 When and by Whom was the last audit conducted?		
Date		
Note		
A - 5.1.4 When was the last audit conducted by Vattenfall?		
Date		
Note		
B - 5.2 Are there special regulations for dangerous goods which have to be followed regarding your products (for instance REACH and/or RoHS 2 EU-directive) http://echa.europa.eu/regulations/reach?		
Yes		If "Yes", which parts of these regulations?
No		If "No", please state the exceptions.
Note		
A - 5.3 Can you confirm that your products are: PCB-free; Lead-free (not applicable for Sub Marine Cabels); Bromine-free; Free of any carcinogenic substance?		
Yes		
No		
Note		
6. Quality management		
A - 6.1 Quality management system		
A - 6.1.1 Do you have a certified quality assurance management system compliant to ISO 9001?		
Yes		If "Yes" please provide valid certificate. System shall be audited/ approved by third party accredited company
No		
Note		
A - 6.1.2 When was the last audit conducted by Vattenfall?		
Date		
Note		
A - 6.1.3 When and by Whom was the last audit conducted?		
Date		
Note		
A - 6.1.4 Who is the QA officer (where applicable, for each production location) and to whom is he or she reporting to?		
Note		
A - 6.1.5 Is there any quality plan of QA in the production process.		
Yes		If "Yes" please provide an overview (quality plan) of QA in the production process.
No		
Note		
B - 6.2 Service providers for Quality management		
B - 6.2.1 Do you use external service providers for QA?		
For testing of cables:		
Yes		
No		
Note		
For calibration of measurement devices:		
Yes		
No		
Note		
B - 6.2.2 Who conducts these tests and which checks do they do?		
Note		
A - 6.3 Tests of HV-cable systems		
A - 6.3.1 Routine testing (electrical tests)		
A - 6.3.1.1 Which products (except cables) are subject to routine testing?		
Note		
A - 6.3.1.2 Which tests are conducted?		
Note		
A - 6.3.1.3 How many test bays are available?		
Note		
B - 6.3.1.4 Which parameters are checked?		
Note		
B - 6.3.1.5 How frequent are the checks?		
Note		
B - 6.3.1.6 Is there a defined process for handling abnormalities/ deviations during the manufacturing process?		
Yes		
No		
Note		
B - 6.3.1.7 How do you document abnormalities/ deviations and how do you analyse them?		
Note		
B - 6.3.1.8 How are rejects laballed?		
Note		
A - 6.3.2 Screening (non-electrical tests)		
Note		
A - 6.3.2.1 Which products undergo screening?		
Note		
A - 6.3.2.2 Which tests are conducted and how often?		
Note		
A - 6.3.3 Technical Equipment		
A - 6.3.3.1 Can you provide the technical equipment to carry out on-site voltage-tests for the setting-up operation?		
Yes		If "Yes", which capacities are available?
No		
Note		
A - 6.3.4 Long-term-test for HV- and Sub Marine cables		
A - 6.3.4.1 Have you done the long-term-test certificate (1-/2-year-report) for high-voltage cables?		
Yes		If "Yes" please provide according certificate
No		
Note		
7. Production		
A - 7.1 Location		
A - 7.1.1 Which requested products are manufactured at each location?		
Note		
A - 7.1.2 Is a QA system in place at each location?		
Note		
A - 7.1.3 Could you provide a plan of the production process (incl. all manufacturing steps) for:		
LV Cables		
Yes		Providing a plan of the production process.
No		
MV Cables		
Yes		Providing a plan of the production process.
No		
HV Cables		
Yes		Providing a plan of the production process.
No		
HV Sub Marine cables		
Yes		Providing a plan of the production process.
No		
Note		
A - 7.1.4 Are the employees able to define settings and make adjustments during the production process in order to optimize the process and quality? If required, can they adjust the machine parameters?		
Yes		
No		
Note		
B - 7.2 Material monitoring		
B - 7.2.1 Which incoming materials are checked? And how?		
Note		
B - 7.2.2 Which division carries out the checks?		
Note		
B - 7.2.3 Who creates the guidelines for the checks? Who updates them?		
Note		
B - 7.2.4 Where are the guidelines stored?		
Note		
B - 7.2.5 Which checks are conducted by the supplier?		
Note		
B - 7.2.6 How are the results of the checking of the incoming goods documented?		
Note		
A - 7.3 Labelling of incoming goods after checking		
A - 7.3.1 How are the incoming goods labelled?		
Note		
A - 7.4 Handling of intermediate products during the production process (e.g. conductor, insulated cables, screened cables)		
A - 7.4.1 Which intermediate products do you have?		

Note		
A - 7.4.2 Do you have test-plans for every intermediate product?		
Yes		
No		
Note		
A - 7.4.3 How are intermediate products labelled?		
Note		
B - 7.4.4 Who creates the guidelines for the checks? Who updates them?		
Note		
B - 7.4.5 Where are the guidelines stored?		
Note		
B - 7.4.6 Where are the intermediate products stored?		
Note		
B - 7.5 Finished product (cable on drum for FAT)		
B - 7.5.1 Who conducts the checks?		
Note		
B - 7.5.2 Do you have test-plans for the finished product?		
Yes		If "Yes" please provide according plan.
No		
Note		
B - 7.5.3 How are finished products labelled?		
Note		
B - 7.5.4 Who creates the guidelines for the checks? Who updates them?		
Note		
B - 7.5.5 Where are the guidelines stored?		
Note		
B - 6.5.6 (7.5.6) Where are the finished products stored?		
Note		
7.6 (7.5) Monitoring of the production process		
A - 7.6.1 (7.5.1) Are the process data recorded and stored for the state of warranty?		
Yes		
No		If "No", how do you ensure that, in case of a claim/warranty issue, there was no failure during?
Note		
B - 7.6.2 (7.5.2) Do you follow-up or analyse on the recorded process data regularly and how is this		
Note		
8. Material/Component suppliers		
8.1 Most important resources for raw-materials		
B - 8.1.1 What are the most important resources (Cu, Al, metal sheath, stell etc)?		
Note		
B - 8.1.2 Which suppliers have been approved for these resources?		
Note: Cu		
Note: Lead		
Note: Al		
Note: Wire		
Note: XLP		
Note: SC.XLP		
Note: SC Poly Water blocking tape		
Note: Jackating Compound		
Note: General		
B - 8.1.3 Who inspects the materials?		
Note		
B - 8.1.4 How often is the quality checked?		
Note		
B - 8.1.5 Who creates the specification for these resources (in-hous resource, external…) ?		
Note		
B - 8.1.6 Have your critical sub-supplier(s) a quality system certified by third party accredited control company?		
Note		
8.2 Most important resources for semi-finished goods		
B - 8.2.1 What are the most important resources (material insulation/ polymer, insulation screen etc.)?		
Note		
B - 8.2.2 Which suppliers have been approved for these resources?		
Note		
B - 8.2.4 How often is the quality checked?		
Note		
B - 8.2.5 Who creates the specification for these resources (in-hous resource, external…)?		
Note		
9. Final assembly, packaging and shipping		
9.1 Location		
B - 9.1.1 From where are the products (outgoing goods) shipped?		
Note		
B - 9.1.2 Do you have intermediate storage facilities in Sweden?		
Note		
A - 9.1.3 Is final assembly, packaging and shipping ensured in the QA at each manufacturing?		
Yes		
No		
Note		
B - 9.1.4 In which form does the final inspection of the products take place?		
Note		
B - 9.1.5 How is the final inspection documented?		
Note		
B - 9.1.6 How is the final inspection labelled?		
Note		
9.2 Logistic system		
A - 9.2.1 Do you use the Selcable-system for the logistic of cable-drums?		
Yes		Only for supply to Vattenfall Nordic
No		If "No", please describe your logistic solution, especially the return of the cable-drums.
Note		
A- B - 9.2.2 Do you have or are you able to build up a logistic system?		Only for supply to Vattenfall Nordic
Yes		
No		
Note		Minimized need for administrative work by Vattenfall administration of cable- drums, tracing of cable drums, delivery acknowledgements, invoicing, etc.). Possibility of integrating planning systems so that the supplier's production planning and Vattenfall's project planning can be matched and jointly optimised. Trucks for the delivery have to be equipped with proper unloading-equipment and GPS-device. Handling of scrap-cables need to be included. Please see enclosed the present logistical solution Vattenfall Nordic has with the current logistic provider regrading LV and MV cables.
10. Technical service		
B - 10.1 Technical sales support		
B - 10.1.1 How many people are employed in the technical sales support for Sweden?		
Note		
B - 10.1.1 How many people are employed in the technical sales support for Germany?		
Note		
B - 10.2 Training		
B - 10.2.1 What product-based training is offered to the client?		
Note		
B - 10.2.2 Do you have your own training centre? If yes, where is this located?		
Note		
10.3 Assembly (on site/ in the field)		
A - 10.3.1 How many employees work in the assembly area?		
Note		
A - 10.3.2 How are these employees organised within the company?		
Note		
A - 10.3.3 How do you document the qualification of your assembling-staff? Are ID-cards with the specific qualification of the assembling-staff available?		
Note		
A - 10.3.4 What product-based training is offered to the client's assembly workers?		
Note		
A - 10.3.5 Where is assembly training carried out?		
Note		
A - 10.3.6 What is the maximum assembling-capacity for assembling of fittings etc. that you can provide? How many projects are possible in parallel?		
Note		
A - 10.3.7 Do you use sub-contractors for the assembling of fittings etc.?		
Yes		If "Yes", how to you ensure the qualification of your sub-contractors?
No		
Note		
A - 10.3.8 In a case of failure, can you start a repair within 24 hours after notification?		
Yes		
No		
Note		
A - 10.3.9 Are you prepared to provide the correspondent volumes of cables and fittings in the case of failure?		
Yes		
No		
Note		
A - 10.3.10 Are there contact persons in your company that are reachable, also outside of the normal working-time?		
Yes		
No		
Note		
A - 10.3.11 Are you prepared to assemble transition joints for different building-types of cables (for instance oil-insulated cable >> XLPE-cable)?		
Yes		If "Yes", which types of cable-building-types:
No		
Note		

A - 10.3.12 Are you prepared to have a Swedish-speaking contact-person which is available at the construction-site at anytime during the project?		
Yes		
No		
Note		
A - 10.3.13 Do you have special guidelines for the laying of cable?		
Yes		If "Yes", please attach them to your checklist.
No		
Note		
11. Facilities & R& D		
11.1 Employees		
B - 11.1.1 How many people are employed in the R&D department?		
Note		
B - 11.1.2 How are these employees organised within the company?		
Note		
11.2 Technical facilities of Research & Development		
B - 11.2.1 What facilities are available (university, internationl testing etc…)?		
Note		
B - 11.2.2 How many development test bays are available (eg. laboratory for mechanical, electrical or polymetric test)?		
Note		
B - 11.2.3 What equipment is available in the test bays?		
Note		
B - 11.2.4 How many test bays are accredited?		
Note		
B - 11.2.5 Which service providers are used for test jobs?		
Note		
12. Technical description		
12. Customer's technical product requirements/ Technical descriptions		
B - 12.1 How are the customer's technical descriptions/specifications stored?		
Note		
B - 12.2 How long are technical descriptions/specifications stored?		
Note		
B - 12.3 Who has access to the technical descriptions/specifications?		
Note		
B - 12.4 Who integrates the technical descriptions/specifications into production?		
Note		
A - 12.5 Can you assure that the correct customer`s testing requirement are available to the employees in the test-field in the manufacturing process?		
Yes		If "Yes" how is this assured?
No		
Note		
A - 12.6 How are requirements from the technical descriptions/specifications incorporated into production?		
Note		
A - 12.7 How are employees informed about changes or exceptions to regular production procedures?		
Note		
A - 12.8 Can you assure that changes to the customer`s testing requirement are available to the employees in the test-field in the manufacturing process?		
Yes		If "Yes" how is this assured?
No		
Note		
13. Quality monitoring		
B - 13.1 Do you accept the following comprehensive concept of annual Quality Monitoring System for cables in the projects where cable supplied by you? This to be mutually agreed on between the Supplier, Vattenfall and Vattenfall´s Contractor.		The "Concept of Quality Monitoring" is attached in the separate worksheet called "Concept Quality Monitoring".
Yes		
No		
Note		

Document type	Document ID	Document No.	Issue No.	C-class	Organization		
Guideline	ND-G-00008	1002653460	1	C1	ND-A		
Search word			Replacing		Page	No. of pages	No. of appendicies
Technical specification, 1 kV, cables					1	13	1
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Per Norberg Torbjörn Jernström Elisabeth Schylander			Lennart Fritz				

Technical specification:
1 kV cables

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1 Purpose

The purpose of this document is to be used as technical specification for 1kV cables within Vattenfall Eldistribution AB.

2 Validity

This technical specification is valid within Vattenfall Eldistribution AB.

3 Responsibility

Responsible for this document is ND-A.

4 Security inspection

C1 – Open information

5 Introduction

This technical specification is mainly based on SS 424 14 18 and SS 424 14 26. The specification can be made binding by the purchaser and will then specify the requirements which together with applicable standards are valid for design, construction and testing.

This document has been approved as suitable support for purchase within framework agreements.

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6 General

System description

Low voltage networks are effectively grounded according to type TN in Swedish Standard SS4364000.

Low voltage cables are protected by fuses and can be categorized as system category A according to IEC 60183.

Installation methods

Installation methods include:

- Indoor installation (flame retardant cables)
- Laying in trench
- Pulling into pipes
- Ploughing
- Overhead installation (aerial bundled cables)

Cable laying and installation

Cables shall be designed and constructed in order to be installed according to “Recommendation for cable laying and installation” in SS 424 14 18.

In **addition to SS 424 141 8**, cables of type N1XE and N1XV shall be suitable for ploughing. The supplier shall describe the cable’s properties related to ploughing. This shall be supported by relevant documentation.

Installation temperature

Minimum installation (outdoor) temperature shall not exceed values below.

Cables with PE sheath:

-10 °C under normal conditions of care and -20 °C with special care in handling and with only moderate bending radius.

Other types:

0 °C under normal conditions of care and -10 °C with special care in handling to avoid any strokes against the cable and with only moderate bending radius.

Current ratings

The maximum current rating resulting from thermal limitations should be possible to calculate according to EN 60287 and SS 4241424.

End caps

Cables shall be equipped with end caps in order to prevent water penetration. End caps shall be of type cold shrink, hot shrink or equivalent. Tape is not accepted.

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Drums and logistics	The supplier shall indicate type of drums and logistics solution.
Heat treatment of wooden packaging	Wooden packaging, such as drums, shall be approved and marked according to the ISPM 15 standard[1] if the cable and/or packaging are imported from outside the European Union.
European directives and regulations	Cables shall fulfill all applicable European directives and regulations. This includes, but are not limited to: - The low voltage directive[2] - Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)[3]

7 Standards

Cables shall fulfill the following standards according to type (latest version including amendments applies). Additional standards are quoted in text.

General	SS 424 14 18[4] Power cables of rated voltage 0.6/1kV – Specifications for design and testing
Aerial bundled cables	SS 424 14 26[5] Power Cables – PE-insulated self-supporting aerial cable of rated voltage 0.6/1kV-Specifications for design and testing

[1] International Standards For Phytosanitary Measures No. 15 (ISPM 15) issued by the International Plant Protection Convention (IPPC)
[2] DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits
[3] REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC
[4] Includes the following harmonized documents: HD 603 S1, HD 603 S1/A1, HD 603 S1/A2 och HD 603 S1/A3, Distribution cables of rated voltage 0,6/1 kV, part 1, part 3 section L, part 5 section O and P. HD 604 S1, HD 604 S1/A1, HD 604 S1/A2 and HD 604 S1/A3, 0,6/1 kV and 1,9/3,3 kV power cables with special fire performance for use in power stations, part 1, part 3 section D.
[5] Includes the following harmonized documents: HD 626 S1 and HD 626 S1/A1, Overhead distribution cables of rated voltage Uo /U(Um): 0,6/1 (1,2) kV, part 1, part 2 (relevant parts) and part 3 section L.

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8 Cable types

Denomination within brackets corresponds to types according to SS 424 14 18.

SE-N1XE (Type 5O) 1 kV XLPE-insulated, PE-sheathed cable with circular conductors to be installed in ground.

Fire rating class F1 according to SS 424 14 75.
(See appendix 1)

Cable designation	Number of cores cross section	Comments
N1XE-U	4G10	Solid copper cond.
N1XE-U	5G10	Solid copper cond.
N1XE-U (Yellow)	5G10	Solid copper cond. For street lighting.
N1XE-R	4G16	Stranded copper cond.
N1XE-AR	4G16	Stranded aluminum cond.
N1XE-R (Yellow)	5G16	Stranded copper cond. For street lighting.
N1XE-AR (Yellow)	5G16	Stranded aluminum cond. For street lighting.
N1XE-AR	4G25	Stranded aluminum cond.
N1XE-AR (Yellow)	4G25	Stranded aluminum cond. For street lighting.
N1XE-AR	4G50	Stranded aluminum cond.
N1XE-AS	4G95	Stranded aluminum cond.
N1XE-AS	4G150	Stranded aluminum cond.
N1XE-AS	4G240	Stranded aluminum cond.

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SE-N1XV (Type 5O)

1 kV XLPE-insulated, PVC-sheathed cable with circular conductors to be installed in ground.

Fire rating class F2 according to SS 424 14 75.
(See appendix 1)

Cable designation	Number of cores and cross section	Comments
N1XV-U	4G10	Solid copper cond.
N1XV-U	5G10	Solid copper cond.
N1XV-R	4G16	Stranded copper cond.
N1XV-AR	4G16	Stranded aluminum cond.
N1XV-R	5G16	Stranded copper cond.

AXQJ (Type 3D)

Halogen-free sheathed 1 kV XLPE-insulated, cable with sector shaped aluminium conductors and concentric copper wire conductor, to be installed indoors, in ground, in pipes or in water.

Fire rating class F4C according to SS 424 14 75.
(See appendix 1)

Cable designation	Number of cores and cross section	Comments
AXQJ	4x50/29	Stranded aluminum cond.
AXQJ	4x95/57	Stranded aluminum cond.
AXQJ	4x150/88	Stranded aluminum cond.
AXQJ	4x240/146	Stranded aluminum cond.

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ALUS-D

1 kV double PE-insulated, aerial bundled cable (ABC) with circular Al conductors.

Fire rating class F1 according to SS 424 14 75.
(See appendix 1)

Cable designation	Number of cores and cross section	Comments
ALUS-D	4x25	Stranded aluminum cond.
ALUS-D	4x50	Stranded aluminum cond.
ALUS-D	4x95	Stranded aluminum cond.
ALUS-D	4x120	Stranded aluminum cond.

9 Additional design requirements

Conductor

Conductors shall be without welding points.

Winding with tape permissible, must be removable without tools.

Insulation (ABC)

Insulation compound for aerial bundled cables of type ALUS-D shall fulfil requirements for TIP-4.

Rip cord

Cables shall be equipped with rip cord (**addition to SS 424 14 18**), not applicable for ABC.

Separator tape

The supplier shall indicate use of separator tape in tender. The separator tape shall be halogen free for halogen free cables.

Colour of outer sheath

The preferred colour is black. Suppliers might offer other colours as an alternative.

Cables used for street lightning shall be yellow.

Colour of insulating sheath (ABC)

The insulating sheath should have a black outer layer and an inner layer of other colour, preferably grey.

Fillers

Cables are preferably manufactured without fillers. If fillers are used, these shall be non-hygroscopic, halogen free (for halogen free cables), rubber-elastic and free from stripping agents.
Fillers must be removable without tools.

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10 Requirements for construction of 4x16 and 5x16 mm^2 cables

Cables of type N1XE with conductor cross-sections 16mm^2 are not included in SS 424 14 18. Requirements for design and construction of this type shall be as described below.

N1XE 16mm^2 Al (Type 5O)

General design requirements shall be as described in the table below. (**Addition to SS 424 14 18**)

CONDUCTOR				NOMINAL THICKNESS (mm)			OUTER DIAMETER (mm)[6]
Number of conductors X cross section	Material	Class[7]	Shape[8]	Insulation	Inner covering[9]	Over-sheath	
4x16	Al	2	R	0,7	1,0	1,8	21
5x16	Al	2	R	0,7	1,0	1,8	23

11 Electrical properties

Resistance: Conductor resistance shall be calculated at 20 ºC reference temperature.

Inductance: Inductance shall be calculated:
- Phase to PEN
- Phase to phase

Loop impedance The cables contribution to the loop impedance shall be calculated at at 20 ºC reference temperature and be expressed as $Z_L=(R_{phase}+R_{PEN})+jX$.

[6] These values are approximate. For information only
[7] According to HD 383
[8] Shape: R = round, S = sector
[9] These values are approximate

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12 Marking

General

Marking of cables shall be durable and must not decrease the mechanical properties of the cable.

Core identification (Phase markings)

Cores shall be identified according to HD 308 by the following colours on the insulation:

L1: Brown
L2: Black
L3: Grey
N: Blue
PE/PEN: Green-and-yellow

Requirements for the identification of the protective conductor (PE/PEN) with the bi-colour combination green-and-yellow should comply with SS 424 14 18 and EN 60446.

Core marking for aerial bundled cables of type ALUS-D shall be according to method D in SS 424 14 26. The protective conductor (PEN) should be marked with a thin longitudinal yellow stripe[10] (**addition to SS 424 14 26**).

Indication of origin

Cables shall be provided with an identification of origin consisting of continuous marking of the manufacturer's name or trademark (if legally protected).

Markings shall be made on outer sheath using indenting or embossing.

Meter marking

Meter marking shall be made on outer sheath using printing, indenting or embossing (not applicable for ABC).

[10] The yellow stripe is requested for ALUS-D in order to create a clear visual distinction between ALUS-D and ALUS (the latter is without yellow stripe).

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13 Testing

Test reports from previously type- and additional tests are accepted if cables are manufactured with the same materials and using the same process and machinery and the test report is maximum 5 years old.

Prequalification testing

Prequalification testing aims to gain general understanding of the supplier's product quality. This testing is done during the prequalification phase before the tender phase.

The following shall be delivered for testing:

- Two cable samples cut into 1 meter long sections.
- Data sheet for actual cable including:
  1. Dimensions of conductor and insulating materials.
  2. Electrical data.

Prequalification testing conducted by Vattenfall includes, but is not limited to:

- Visual inspection.
- Measurement of conductor and insulation thickness.
- Stripping of insulation and sheath (if applicable).

Requirements for cable sample:

- Similar design regarding:
  1. Same conductor type (stranded or solid).
  2. Same conductor cross-section.
  3. Colour marking of cores same as required in this specification.

Routine test

According to SS 424 14 18 or SS 424 14 26 (for ABC).

Sample test

According to SS 424 14 18 or SS 424 14 26 (for ABC).

Sample tests shall be conducted on every 20th drum.

Type test

According to SS 424 14 18 or SS 424 14 26 (for ABC).

Vattenfall's representative shall be invited to participate during type testing.

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Additional sheath testing	Vattenfall is considering additional test requirements for sheaths similar to the abrasion test described in EN 60229 and shore D measurement as described in HD 605..
Repetition of tests	If the sample from any length selected for the tests (type or sample test) fails, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of the standard. If either fail, this batch of cables shall be regarded as having failed to comply.

14 Documentation

Test protocols	Test protocols from type- and sample tests shall be delivered and accepted before first cable delivery.
Material safety data sheet	A material safety data sheet shall be submitted together with tender for each cable type. The data sheet shall be structured according to REACH (16 sections).
Additional documentation	Additional documentation can be requested during pre-qualification and/or tendering.

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Appendix 1 – Fire rating classes according to SS4241475

Swedish standard SS 4241475 refers to older European standards within the EN 50265-series. The table below lists fire classes as requested in this technical specification including references to standards replacing the 50265- and 50266-series.

Fire class	References for testing	
	According to SS 424 14 75:	**Standard replaced by:**
F1	-	-
F2	SS-EN 50265-1 and SS-EN 50265-2-1 or SS-EN 50265-2-2 (depending on conductor area)	EN 60332-1-series
F4C	SS-EN 50266-2-4	EN 60332-3-24

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Technical specification:

Medium voltage cables, 12-24 kV

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1 Purpose

The purpose of this document is to be used as technical specification for 12 and 24 kV cables within Vattenfall Eldistribution AB.

2 Validity

This technical specification is valid within Vattenfall Eldistribution AB.

3 Responsibility

Responsible for this document is ND-A.

4 Security inspection

C1 – Open information

5 Introduction

This technical specification is mainly based on SS 424 14 18 and SS 424 14 26. The specification can be made binding by the purchaser and will then specify the requirements which together with applicable standards are valid for design, construction and testing.

This document has been approved as suitable support for purchase within framework agreements.

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6 General

System description

The 11-22 kV networks are generally designed as reactance grounded systems with a central Petersén coil and/or distribution transformers with built-in neutral point reactors.

Installation methods

Installation methods include:

- Indoor installation (flame retardant cables)
- Laying in trench
- Pulling into pipes
- Ploughing
- Overhead installation (aerial bundled cables)

Cable laying and installation

Cables shall be designed and constructed in order to be installed according to “Recommendation for cable laying and installation” in SS 424 14 18 and .

In **addition to SS 424 14 18**, cables with conductor area ≤ 240 shall be suitable for ploughing. The supplier shall describe the cable’s properties related to ploughing. This shall be supported by relevant documentation.

Installation temperature

Minimum installation temperature shall not exceed values below.

Cables with PE sheath:

-10 °C under normal conditions of care and -20 °C with special care in handling and with only moderate bending radius.

Other types:

0 °C under normal conditions of care and –10 °C with special care in handling to avoid any strokes against the cable and with only moderate bending radius.

Drums and logistics

The supplier shall indicate type of drums and logistics solution.

Heat treatment of wooden packaging

Wooden packaging, such as drums, shall be approved and marked according to the ISPM 15 standard[1] if the cable and/or packaging are imported from outside the European Union.

[1] International Standards For Phytosanitary Measures No. 15 (ISPM 15) issued by the International Plant Protection Convention (IPPC)

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European directives and regulations	Cables shall fulfill all applicable European directives and regulations. This includes, but are not limited to: - Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)[2]

7 Standards

Cables shall fulfill the following standards according to type (latest version including amendments applies). Additional standards are quoted in text.

General	SS 424 14 16[3] Power cables – XLPE-insulated cables of rated voltages 7/12 kV to 21/36kV – Specifications for design and testing
Testing	SS 424 14 19[4] Power cables – Test methods

[2] REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

[3] Includes the following harmonized documents: HD 620 S2, HD 622 S1 + A1 + A2

[4] Includes the following harmonized documents: HD 605 S2

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8 Cable types

Denomination within brackets corresponds to types according to SS 424 14 16 (HD 620).

Single core cables (Type 10M-1)

12 and 24 kV XLPE-insulated, PE-sheathed cable with circular conductors to be installed in ground.

Number of cores and cross sections:
- 1 x 630 mm^2

Three core cables (Type 10M-1)

12 and 24 kV XLPE-insulated, PE-sheathed cable with circular conductors to be installed in ground.

Number of cores and cross sections:
- 3 x 50 mm^2
- 3 x 95 mm^2
- 3 x 150 mm^2
- 3 x 240 mm^2
- 3 x 300 mm^2

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9 Design

Conductor material	Al
Conductor design	Round stranded compacted. Conductors shall be without welding points.
Insulation material	Triple extruded XLPE, dry cured
Water blocking	Totally water blocked (longitudinal and transversally blocked)
Metallic screen	Wires (Al or Cu) helically applied around the cable cores. or: Wires (Al or Cu) applied along each cable core. The wires may be applied in a bed of semiconducting material to be corrosion protected. Lägg till hur Al-mantel är korrosionsskyddad.
Screen area	The supplier must describe how the screen area is calculated, e.g. if water blocking foil or similar is included in the screen area. If foil or similar is included in the screen area, the supplier must describe how this affects the cable's properties during short-circuit through the screen (e.g. cross-country faults).
Outer sheath	The outer sheath can be constructed as: - Homogenous layer of PE. - Multi- layer PE. Mantelns skall testas I sin helhet beträffande draghållfasthet.

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10 Testing

Routine, sample and type test	According to SS 424 14 16.
Shore D	In tender, supplier shall include typical values for shore D hardness of PE sheath for all PE sheathed cables.
Long duration test	Long duration test is not required. However, Vattenfall Eldistribution is considering implementing long duration test according to HD 605 subclause 5.4.15 as a future requirement.
Zero sequence impedance	Zero sequence impedance shall be measured and/or calculated for each cable type.
High frequency properties	For cables with metallic screen consisting of wires applied along each cable core embedded in semiconducting material, it is required that damping is documented for the frequency range 1 kHz-1 MHz and submitted together with tender. (**addition to SS 424 14 16**)

11 Electrical properties

Resistance:	Conductor resistance shall be calculated at 20 ºC reference temperature.
Inductance:	Inductance shall be calculated phase to phase.
Zero sequence impedance:	The zero-sequence impedance shall be calculated at at 20 ºC reference temperature and expressed as: $Z_{(0)}=R_{(0)}+jX_{(0)}$
Charging capacitance	The charging capacitance shall be calculated.

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12 Marking

General	Marking of cables shall be durable and must not decrease the mechanical properties of the cable.
Indication of origin	Marking shall be made on outer sheath using indenting or embossing. Identification thread inside the cable is not accepted.
Meter marking	Meter marking shall be made on outer sheath using printing, indenting or embossing.

13 Sealing and packing

End caps	Cables shall be equipped with end caps in order to prevent water penetration. End caps shall be of type cold shrink, hot shrink or equivalent. Tape is not accepted.

14 Documentation

Test protocols	Test protocols from type- and sample tests shall be delivered and accepted before first cable delivery.
Material safety data sheet	A material safety data sheet shall be submitted together with tender for each cable type. The data sheet shall be structured according to REACH (16 sections).
Additional documentation	Additional documentation can be requested during pre-qualification and/or tendering.

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David Söderberg			Essi Ransed				
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Per Norberg Elisabeth Schylander Torbjörn Jernström			Lennart Fritz				

Technical specification:

Covered conductors for overhead lines not exceeding 36 kV

SAP DMS DIR 001 / 1002656491 Ver 01 - Frisläppt 2014.09.22 - Confidentiality (C1) - None Godkänt av Lennart Fritz

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SAP DMS DIR 001 / 1002656491 Ver 01 - Frisläppt 2014.09.22 - Confidentiality (C1) - None Godkänt av Lennart Fritz

1 Purpose

The purpose of this document is to be used as technical specification for covered conductors of for rated voltages above 1kV and not exceeding 36 kV within Vattenfall Eldistribution AB.

2 Validity

These technical specifications concern the facilities of Vattenfall BU Distribution Nordic.

3 Responsibility

Responsible for this document is ND-A.

4 Security inspection

C1 – Open information

5 Introduction

This technical specification is mainly based on EN 50 397 and EN 50 182. The specification can be made binding by the purchaser and will then specify the requirements which together with applicable standards are valid for design, construction and testing.

This document has been approved as suitable support for purchase within framework agreements.

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6 General

Installation temperature	Minimum installation temperature shall not exceed -10 °C under normal conditions of care and -20 °C with special care in handling and with only moderate bending radius.
Drums and logistics	The supplier shall indicate type of drums and logistics solution.
Heat treatment of wooden packaging	Wooden packaging, such as drums, shall be approved and marked according to the ISPM 15 standard[1] if the cable and/or packaging are imported from outside the European Union.
European directives and regulations	Cables shall fulfill all applicable European directives and regulations. This includes, but are not limited to: - Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)[2]

7 Standards

Cables shall fulfill the following standards according to type (latest version including amendments applies). Additional standards are quoted in text.

General	EN 50397-series Covered conductors for overhead lines and the related accessories for rated voltages above 1 kV a.c. and not exceeding 36 kV a.c.
Conductors	EN 50182 Conductors for overhead lines – Round wire concentric lay stranded conductors

[1] International Standards For Phytosanitary Measures No. 15 (ISPM 15) issued by the International Plant Protection Convention (IPPC)

[2] REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

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8 Design

Type	Covered conductors for overhead lines.
Standard code for covered conductors	Conductors shall be designed according to the following standard codes: CCST 54-AL1 / 9-ST1A W 24kV CCST 85-AL1 / 14-ST1A W 24kV CCST 159-AL7 W 24kV [3] CCST 241AL7 W 24kV
Conductor material	ACSR AlMgSi
Conductor design	Round stranded Conductors shall be without welding points.
Conductor screen	Semiconducting conductor screen
Insulation material	PE
Water blocking	Longitudinal water blocked

9 Testing

Routine, sample and type test	According to EN 50397-1. Sample tests shall be conducted on every 20th drum or 10 km.

10 Documentation

Test protocols	Test protocols from type- and sample tests shall be delivered and accepted before first cable delivery.
Material safety data sheet	A material safety data sheet shall be submitted together with tender for each cable type. The data sheet shall be structured according to REACH (16 sections).
Additional documentation	Additional documentation can be requested during pre-qualification and/or tendering.

[3] Note that this code has been changed. The old code was 157, but electrical and mechanical data are unchanged.

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VTR14-01E_Cables 36-170 kV

Summary
The following guidelines contain technical requirements and data for high voltage cables to be installed in the Vattenfall Swedish grid. Due to practical reasons medium voltage single core cables of 36 kV have been included.
The Swedish standard specification for high voltage cables SS 424 14 17 is based upon IEC 60 840. A corresponding Swedish standard for cable design is not available. The guidelines state the suitable choice where alternative possibilities exist and contain further amendments and clarifications to the Swedish standard SS 424 14 16 and SS 424 14 17. The purchaser may make the guidelines binding for the supplier and specifies than requirements in addition to the relevant standard applicable for fulfilment and testing.

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1 Design and application

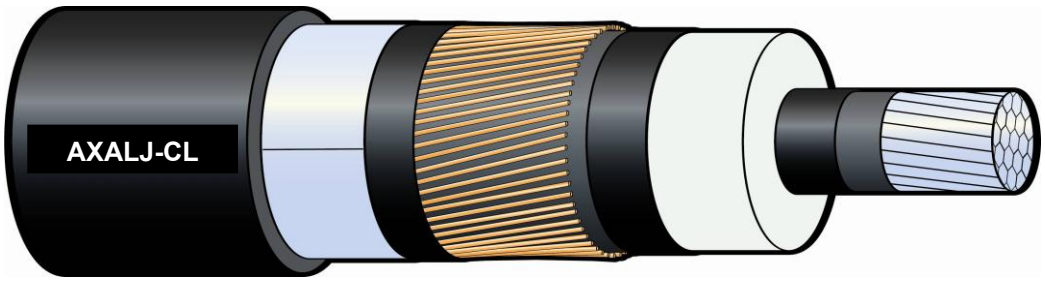
1.1 General

When calculating and selecting the cross section of the cable the technical guidelines *" VTR14-02_Vägledning vid dimensionering av kablar 36-170 kV"* may give useful information to people working with designing, planning and installation of cables. " *VTR14-03_Kabelförläggning 36-170 kV"* deals with different installation cases and the Vattenfall requirements on the installation.

The conductor of the cables shall be of type stranded, compacted, round aluminium conductors insulated with triple extruded, dry cured XLPE. The cables shall have concentric copper wire screens and be of type totally water blocked, i.e. being both longitudinally and radial water blocked. The outer sheaths shall have an external extruded conductive layer in order to facilitate the testing of the sheath.

The cable manufacturer shall make sure that any material used in the cables will not be harmful to the environment during installation and operation.

The following picture shows a typical cable design. Counter helix of copper tape over the copper wire screen is not a requirement; however the outer sheath shall be co-extruded in two layers with an outer conductive layer.



1.2 Vattenfall voltage levels

The following voltage levels and cross sections are in use:

Table A: Vattenfall voltage levels.

U kV	U_m kV	U_p kV Lightning impulse voltage test	Nominal cross sections for conductors, mm^2
30	36	180	300-1600
45	52	250	300-1600
66	72	325	300-1600
70	84	380	300-1600
110	123	550	300-1600
132	145	650	300-1600
150	170	750	400-1600

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2 Requirments for cable design

2.1 Conductor

The conductor shall meet the requirements for stranded aluminium conductors of class 2 according to IEC 60228 and be longitudinal water blocked. For conductor cross section of 1600 mm^2 and above Milliken conductors should be considered.

2.2 Insulation

The conductor shall be insulated with polyethylene, extruded in a triple cross head simultaneously with the conductive layers for the conductor and the insulation screen, then cross linked (vulcanised) by dry curing. The insulation shall meet the applicable requirements in SS 424 14 16 and SS 424 14 17. The following table shows the minimum insulation thicknesses at any point. For cables of voltage levels 52-170 kV the minimum insulation thickness shall exceed 90 % of the nominal insulation thickness. For cables of voltage level 36 kV the minimum insulation thickness at any point shall not be below the nominal value by more than 0.1 mm. (Method of measurement according to Clause 8 of EN 60811-201, 202, 203)

Table B: Minimum insulation thicknesses

Conductor cross section, mm^2	Minimum insulation thickness at any point, mm for maximum operating voltage U_m						
	36 kV	52 kV	72 kV	84 kV	123 kV	145 kV	170 kV
300	7.10	8.10	9.90	11.25	12.60	16.20	-
400	7.10	8.10	9.45	10.80	12.60	16.20	18.00
500	7.10	8.10	9.45	10.80	12.60	15.30	17.10
630	7.10	8.10	9.45	10.80	12.60	15.30	17.10
800	7.10	8.10	9.45	10.80	12.60	15.30	17.10
1000	7.10	8.10	9.45	10.80	12.60	15.30	17.10
1200	7.10	8.10	9.45	10.80	12.60	15.30	17.10
1600	7.10	8.10	9.45	10.80	12.60	15.30	17.10

2.3 Conductive layers

2.3.1 Conductor screening

The inner conductive polymer layer (conductor screening) shall be bonded to the insulation and the minimum thickness at any point shall not be less than 0.3 mm and meet the requirements in applicable SS-standard.

2.3.2 Insulation screening

The external conductive layer (insulation screening) shall be bonded to the insulation and the minimum thickness at any point shall not be less than 0.5 mm and meet the requirements in applicable SS-standard.

2.4 Core

Degassing of the core produced shall be performed in a dedicated heat chamber.

2.5 Metallic screen

The metallic screen shall consist of round, annealed copper wires with a minimum wire diameter of 0.5 mm locked with a counter helix of copper tape with a minimum

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thickness of 0.1 mm as an alternative the copper tape may be replaced by a swelling tape.
The metallic screen cross sections given in Table C are the minimum total geometrical cross sections of the copper wires. Maximum distance between adjacent copper wires may not exceed 8 mm and the average distance between the wires shall be less than 4 mm.

Table C: Minimum metallic screen cross sections.

Conductor cross section, mm^2	Minimum metallic screen cross section, mm^2 at maximum operating voltage U_m						
	36 kV	52 kV	72 kV	84 kV	123 kV	145 kV	170 kV
300	35	35	35	35	95	95	-
400	35	35	35	35	95	95	95
500	35	35	35	35	95	95	95
630	35	35	35	35	95	95	95
800	35	35	35	35	95	95	95
1000	35	35	35	35	95	95	95
1200	35	35	35	35	95	95	95
1600	35	35	35	35	95	95	95

2.6 Separation layer

An appropriate separation layer may be included between shield and sheath. When being exposed to the maximum permitted short circuit stress, the separating layer must not be changed in a way that affects the functioning of the cable (incl. longitudinal water tightness. The interstices between insulation screening and the outer sheath shall be longitudinally water blocked with a non-toxic material.

2.7 Outer sheath

The outer sheath shall consist of a longitudinally applied coated aluminium tape glued to the surrounding outer MDPE/HDPE sheath during the extrusion process. Simultaneously an external conductive layer will be extruded by co-extrusion. In order to facilitate the removal of the external conductive layer for testing and at installation without destroying the outer sheath the outer sheath of MDPE/HDPE shall be UV-stabilized without carbon black or separable by other suitable means. The sheath shall be longitudinally marked by embossing or indenting with the following text: The name of the manufacturer or logotype and cable type designation, for example: ”AXALJ-CL 170 kV 1x630/95+year and month of manufacture and Conductive layer”. Maximum distance between markings is 100 cm. Contactless metres marking with colour or as an alternative metre marking by embossing according to actual project requirement and cable designation system according to SS 424 17 01.

The required hardness of the MDPE/HDPE sheath material is under consideration.

The minimum outer sheath thickness in a single point shall not be lower than the values given in the following table. The thickness of the external conductive layer over the outer sheath shall not be included in the minimum sheath thickness. (Method of measurement according to Clause 8 of EN 60811-202)

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Table D: Minimum sheath thickness at any point

Conductor cross section, mm^2	Minimum sheath thickness at any point, mm at maximum operating voltage U_m						
	36 kV	52 kV	72 kV	84 kV	123 kV	145 kV	170 kV
300	1.82	2.11	2.20	2.28	2.37	2.62	-
400	1.90	2.20	2.28	2.37	2.45	2.71	2.88
500	1.98	2.28	2.37	2.45	2.54	2.71	2.88
630	2.06	2.37	2.45	2.54	2.62	2.88	2.96
800	2.22	2.45	2.54	2.62	2.79	2.96	3.05
1000	2.30	2.54	2.62	2.71	2.88	3.05	3.22
1200	2.46	2.62	2.71	2.79	2.96	3.13	3.30
1600	2.62	2.79	2.96	3.05	3.13	3.30	3.47

The nominal values for sheath thicknesses are as follows:

36 kV 300-630 mm^2 according to Table 3 A in SS 424 14 16, where the minimum values are calculated as 80% of the nominal values minus 0.1 mm.

36 kV 800-1600 mm^2 and for voltage levels 52-170 kV the nominal values are calculated according to IEC 60502-2 based upon the fictive diameter (0.035xD+1.0) where D in mm is the diameter under the external sheath. The minimum sheath thickness at any point is calculated as 85% of the nominal values minus 0.1 mm

2.8 External diameter

The diameter of the outer sheath may not exceed the following values:
(Method of measurement according to Clause 8.3 of EN 60811-203)

Table E: Maximum external diameter

Conductor cross section, mm^2	Maximum external diameter, mm at maximum operating voltage U_m						
	36 kV	52 kV	72 kV	84 kV	123 kV	145 kV	170 kV
300	50	52	57	61	66	74	-
400	52	55	58	63	68	77	81
500	58	60	63	67	72	78	83
630	62	64	67	70	76	82	87
800	65	68	71	74	80	86	90
1000	70	72	75	78	84	90	95
1200	73	75	78	82	87	94	98
1600	80	82	85	88	94	100	104

2.9 Take up on delivery drums

At the taking up of the cable on delivery drums, about 100 mm of the external conductive layer over the sheath shall be removed in both ends, before the ends of the cable are sealed. This is made in order to facilitate voltage testing of the sheath before the laying of the cable, when the cable is still on the delivery drum.

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3 Standard conditions for testing

Generally the frequency of the power frequency for test voltage shall be 50±1 Hz. The voltage shall have sinusoidal waveform. Stated values are RMS-values.

Unless a different value has been specified, the ambient temperature during the test shall be 20±15 °C.

In reasonable time before the start of the routine tests of the cables the representative for Vattenfall shall be informed and given the opportunity to in cooperation with the manufacturer agree on a testing program where the representative of Vattenfall will be able to participate. The manufacturer shall in a table show the tests made during manufacture, from the control of incoming goods to final control of finished goods and how the tests are documented (Quality Plan). The quality plan shall be forwarded to the Vattenfall representative together with the order confirmation.
In the quotation, the cost for a type test of the cable, the cable system as well as the cost for the testing of the longitudinally water blocking properties shall be presented.

The tests shall be made according applicable parts of the latest edition of SS 424 14 17 and SS 424 14 19.

4 Tests on cables

4.1 Routine tests

In Table 1 the tests to be made are given.

4.2 Sample tests

In Table 2 the test to be made are given.

4.2.1 Frequency of sample tests

According to applicable parts of the latest editions of SS 424 14 17 and SS 424 14 19, the Vattenfall representative shall be invited to the sample tests.

4.2.2 Repeated sample tests

The tests shall be made according applicable parts of the latest editions of SS 424 14 17 and SS 424 14 19.

4.3 Type tests

The type tests include the testing of the cable systems electrical and non electrical properties.

4.3.1 Type tests (electrical properties)

In Table 3 the test to be carried out are given. The tests mentioned in this table shall be performed on one cross section. The length of the cable shall be 10 m or more (without accessories).

4.3.2 Type tests (non electrical properties)

Table 4 applies to the tests to be carried out.

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4.3.3 Repeated type tests
The tests shall be made according applicable parts of the latest edition of SS 424 14 17 and SS 424 14 19.

4.4 Clearing test
Cylindrical beakers of sufficient size, clear and clean silicone oil, and a suitable light source (area lighting) shall be used for the clearing test. The test shall be carried out in silicone oil. The axial test samples shall have a length of 250 mm or more. The outer semi-conductive layer shall be removed in such a way that only a very small amount of the insulation is removed.
Furthermore, radial test samples with an outer semi-conductive layer but without a conductor shall be produced. The length should be 100 mm or more. The visible surfaces of the insulation shall be prepared in such a way that clear view into the insulation is possible.
Clearing tests shall be carried out on both ends of each coil and shall be documented. The test reports shall be handed over to the Vattenfall representative prior to delivery.

If the clearing test shows abnormalities more tests shall be carried out. The number of tests shall be agreed upon between the Vattenfall representative and the contractor. However, the minimum number of test samples which have to be subjected to further clearing tests is three.

5 Design requirements for accessories

5.1 Type of accessories
Only prefabricated, slip-on joints or stress cones are allowed to be used in terminations and joints. A routine test of the prefabricated joints, cast-resin parts, and stress cones has to show that there is no noticeable partial discharge from the sample.

5.2 Radial water blocking of joints
To ensure protection from the ingress of water, the joint shall have a radial water barrier of metal.
The radial water blocking and the metallic screen of the cable shall be electrically connected to each other.

5.3 Connection between radial water blocking and the metallic screen
A connection with current-carrying capacity (corresponding to metallic screen cross section) shall be provided in the joints and terminations between the metallic radial water barrier of the cable and the cable metallic screen**.**

6 On site test of cable installations in grid

6.1 New cable installations after laying
The requirements for voltage tests of newly installed cable installations are as follows.

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6.1.1 Insulation test

Test requirements:
Test voltage 1.73 U_o
Duration 60 minutes
Voltage frequency 20 – 300 Hz

6.1.2 Test of outer sheath

The test shall be carried out at a d.c. voltage of 10 kV for 1 minute. Cables with one-sided screen earthing or cross-bonding of metallic screens shall be subjected to a test at a d.c. voltage of 10 kV for 1 minute (Clause 5 of EN 60229).

6.2 Existing cable installations

6.2.1 Cable installations with a service life of less than 10 years

The requirements for voltage tests of existing cable installations are as follows:

6.2.1.1 Insulation test

Test requirements:
Test voltage 1.73 U_o
Duration 60 minutes
Voltage frequency 20 – 300 Hz

6.2.1.2 Test of the outer sheath

The test shall be carried out at a d.c. voltage of 10 kV for 1 minute.

6.2.2 Cable installations with a service life of 10 years and more

The requirements for cable installations 10 years or older are as follows**:**

6.2.2.1 Insulation test

Test requirements:
Test voltage 1.4 U_o (under consideration)
Duration 30 minutes
Voltage frequency 20 – 300 Hz

6.2.2.2 Test of outer sheath

The test shall be carried out at a d.c. voltage of 5 kV for 1 minute

7 Test tables

Table 1: Routine tests of XLPE-cables 36-170 kV

Table 2: Sample tests of XLPE-cables 36-170 kV

Table 3: Type tests of XLPE-cables 36-170 kV (electrical properties)

Table 4: Type tests of XLPE-cables 36-170 kV (non-electrical properties)

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Table 1: Routine tests of XLPE-cables 36 – 170 kV

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence	Section 2 to 4 of this table	
2	Conductor resistance	HD 632, (SS 424 14 17)	HD 383, (SS 424 14 08) HD 605 Section 3.1.1, (SS 424 14 19)
3	Voltage test -Sample from factory length -Test voltage 3.0 U_0 -Test duration 30 minutes	No break down	HD 605, Section 3.2.1, (SS 424 14 19)
4	Partial discharge test -Sample: factory length -Admissible noise level ≤1 pC -Calibration pulse 2 pC -Power-frequency test voltage 2.5 U_0	No noticeable internal partial discharge from the sample	EN 60885-3, (IEC 60885)

*Standards/norms referred to in the tables within brackets are corresponding Swedish Standard SS or IEC-standard. See also the **Reference list** in the end of this document!*

Note:
The partial discharge test shall be carried out directly after completion of the voltage test during voltage reduction.

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Table 2: Sample tests of XLPE-cables 36-170 kV

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Conductor design	HD 632 VTR14-01 Sec. 6.1	HD 632 Sec.10.4 and visual inspection
2	Conductor screening - Wall thickness - Irregularities - Conductivity	 VTR14-01 Sec. 6.3 VTR14-01 Sec. 6.3 HD 632	 EN 60811-201 EN 60811-201 HD 605
3	Insulation - Design - Wall thickness - Minimum wall thickness - Wall thickness uniformity - Irregularities - Clearing test - Thermal expansion behaviour	 HD 620 Part 1, Table 2 A, DIX 8 VTR14-01 Sec. 6.2 HD 632 HD 632 VTR14-01 Sec. 6.2 HD 632	 EN 60811-201 EN 60811-201 EN 60811-201 HD 605/A1 Section 2.110.2 EN 60811-507 S
4	Insulation screening - Wall thickness - Wall thickness uniformity - Conductivity	 VTR14-01 Sec. 6.3 VTR14-01 Sec. 6.3 HD 632	 EN 60811-201 EN 60811-201 HD 605
5	Diameter above the insulation	VTR14-01 Sec. 6.2	EN 60811-201
6	Metallic screen - Dimensions of copper wires - Distance between screen wires - DC-resistance of metallic screen	VTR14-01 Sec. 6.5 VTR14-01 Sec. 6.5 VTR14-01 Sec. 6.5 Min. 101% IACS	 EN 60811-201 HD 620 HD 605 Under consideration
7	Outer sheath - Design - Wall thickness - Minimum wall thickness	 HD 620 Part 1 Table 4 B, DMP 2 VTR14-01 Sec. 6.7 VTR14-01 Sec. 6.7 HD 632	 EN 60811-202 EN 60811-202 EN 60811-202
8	Outer diameter	VTR14-01 Sec. 6.8	EN 60811-203
9	Capacitance	HD 632	HD 632 10.10
10	Marking	VTR14-01 Sec. 6.7	

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Table 3: Type tests of XLPE-cables 36-170 kV (electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence Sample: Complete cable	Section 2 to 5 of this table	
2	Flexing test followed by rated power frequency voltage withstand test and partial discharge test		
2.1	Flexing test -Flexing diameter 20*(d+D)+5 % D = outer diam, actual value d = conductor diam., actual value		HD 605 Section 2.4.1
2.2	Rated power frequency voltage withstand test Test duration 1 minute For U_m = 36 kV 70 kV U_m = 52 kV 95 kV U_m = 72 kV 140 kV U_m = 145 kV 275 kV U_m = 170 kV 325 kV	No breakdown	HD 605 Section 3.2.1
2.3	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC -Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3
3	Load change test followed by partial discharge test		
3.1	Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^oK above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Power frequency test voltage 2,5 U_o -Number of cycles 20		
3.2	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC -Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3
4	Impulse voltage test followed by a.c. voltage test		

Cont…

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
4.1	Impulse voltage test Heating by conductor heating to 5-10 ^{o}K above the admissible conductor temperature, keeping it at this temperature for a minimum of 2 hours -Impulse level acc. to Table A! -Number of impulses •10 impulses of positive polarity •10 impulses of negative polarity	 No breakdown No breakdown	EN 60230
4.2	Voltage test -Power freq. test voltage 2.5 Uo -Test duration 4 hours	 No breakdown	HD 605 Section 3.2.1
5	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC -Test voltage 2.5 U_o	 No noticeable internal partial discharge from the sample	EN 60885-3

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Table 4: Type tests of XLPE-cables 36 - 170 kV (non-electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Insulation tests		
1.1	Mechanical properties		
	a) Before ageing	HD 620, Part 1 Table 2 A, DIX 8	EN 60811-501
	b) After ageing in a heat chamber	HD 620, Part 1 Table 2 A, DIX 8	EN 60811-401
2	Core test		
2.1	Shrinkage	HD 620, Part 1 Table 2 A, DIX 8	EN 60811-502
3	Tests on the outer sheath		
3.1	Mechanical properties		
	a) Before ageing	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-501
	b) After ageing in a heat chamber	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-401
3.2	Resistance to pressure at high temperatures	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-508
3.3	Stress cracking resistance	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-406 Method B, duration 1000 h
3.4	Carbon black content	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-605
4	Tests on the complete cable		
4.1	Ageing on the complete cable	HD 620,Part 1 Table 2 A, DIX 8 Table 2 B, DMP 2	EN 60811-501 EN 60811-401
4.2	Shore D hardness of the PE sheath	HD 620, Part 1 Table 4 B, DMP 2	HD 605 Section 2.2.1
4.3	Longitudinal water tightness in the metallic screen area	HD 632	HD 632

Cont....

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Cont...

	1	2	3
	Tests	**Requirements**	**Test methods**
5	Conductor design	HD 632 VTR14-01 Sec. 6.1	HD 632 Sec. 10.4 and visual inspection
6	Conductor screening •Wall thickness •Irregularities •Conductivity	 VTR14-01 Sec. 6.3 VTR14-01 Sec. 6.3 HD 632	 EN 60811-201 EN 60811-201 HD 605
7	Insulation •Design •Wall thickness •Minimum wall thickness •Wall thickness uniformity •Irregularities •Clearing test •Thermal expansion behaviour	 HD 620, Part 1 Table 2 A, DIX 8 VTR14-01 Sec. 6.2 HD 632 HD 632 VTR14-01 Sec. 8.4 HD 632	 EN 60811-201 EN 60811-201 EN 60811-201 HD 605/A1 Section 2.1.10.2 EN 60811-507
8	Insulation screening •Wall thickness •Wall thickness uniformity •Conductivity	 VTR14-01 Sec.6.3 VTR14-01 Sec. 6.3 HD 632	 EN 60811-201 EN 60811-201 HD 605
9	Diameter above the insulation	VTR14-01 Sec. 6.2	EN 60811-201
10	Metallic screen • Dimensions of copper wires • Distance between screen wires • DC-resistance of metallic screen	 VTR14-01 Sec. 6.5 VTR14-01 Sec. 6.5 VTR14-01 Sec. 6.5 Min 101% IACS	 EN 60811-201 HD 620 HD 605
11	Outer sheath •Design •Wall thickness •Minimum wall thickness	 HD 620, Part 1 Table 4 B, DMP 2 VTR14-01 Sec. 6.7 VTR14-01 Sec. 6.7 HD 632	 EN 60811-202 EN 60811-202 EN 60811-202
12	Outer diameter	VTR14-01 Sec. 6.8	EN 60811-203
13	Clearing test	VTR14-01 Sec. 8.4	

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8 Reference list

International standard	Title	Corresponding national standard
EN 60228 IEC 60228	Conductors of insulated cables	SS-IEC 4241408
IEC 60229 EN 60229	Test on cable oversheaths which have a special protective function and are applied by extrusion	SS-IEC4241416
EN 60230 IEC 60230	Impulse tests on cables and their accessories	
EN 60332 IEC 60332	Test on electric and optical fibre cables under fire conditions	
IEC 60502-2 HD 620 HD 605	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) - Part 2: Cables for rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)	SS 4241416 SS 4241419
EN 60811 Series IEC 60811	Insulating and sheathing materials of electric and optical fibre cables – Common test methods	
IEC 60840 HD 632	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (U_m 36 kV) up to 150 kV (U_m 170 kV) – Test methods and requirements	SS 4241717
EN 60885 Series	Electrical test methods of electrical cables	

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VTR14-04E _Single core submarine cable 36-170 kV and accessories

Summary
Technical guideline for XLPE-insulated 150 kV submarine single core cables and their accessories

SAP DMS DIR 001 / 1002865440 Ver 01 - Frislappt 2016.07.05 - Confidentiality (C1) - None Godkänt av David Ringmar

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1 General

This Technical Guideline (VTR) shall be used as a complement to each of the valid standards IEC, EN, HD and DIN.
Health and safety data sheets shall be handed over for all material used unless they are clearly environmentally friendly.
Drawings of design of the cable and assembly drawings for the used terminations and joints shall be handed over by the supplier.
These drawings will be handled confidentially by the customer.

References to standards:

- **DIN-VDE 0276-632:**

Starkstromkabel mit extrudierter Isolierung und ihre Garnituren für Nennspannungen über 36kV bis 150kV.

- **IEC 60840 (SS 4241417):**

Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) – Test methods and requirements.

- **Cigré Electra Nr.171 April 1997:**

Recommendations for Mechanical Tests on Submarine Cables.

- **Cigre TB 490 February 2012:**

Recommendations for Testing of Long AC Submarine Cables with Extruded Insulation for System Voltage above 30 (36) to 500 (550) kV.

2 Net conditions

The cable and the accessories shall be suitable for operation on an AC system (50 Hz) with insulated neutral point, with earth fault compensation or low resistance neutral point earthing.

3 Voltage levels

This Technical Guideline is applicable for single core submarine cable having an insulation of cross-linked polyethylene and the accessories (joints and terminations).

- U_m = 36-170 kV (Maximum operating voltage)

4 Design and use

The conductor shall be of type round, stranded and compacted copper or aluminium.

In order to limit the field strength, the cable shall have conductive layer over the conductor and over the insulation.

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The layers shall be bonded to each other by a three layer extrusion. The extrusion shall be made by using a cross head for three extruders.

Each core of the three core cable must be totally water blocked (radial and longitudinally). The test of radial and longitudinally water blocking shall be made by using salt water.

5 Identification

Every submarine cable must have an individual external sheath marking.

The customer shall be informed of all designations and markings.

The text must be of suitable size and be easy readable.

The submarine cable shall on every 100 m be marked on the external sheath with the manufacturing number, meter marking and manufacturer.

The marking shall be of a durable colour contrasting to the external sheath of the submarine cable.

The position of all manufacturer joints must be durably marked on the external sheath of the submarine cable.

6 Design requirement of the cable

6.1 Core

The core i.e. the metallic conductor, conductor screen, insulation and the insulation screen shall meet the requirements in “VTR14-01E_Cables 36-170 kV”.

All finished cores shall be degassed. The manufacturer shall hand over documents related to the degassing process and if applicable document from the measurement of the rest gas content.

6.2 Metal sheath (radial water blocking)

The cable shall have a metal sheath suitable for radial water blocking. Preferably the metal sheath shall consist of lead. All other types have to be discussed with the customer in advance.
The metal sheath shall withstand the electrical and the mechanical stresses during short circuit and installation. The nominal thickness (of the lead sheath) is 2.8 mm. The minimum value at any point may not be less than 2.6 mm.

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6.3 Internal sheath

The internal sheath shall consist of conductive PE. The nominal value of the thickness of the PE over sheath is 2.5 mm. The minimum value at any point may not be less than 2.0 mm.
The sheath shall be made by an extrusion process.

The internal sheath shall have the following marking:
manufacturer's identification, type, year of manufacture and the cable code number.
The marking on the internal sheath shall be repeated at an interval of minimum 100 cm.

6.4 Armouring

In order to get mechanical protection a layer of alloyed aluminium wires are placed over the internal sheath.

Minimum diameter of wire is 4 mm.

The wire must cover the total surface of the cable.

6.4.1 External protection

The external protection shall consist of two layers of black PP-Yarn. The inner layer must be embedded in bitumen. The outer layer must have three coloured markings.

7 General test requirements

The nominal frequency for the test is 50 Hz.

The frequency of the AC-test voltage shall be 20 Hz to 300 Hz unless another value has been decided. The voltage shall approximately have a sinusoidal waveform.

The ambient temperature during the test shall be 20±15 ^{o}C.

7.1 Cable testing

7.1.1 Routine test (electrical properties)

The tests will be carried out according to Table 1.

At least 30% of the tests shall be made during the presence of the customer.

The dates for these tests shall be agreed upon three weeks in advance.

The routine tests will be made on all manufactured cores, without factory joints, after the extrusion of the PE-sheath, but before the lay up of the cores and the application of the armoring.

If the cores are too long, alternative test conditions to the in Table 1 mentioned shall be agreed upon between the manufacturer and the customer. If factory joints are necessary, additional test of the total core length including joints after the extrusion of the PE-sheath, but before the armoring is applied, will be required.

In case the length of the finished core is too long alternative test conditions to the in Table 1 mentioned shall be agreed upon between the manufacturer and the customer.

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7.1.2 Sample test

The tests shall be performed according to Table 2.
The sample test will be made on the finished core, before the joints of the single cores and before the lay up and the application of the reinforcement.

7.1.3 Frequency of the sample test

According to HD 632 but at least 30% during the presence of the customer.
The dates for these tests shall be agreed upon three weeks in advance.

During the factory acceptance tests the results from the quality assurance and the documents from the factory internal routine and sample test shall be handed over to the costumer.

The routine and the sample tests according to Table 1 and 2 shall be made in presence of the customer. Samples shall be cut from the selected cores in presence of the customer. The number of samples shall in advance be stated by the customer.

A repeated test will be made according to the agreement in the individual case.

7.1.4 Repeated sample tests

According to HD 632.

8 Type test of the cable

The procedure and test set-up as well as the selection of accessories shall be accepted by the customer before the start of the type test. The proof of a successful execution of the type test made by an accredited testing station and the results shall be handed over to the customer. The customer reserves the right to be present at the type test.

8.1 Type test (electrical properties)

The tests shall be made according to Table 3. The tests stated in the table shall be made on one piece of cable and follow the sequence given. The length of the cable must at least be 30 m without accessories. The length of the cable between the accessories must at least be 10 m.
The type test shall basically be carried out as a system test with accessories and controlled by an accredited testing station.

The procedure and test set-up as well as the selection of accessories shall be accepted by the customer before the start of the type test.

The test shall include a single core of the submarine cable to be bending tested according to IEC 60840.

After the completed type test, the cable shall be visually inspected.

8.1.1 Type test (non-electrical properties)

The tests shall be made according to Table 4.

8.1.2 Repeated type tests

-In case the included types of accessories for type test and system test requires an additional test set up, the type test will regarded as approved when the two test set ups and all the required tests are successfully made.
- According to HD 632.

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9 Clearing test

Cylindrical beakers of sufficient size, clear and clean silicone oil, and a suitable light source (area lighting) shall be used for the clearing test. The test shall be carried out in silicone oil.

The axial test sample shall have a length of 250 mm or more. The outer semi-conductive layer shall be removed in such a way that only a very small amount of the insulation is removed.
Furthermore, radial test samples with an outer semi-conductive layer but without a conductor shall be produced. The length should be 100 mm or more. The visible surfaces of the insulation shall be prepared in such a way that clear view into the insulation is possible.
Clearing tests shall be carried out on both ends of each core and shall be documented. The test reports shall be handed over to the customer prior to delivery.

If the clearing test shows abnormalities more tests shall be carried out. The number of tests shall be agreed upon between the customer and the manufacturer. However, the minimum number of test samples which have to be subjected to further clearing tests is three.

10 Requirements for accessories

10.1 Type of accessories

For terminations or joints (for XLPE sub marine cables and XLPE cables in ground) only pre-fabricated, slip-on joints or stress cones are allowed.
By routine test of the pre-fabricated sleeve-bodies, cast resin bodies and stress cones the non-existing partial discharges (pd) shall be checked (no recognizable pd from the sample).

Joints, factory joints and repair joints shall be included in the type test of the sub marine cable.

For all joints the salt water resistance according to the type test shall be proven.

All other accessories and their components have to be salt water resistant.

The manufacturer has to show that this has been effected.

10.2 Routine test of accessories

All manufactured pre-testable joints, cast resin bodies and stress cones for the terminations shall be tested in the presence of the customer.
The routine tests has to be performed according to Table 5.

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11 Type tests for accessories (electrical properties) terminations and joints (XLPE sub marine cable/XLPE ground cable)

11.1 General

All accessories have to be routine tested according to Table 5 before the start of the type test.
The type tests of the accessories shall be made according to Table 6.

This test shall be made on a sample in the sequence stated.

The accessories shall be mounted on a cable having a design in principle corresponding to “Technical guideline single core sub marine cable 170 kV”.

For joints (sub marine cable/cable in ground) additional type test of a sample having a design corresponding to “VTR14-01E_Cables 36-170 kV” shall be included.

Type test of accessories may be made together with the type test of the cable.

After completion of the type test a visual check of the cable and the accessories will be made.

Factory joints will be cut open and checked for alterations.

All other accessories will be dismantled and checked for alterations.

11.2 Tightness test with load cycles and DC-voltage test of the external protection of the joints

In order to verify the tightness of a joint it will be subjected to a load cycle consisting of 10 cycles in air and 10 cycles in water. The test may be made together with the load cycle test according to Table 6, section 4.1.

In a separate test the mounted joint will be tested for tightness during a 20 cycle’s heat cycle test in water. The water will then be heated to 70^{o}C and kept at this temperature for at least 5 hours. Finally follows a cooling down of the water to ambient temperature +10K.

During the water test a water pressure of 1 m water column is applied. The test shall be made in such a way that the water pressure is applied on every seal of the external protection.

I connection with the load cycle test a DC voltage of 20 kV will be applied during 1 min on the sample cooled down to room temperature. The voltage will be applied to the metallic screen of the cable and to an electrode connected to the common external surface of the joint.

11.3 Repeated type test

According to HD 632

12 On-site testing of cable system

This test is made when the cable system (cable and accessories) is completely assembled and when after a ready statement for the operation of the system. The customer will take the cost.

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12.1 Test of insulation

The test requirements are:

Test voltage	2.0 U_o
Duration of test	30 Minutes
Voltage frequency	20 – 300 Hz

Alternative: 1.7 U_0 60 Minutes

13 Test tables

Table 1	Routine test of XLPE submarine cable
Table 2	Sample test of XLPE submarine cable
Table 3	Type test of XLPE submarine cable (electrical properties)
Table 4	Type test of XLPE submarine cable (none electrical properties)
Table 5	Routine test of pre-fabricated accessories and pre-testable parts of accessories
Table 6	Type test of accessories for XLPE cable (electrical properties)

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Table 1: Routine test of XLPE submarine cable

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence	Section 2 to 5 of this table	
2	Voltage test -Sample from factory length -Test voltage 2.5 U_0 -Test duration 30 minutes	No break down	HD 605, Section 3.2.1, (SS 424 14 19)
3	Partial discharge test ***** -Sample: factory length -Admissible noise level ≤1 pC -Calibration pulse 2 pC -Power-frequency test voltage 2 U_o	No noticeable internal partial discharge from the sample	EN 60885-3, (IEC 60885)
4	Conductor resistance	HD 632, (SS 424 14 17)	HD 383, (SS 424 14 08) HD 605 Section 3.1.1, (SS 424 14 19)
5	Capacitance	HD 632	DIN VDE 0472 Teil 5, Prüfart B

Standards/norms referred to in the tables within brackets are corresponding Swedish Standard SS or IEC-standard.

Note:
The partial discharge test shall be carried out directly after completion of the voltage test during voltage reduction.

***** In case the tested single length / complete length is too long alternative test parameters have to be agreed upon between the manufacturer and the customer.

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Table 2: Sample test of XLPE submarine cable

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Conductor design	HD 632 VTR* Sect. 6.1	EN 60811-1-1 Section 8.3 and visual inspection
2	Conductor screening - Wall thickness - Irregularities - Wall thickness uniformity	 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1	 EN 60811-1-1 EN 60811-1-1
3	Insulation - Design - Wall thickness - Minimum wall thickness - Wall thickness uniformity - Irregularities - Clearing test - Thermal expansion behaviour	 HD 620 Part 1, Table 2 A, DIX 8 VTR 6.1 VTR 6.1 VTR 6.1 VTR Sect. 9 HD 632	 EN 60811-1-1 EN 60811-1-1 EN 60811-1-1 HD 605/A1 Section 2.110.2 EN 60811-2-1 Section 9
4	Insulation screening - Wall thickness - Irregularities - Wall thickness uniformity	 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1	 EN 60811-1-1 EN 60811-1-1
5	Metal sheath (radial water blocking) •Wall thickness	 VTR Sect. 6.2 IEC 60840	 HD 605 2.1.5
6	Inner sheath - Wall thickness - Minimum wall thickness - Marking	 VTR Sect. 6.3 VTR Sect. 6.3 VTR Sect. 6.3	 EN 60811-1-1 EN 60811-1-1 Visual test

* VTR refers to sections in this document

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Table 3: Type test of XLPE submarine cable (Electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence - Sample: Complete cable about 30 m	Section 2 to 5 of this table	
2	Pulling and bending test Bending test of the individual core Bending test -Bending diameter 20*(d+D)+5 % D = outer diam. actual value d = conductor diam., actual value	 IEC 60840	WG 21.02 Cigré Electra Nr. 171 Sect. 2.2 HD 605 Section 2.4.1
2.2	Rated power frequency voltage withstand test - AC test voltage 2.5 U_o -Test duration 1 minute	 No breakdown	HD 605 Section 3.2.1
2.3	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	 No noticeable internal partial discharge from the sample	EN 60885-3

Cont.

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
3	Load change test followed by partial discharge test		
3.1	Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^{o}K above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Power freq. test voltage 2.5 U_o -Number of cycles 20		
4	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
5	Impulse voltage test in combination with AC voltage test		
5.1	Flash and switching impulse voltage test - Heating by conductor heating to 5-10 ^{o}K above the admissible conductor temperature, keeping it at this temperature for a minimum of 2 hours Flash voltage level, kV acc. To Table A -Number of impulses •10 impulses of positive polarity •10 impulses of negative polarity	No breakdown	EN 60230
5.2	Voltage test - Test voltage 2.5 U_o - Duration of test 4 hours	No breakdown	HD 605 Sect. 3.2.1
6	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2 U_o	No noticeable internal partial discharge from the sample	EN 60885-3
7	Tests of factory joints	WG. 21.02 (AC cable) Cigré TB 490 Sect. 6.4	
8	Visual inspection of cable and accessories	WG 21.02 Cigré Electra No. 171 Sect. 2.2.3	EN 60811-1-3 Section 10

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Table 4: Type tests XLPE-submarine cable (Non-electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Water blocking test	Cigré TB 490 Sect. 8.7	Cigré TB 490 Sect. 8.7
2	Tests on the insulation		
2.1	Mechanical properties a) before ageing b) after ageing in heat chamber	HD 620, Part 1 Table 2 A, DIX 8 HD 620, Part 1 Table 2 A, DIX 8	EN 60811-1-1 Section 9 EN 60811-1-1 Section 8
3 3.1	Tests of cores Shrinkage test	HD 620 Part 1 Table 2 A, DIX 8	EN 60811-1-3 Section 10
4	Tests of external PE-sheath		
4.1	Mechanical properties a) Before ageing b) After ageing in a heat chamber	HD 620, Part 1 Table 4 B, DMP 2 HD 620, Part 1 Table 4 B, DMP 2	EN 60811-1-1 Section 9 EN 60811-1-2 Section 8
4.2	Resistance to pressure at high temperatures	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-3-1 Section 8.2
4.3	Cracking resistance	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-4-1 Test method B, However duration 1000 hours
	Shore-D hardness of PE outer sheath	Minimum 48	HD 605 Sect. 2.2.1
5	Tests of the complete cable		
5.1	Ageing of the complete cable	HD 620, Part 1 Table 2 A, DIX 8 Table 2 B, DMP 2	EN 60811-1-1 Section 9 EN 60811-1-2 Section 8

Cont....

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Cont...

6	Conductor design	HD 632 VTR Sect. 6.1	EN 60811-1-1 Section 8.3 and visual inspection
7	Conductor screening •Wall thickness •Irregularities •Conductivity	 VTR Sect. 6.1 VTR Sect. 6.1 HD 632	 EN 60811-1-1 EN 60811-1-1 HD 605
8	Insulation •Design •Wall thickness •Minimum wall thickness •Wall thickness uniformity •Irregularities •Clearing test •Thermal expansion behaviour	 HD 620, Part 1 Table 2 A, DIX 8 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 9 HD 632	 EN 60811-1-1 EN 60811-1-1 EN 60811-1-1 HD 605/A1 Sect. 2.1.10 EN 60811-2-1 Sect. 9
9	Insulation screening •Wall thickness •Wall thickness uniformity •Conductivity	 VTR Sect.6.1 VTR Sect. 6. HD 632	 EN 60811-1-1 EN 60811-1-1 HD 605
10	Metal sheath (radial water blocking)	VTR Sect. 6.2 HD IEC 60840	HD 605 2.1.5
11	PE inner sheath •Wall thickness •Minimum wall thickness •Marking	 VTR Sect. 6.3 VTR Sect. 6.3 VTR Sect. 6.3	 EN 60811-1-1 EN 60811-1-1 Visual inspection
12	Armouring, external protection sheath	VTR Sect. 6.4 IEC 60502-2	HD 605 2.3.2 2.4.2

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Table 5: Routine test of pre-fabricated accessories and pre-testable parts of accessories

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Visual inspection	No noticeable deviations from requirements	
2	Voltage test - Level of calibration pulses 2 pC - Test voltage 2.5 U_o - Duration of test 15 min - Acceptable noise level ≤1 pC Immediately followed by: - Voltage level increase 3 Uo - Duration of increase 1 min - Voltage test 2.5 Uo - Duration of test 1 min - Acceptable noise level ≤1 pC	 No break down No noticeable internal partial discharges in tested sample	EN 60885-3
3	Visual inspection	Tested sample cleaned and free of grease; No noticeable deviations from requirements	EN 60885-3

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Table 6: Type test of accessories for XLPE cable (Electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence	Sect. 2 to 7 of this table	
2	Rated power frequency voltage withstand test - AC test voltage 2.5 U_o - Test duration 1 minutes	No breakdown	HD 605 Sect. 3.2.1
3	Partial discharge test -Calibration pulse level 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3
4 4.1	Load change test followed by partial discharge test Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^oK above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Power freq. test voltage 2.5 U_o -Number of cycles in water 10 -Number of cycles in air 10		
4.2	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC -Power freq. test voltage 2.5 U_o		EN 60885-3

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
5	Impulse voltage test followed by AC voltage test		
5.1	Flash voltage test - Heating the sample to 5-10 °K above the admissible conductor temperature by conductor heating, keeping it at this temperature for a minimum of 2 hours Flash voltage level 2.5 U_o - No of flashes 10 flashes of positive polarity 10 flashes of negative polarity	No breakdown	EN 60230
5.2	Voltage test - AC voltage test 2.5 Uo - duration of test 4 hours	No breakdown	HD 605 Sect. 3.2.1
6	Partial discharge test -Calibration pulse level 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3

Cont....

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
7	Water blocking of joints The joint will be tested by a load change test in water. All sealing areas of the joint shall be subjected to a water column of 1 m when positioned in water		
7.1	Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^{o}K above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Number of cycles in air 10 -Number of cycles in water 10		
7.2	20 heating cycles in water 70 C^{o}	IEC 60840	IEC 60840
7.3	Voltage test - DC voltage test 20 kV - Duration of test 1 min	No breakdown	HD 605 Sect. 3.2.1

Reference:

During the test of the joints, the heating current used shall be for the lowest admissible conductor temperature.

***** The test can be made on a separate sample of similar design.

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14 Reference list

International standard	Title	Corresponding national standard
EN 60228 IEC 60228	Conductors of insulated cables	SS-IEC 4241408
IEC 60229 EN 60229	Test on cable over sheaths which have a special protective function and are applied by extrusion	SS-IEC4241416
EN 60230 IEC 60230	Impulse tests on cables and their accessories	
EN 60332 IEC 60332	Test on electric and optical fibre cables under fire conditions	
IEC 60502-2 HD 620 HD 605	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) - Part 2: Cables for rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)	SS 4241416 SS 4241419
EN 60811 Series IEC 60811	Insulating and sheathing materials of electric and optical fibre cables – Common test methods	
IEC 60840 HD 632	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (U_m 36 kV) up to 150 kV (U_m 170 kV) – Test methods and requirements	SS 4241717
EN 60885 Series	Electrical test methods of electrical cables	

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VTR14-05E_3-core submarine cables 36-170 kV and accessories

Summary
Technical guideline for XLPE-insulated 150 kV submarine cables with 3 cores and their accessories.

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1 General

This Technical Guideline (VTR) shall be used as a complement to each of the valid standards IEC, EN, HD and DIN.
Health and safety data sheets shall be handed over for all material used unless they are clearly environmentally friendly.
Drawings of design of the cable and assembly drawings for the used terminations and joints shall be handed over by the supplier.
These drawings will be handled confidentially by the customer.

References to standards:

- **DIN-VDE 0276-632:**

Starkstromkabel mit extrudierter Isolierung und ihre Garnituren für Nennspannungen über 36kV bis 150kV.

- **IEC 60840 (SS 4241417):**

Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) –
Test methods and requirements.

- **Cigré Electra Nr.171 April 1997:**

Recommendations for Mechanical Tests on Submarine Cables.

- **Cigre TB 490 February 2012:**

Recommendations for Testing of Long AC Submarine Cables with Extruded Insulation for System Voltage above 30 (36) to 500 (550) kV.

2 Net conditions

The cable and the accessories shall be suitable for operation on an AC system (50 Hz) with insulated neutral point, with earth fault compensation or low resistance neutral point earthing.

3 Voltage levels

This Technical Guideline is applicable for a three core submarine cable having an insulation of cross-linked polyethylene and the accessories (joints and terminations).

- U_m = 36-170 kV (Maximum operating voltage)

4 Design and use

The conductor shall be of type round, stranded and compacted copper or aluminium.

In order to limit the field strength, the cable shall have conductive layer over the conductor and over the insulation.

The layers shall be bonded to each other by a three layer extrusion. The extrusion shall be made by using a cross head for three extruders.

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Each core of the three core cable must be totally water blocked (radial and longitudinally). The test of radial and longitudinally water blocking shall be made by using salt water.

5 Identification

Every submarine cable must have an individual external sheath marking.

The customer shall be informed of all designations and markings.

The text must be of suitable size and be easy readable.

The submarine cable shall on every 100 m be marked on the external sheath with the manufacturing number, meter marking and manufacturer.

The marking shall be of a durable colour contrasting to the external sheath of the submarine cable.

The position of all manufacturer joints must be durably marked on the external sheath of the submarine cable.

6 Other design requirements of the cable

6.1 Core

The core i.e. the metallic conductor, conductor screen, insulation and the insulation screen shall meet the requirements in “VTR14-01_Cables 36-170 kV”.
All finished cores shall be degassed. The manufacturer shall hand over documents related to the degassing process and if applicable document from the measurement of the rest gas content.

6.2 Metal sheath (radial water blocking)

Each core shall have a metal sheath suitable for radial water blocking. Preferably the metal sheath shall consist of lead. All other types have to be discussed with the customer in advance. The metal sheath shall withstand the electrical and the mechanical stresses during short circuit and installation.
The nominal thickness (of the lead sheath) is 2.8 mm. The minimum value at any point may not be less than 2.6 mm.

6.3 Over sheath of each core

Each core must have an over sheath consisting of conductive PE. The nominal value of the thickness of the PE over sheath is 2.5 mm. The minimum value at any point may not be less than 2.0 mm.
The sheath shall be made by an extrusion process.
The over sheath of each core shall have the following marking: manufacturer’s identification, type, year of manufacture and the cable code number. The marking on the over sheath shall be repeated at an interval of minimum 100 cm.

6.4 Armouring, external protection sheath

A layer of PP-yarn has to be placed over the laid up cores and underneath the armouring.

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6.4.1 Armouring

In order to get mechanical protection a layer of galvanized steel wires embedded in bitumen are placed over the laid cores. Minimum diameter of wire is 5.5 mm.
The wire must cover the total surface of the cable.

6.4.2 External protection

The external protection shall consist of two layers of black PP-Yarn. The inner layer must be embedded in bitumen. The outer layer must have three coloured markings.

7 General test requirements

The nominal frequency for the test is 50 Hz. The frequency of the AC-test voltage shall be 20 Hz to 300 Hz unless another value has been decided. The voltage shall approximately have a sinusoidal waveform.

The ambient temperature during the test shall be 20±15 ^{o}C.

7.1 Cable testing

7.1.1 Routine test (electrical properties)

The tests will be carried out according to Table 1.
At least 30% of the tests shall be made during the presence of the customer.
The dates for these tests shall be agreed upon three weeks in advance.

The routine tests will be made on all manufactured cores, without factory joints, after the extrusion of the PE-sheath, but before the lay up of the cores and the application of the armoring.

If the cores are too long, alternative test conditions to the in Table 1 mentioned shall be agreed upon between the manufacturer and the customer. If factory joints are necessary, additional test of the total core length including joints after the extrusion of the PE-sheath, but before the armoring is applied, will be required.

In case the length of the finished core is too long alternative test conditions to the in Table 1 mentioned shall be agreed upon between the manufacturer and the customer.

7.1.2 Sample test

The tests shall be performed according to Table 2.
The sample test will be made on the finished core, before the joints of the single cores and before the lay up and the application of the reinforcement.

7.1.3 Frequency of the sample test

According to HD 632 but at least 30% during the presence of the customer.
The dates for these tests shall be agreed upon three weeks in advance.
During the factory acceptance tests the results from the quality assurance and the documents from the factory internal routine and sample test shall be handed over to the costumer.

The routine and the sample tests according to Table 1 and 2 shall be made in presence of the customer. Samples shall be cut from the selected cores in presence of the customer. The number of samples shall in advance be stated by the customer.

A repeated test will be made according to the agreement in the individual case.

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7.1.4 Repeated sample tests

According to HD 632.

8 Type test of the cable

The procedure and test set-up as well as the selection of accessories shall be accepted by the customer before the start of the type test. The proof of a successful execution of the type test made by an accredited testing station and the results shall be handed over to the customer. The customer reserves the right to be present at the type test.

8.1 Type test (electrical properties)

The tests shall be made according to Table 3. The tests stated in the table shall be made on one piece of cable and follow the sequence given. The length of the cable must at least be 30 m without accessories. The length of the cable between the accessories must at least be 10 m.
The type test shall basically be carried out as a system test with accessories and controlled by an accredited testing station.

The procedure and test set-up as well as the selection of accessories shall be accepted by the customer before the start of the type test.

The test shall include a single core of the submarine cable to be bending tested according to IEC 60840.

After the completed type test, the cable shall be visually inspected.

8.1.1 Type test (non-electrical properties)

The tests shall be made according to Table 4.

8.1.2 Repeated type tests

-In case the included types of accessories for type test and system test requires an additional test set up, the type test will regarded as approved when the two test set ups and all the required tests are successfully made.
- According to HD 632.

9 Clearing test

Cylindrical beakers of sufficient size, clear and clean silicone oil, and a suitable light source (area lighting) shall be used for the clearing test. The test shall be carried out in silicone oil.

The axial test sample shall have a length of 250 mm or more. The outer semi-conductive layer shall be removed in such a way that only a very small amount of the insulation is removed.
Furthermore, radial test samples with an outer semi-conductive layer but without a conductor shall be produced. The length should be 100 mm or more. The visible surfaces of the insulation shall be prepared in such a way that clear view into the insulation is possible.
Clearing tests shall be carried out on both ends of each core and shall be documented. The test reports shall be handed over to the customer prior to delivery.

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If the clearing test shows abnormalities more tests shall be carried out. The number of tests shall be agreed upon between the customer and the manufacturer. However, the minimum number of test samples which have to be subjected to further clearing tests is three.

10 Requirements for accessories

10.1 Type of accessories

For terminations or joints (for XLPE sub marine cables and XLPE cables in ground) only pre-fabricated, slip-on joints or stress cones are allowed.
By routine test of the pre-fabricated sleeve-bodies, cast resin bodies and stress cones the non-existing partial discharges (pd) shall be checked (no recognizable pd from the sample).
Joints, factory joints and repair joints shall be included in the type test of the sub marine cable.

For all joints the salt water resistance according to the type test shall be proven.

All other accessories and their components have to be salt water resistant.

The manufacturer has to show that this has been effected.

10.2 Routine test of accessories

All manufactured pre-testable joints, cast resin bodies and stress cones for the terminations shall be tested in the presence of the customer.
The routine tests has to be performed according to Table 5.

11 Type tests for accessories (electrical properties) terminations and joints (XLPE sub marine cable/XLPE ground cable)

11.1 General

All accessories have to be routine tested according to Table 5 before the start of the type test.

The type tests of the accessories shall be made according to Table 6.

This test shall be made on a sample in the sequence stated.

The accessories shall be mounted on a cable having a design in principle corresponding to “Technical guideline 3 core sub marine cable 170 kV”.

For joints (sub marine cable/cable in ground) additional type test of a sample having a design corresponding to “VTR14-01_Cables 36-170 kV” shall be included.

Type test of accessories may be made together with the type test of the cable.

After completion of the type test a visual check of the cable and the accessories will be made.

Factory joints will be cut open and checked for alterations.

All other accessories will be dismantled and checked for alterations.

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11.2 Tightness test with load cycles and DC-voltage test of the external protection of the joints

In order to verify the tightness of a joint it will be subjected to a load cycle consisting of 10 cycles in air and 10 cycles in water. The test may be made together with the load cycle test according to Table 6, section 4.1.

In a separate test the mounted joint will be tested for tightness during a 20 cycle's heat cycle test in water. The water will then be heated to 70^{o}C and kept at this temperature for at least 5 hours. Finally follows a cooling down of the water to ambient temperature +10K.

During the water test a water pressure of 1 m water column is applied. The test shall be made in such a way that the water pressure is applied on every seal of the external protection.

I connection with the load cycle test a DC voltage of 20 kV will be applied during 1 min on the sample cooled down to room temperature. The voltage will be applied to the metallic screen of the cable and to an electrode connected to the common external surface of the joint.

11.3 Repeated type test

According to HD 632

12 On-site testing of cable system

This test is made when the cable system (cable and accessories) is completely assembled and when after a ready statement for the operation of the system. The customer will take the cost.

12.1 Test of insulation

The test requirements are:

Test voltage	2.0 U_o
Duration of test	30 Minutes
Voltage frequency	20 – 300 Hz

Alternative: 1.7 U_0 ,60 Minutes

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13 Test tables 1 to 6

Table 1 Routine test of XLPE submarine cable

Table 2 Sample test of XLPE submarine cable

Table 3 Type test of XLPE submarine cable (electrical properties)

Table 4 Type test of XLPE submarine cable (none electrical properties)

Table 5 Routine test of pre-fabricated accessories and pre-testable parts of accessories

Table 6 Type test of accessories for XLPE cable (electrical properties)

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Table 1: Routine test of XLPE submarine cable

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence	Section 2 to 5 of this table	
2	Voltage test -Sample from factory length -Test voltage 2.5 U_0 -Test duration 30 minutes	No break down	HD 605, Section 3.2.1, (SS 424 14 19)
3	Partial discharge test * -Sample: factory length -Admissible noise level ≤1 pC -Calibration pulse 2 pC -Power-frequency test voltage 2 U_o	No noticeable internal partial discharge from the sample	EN 60885-3, (IEC 60885)
4	Conductor resistance	HD 632, (SS 424 14 17)	HD 383, (SS 424 14 08) HD 605 Section 3.1.1, (SS 424 14 19)
5	Capacitance	HD 632	DIN VDE 0472 Teil 5, Prüfart B

Standards/norms referred to in the tables within brackets are corresponding Swedish Standard SS or IEC-standard.

Note:

The partial discharge test shall be carried out directly after completion of the voltage test during voltage reduction.

* In case the tested single length / complete length is too long alternative test parameters have to be agreed upon between the manufacturer and the customer.

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Table 2: Sample test of XLPE submarine cable

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Conductor design	HD 632 VTR* Sect. 6.1	EN 60811-1-1 Section 8.3 and visual inspection
2	Conductor screening - Wall thickness - Irregularities - Wall thickness uniformity	 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1	 EN 60811-1-1 EN 60811-1-1
3	Insulation - Design - Wall thickness - Minimum wall thickness - Wall thickness uniformity - Irregularities - Clearing test - Thermal expansion behaviour	 HD 620 Part 1, Table 2 A, DIX 8 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 9 HD 632	 EN 60811-1-1 EN 60811-1-1 EN 60811-1-1 HD 605/A1 Section 2.110.2 EN 60811-2-1 Section 9
4	Insulation screening - Wall thickness - Irregularities - Wall thickness uniformity	 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1	 EN 60811-1-1 EN 60811-1-1
5	Metal sheath (radial water blocking) •Wall thickness	 VTR Sect. 6.2 IEC 60840	 HD 605 2.1.5
6	Over sheath, of each core - Wall thickness - Minimum wall thickness - Marking	 VTR Sect. 6.3 VTR Sect. 6.3 VTR Sect. 6.3	 EN 60811-1-1 EN 60811-1-1 Visual test

* VTR refers to sections in this document

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Table 3: Type test of XLPE submarine cable (Electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence - Sample: Complete cable about 30 m	Section 2 to 5 of this table	
2	Pulling and bending test Bending test of the individual core Bending test -Bending diameter 20*(d+D)+5 % D = outer diam. actual value d = conductor diam., actual value	 IEC 60840	WG 21.02 Cigré Electra Nr. 171 Sect. 2.2 HD 605 Section 2.4.1
2.2 2.3	Rated power frequency voltage withstand test - AC test voltage 2.5 U_o -Test duration 1 minute Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	 No breakdown No noticeable internal partial discharge from the sample	HD 605 Section 3.2.1 EN 60885-3

Cont.

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
3	Load change test followed by partial discharge test		
3.1	Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^{o}K above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Power freq. test voltage 2.5 U_o -Number of cycles 20		
4	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3

Cont....

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
5	Impulse voltage test in combination with AC voltage test		
5.1	Flash and switching impulse voltage test - Heating by conductor heating to 5-10 ^{o}K above the admissible conductor temperature, keeping it at this temperature for a minimum of 2 hours Flash voltage level acc. To Table A -Number of impulses •10 impulses of positive polarity •10 impulses of negative polarity	No breakdown	EN 60230
5.2	Voltage test - Test voltage 2.5 U_o - Duration of test 4 hours	No breakdown	HD 605 Sect. 3.2.1
6	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2 U_o	No noticeable internal partial discharge from the sample	EN 60885-3
7	Tests of factory joints	WG. 21.02 (AC cable) Cigré TB 490 Sect. 6.4	
8	Visual inspection of cable and accessories	WG 21.02 Cigré Electra No. 171 Sect. 2.2.3	EN 60811-1-3 Section 10

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Table 4: Type tests of XLPE-submarine cable (Non-electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Water blocking test	Cigré TB 490 Sect. 8.7	Cigré TB 490 Sect. 8.7
2 2.1	Tests on the insulation Mechanical properties a) before ageing b) after ageing in heat chamber	 HD 620, Part 1 Table 2 A, DIX 8 HD 620, Part 1 Table 2 A, DIX 8	 EN 60811-1-1 Section 9 EN 60811-1-1 Section 8
3 3.1	Tests of cores Shrinkage test	HD 620 Part 1 Table 2 A, DIX 8	EN 60811-1-3 Section 10
4 4.1	Tests of external PE-sheath Mechanical properties a) Before ageing b) After ageing in a heat chamber	 HD 620, Part 1 Table 4 B, DMP 2 HD 620, Part 1 Table 4 B, DMP 2	 EN 60811-1-1 Section 9 EN 60811-1-2 Section 8
4.2	Resistance to pressure at high temperatures	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-3-1 Section 8.2
4.3	Cracking resistance	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-4-1 Test method B, However duration 1000 hours
	Shore-D hardness of PE outer sheath	Minimum 48	HD 605 Sect. 2.2.1
5 5.1	Tests of the complete cable Ageing of the complete cable	 HD 620, Part 1 Table 2 A, DIX 8 Table 2 B, DMP 2	 EN 60811-1-1 Section 9 EN 60811-1-2 Section 8

Cont....

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Cont...

6	Conductor design	HD 632 VTR Sect. 6.1	EN 60811-1-1 Section 8.3 and visual inspection
7	Conductor screening •Wall thickness •Irregularities •Conductivity	 VTR Sect. 6.1 VTR Sect. 6.1 HD 632	 EN 60811-1-1 EN 60811-1-1 HD 605
8	Insulation •Design •Wall thickness •Minimum wall thickness •Wall thickness uniformity •Irregularities •Clearing test •Thermal expansion behaviour	 HD 620, Part 1 Table 2 A, DIX 8 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 6.1 VTR Sect. 9 HD 632	 EN 60811-1-1 EN 60811-1-1 EN 60811-1-1 HD 605/A1 Sect. 2.1.10 EN 60811-2-1 Sect. 9
9	Insulation screening •Wall thickness •Wall thickness uniformity •Conductivity	 VTR Sect.6.1 VTR Sect. 6.1 HD 632	 EN 60811-1-1 EN 60811-1-1 HD 605
10	Metal sheath (radial water blocking)	VTR Sect. 6.2 HD IEC 60840	HD 605 2.1.5
11	PE outer sheath •Wall thickness •Minimum wall thickness •Marking	 VTR Sect. 6.3 VTR Sect. 6.3 VTR Sect. 6.3	 EN 60811-1-1 EN 60811-1-1 Visual inspection
12	Armouring, external protection sheath	VTR Sect. 6.4 IEC 60502-2	HD 605 2.3.2 2.4.2

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Table 5: Routine test of pre-fabricated accessories and pre-testable parts of accessories

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Visual inspection	No noticeable deviations from requirements	
2	Voltage test - Level of calibration pulses 2 pC - Test voltage 2.5 U_o - Duration of test 15 min - Acceptable noise level ≤1 pC Immediately followed by: - Voltage level increase 3 Uo - Duration of increase 1 min - Voltage test 2.5 Uo - Duration of test 1 min - Acceptable noise level ≤1 pC	 No break down No noticeable internal partial discharges in tested sample	EN 60885-3
3	Visual inspection	Tested sample cleaned and free of grease; No noticeable deviations from requirements	EN 60885-3

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Table 6: Type test of accessories for XLPE cable (Electrical properties)

	1	2	3
	Tests	**Requirements**	**Test methods**
1	Test sequence	Sect. 2 to 7 of this table	
2	Rated power frequency voltage withstand test - AC test voltage 2.5 U_o - Test duration 1 minutes	No breakdown	HD 605 Sect. 3.2.1
3	Partial discharge test -Calibration pulse level 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3
4 4.1	Load change test followed by partial discharge test Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^oK above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Power freq. test voltage 2.5 U_o -Number of cycles in water 10 -Number of cycles in air 10	No noticeable internal partial discharge from the sample	
4.2	Partial discharge test -Calibration pulse 2 pC -Admissible noise level ≤ 1 pC -Power freq. test voltage 2.5 U_o		EN 60885-3

Cont....

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
5	Impulse voltage test followed by AC voltage test		
5.1	Flash voltage test - Heating the sample to 5-10 °K above the admissible conductor temperature by conductor heating, keeping it at this temperature for a minimum of 2 hours Flash voltage level acc. To Table A - No of flashes 10 flashes of positive polarity 10 flashes of negative polarity	 No breakdown	EN 60230
5.2	Voltage test - AC voltage test 2.5 Uo - duration of test 4 hours	No breakdown	HD 605 Sect. 3.2.1
6	Partial discharge test -Calibration pulse level 2 pC -Admissible noise level ≤ 1 pC Power freq. test voltage 2.5 U_o	No noticeable internal partial discharge from the sample	EN 60885-3

Cont....

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Cont....

	1	2	3
	Tests	**Requirements**	**Test methods**
7	Water blocking of joints The joint will be tested by a load change test in water. All sealing areas of the joint shall be subjected to a water column of 1 m when positioned in water		
7.1	Load change test -Heating the sample by conductor heating -Heating cycle: 24 hours Heating up to 5-10 ^{o}K above the admissible conductor temperature for 8 hours, keeping it at this temperature a minimum of 2 hours, cooling down for 16 hours -Number of cycles in air 10 -Number of cycles in water 10		
7.2	20 heating cycles in water 70 C^{o}	IEC 60840	IEC 60840
7.3	Voltage test - DC voltage test 20 kV - Duration of test 1 min	No breakdown	HD 605 Sect. 3.2.1

Reference:

During the test of the joints, the heating current used shall be for the lowest admissible conductor temperature.

***** The test can be made on a separate sample of similar design.

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14 Reference list

International standard	Title	Corresponding national standard
EN 60228 IEC 60228	Conductors of insulated cables	SS-IEC 4241408
IEC 60229 EN 60229	Test on cable over sheaths which have a special protective function and are applied by extrusion	SS-IEC4241416
EN 60230 IEC 60230	Impulse tests on cables and their accessories	
EN 60332 IEC 60332	Test on electric and optical fibre cables under fire conditions	
IEC 60502-2 HD 620 HD 605	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) - Part 2: Cables for rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)	SS 4241416 SS 4241419
EN 60811 Series IEC 60811	Insulating and sheathing materials of electric and optical fibre cables – Common test methods	
IEC 60840 HD 632	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (U_m 36 kV) up to 150 kV (U_m 170 kV) – Test methods and requirements	SS 4241717
EN 60885 Series	Electrical test methods of electrical cables	

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Technical specification:

Covered conductors for overhead lines not exceeding 24 kV

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1 Purpose

The purpose of this document is to be used as technical specification for covered conductors of rated voltages above 1kV and not exceeding 24 kV within Vattenfall Eldistribution AB.

2 Validity

This technical specification is valid within Vattenfall Eldistribution AB.

3 Responsibility

Responsible for this document is Network Technology (DS-ST).

4 Security inspection

C1 – Open information

5 Introduction

This technical specification is mainly based on EN 50397 and EN 50182. The specification can be made binding by the purchaser and will then specify the requirements which together with applicable standards are valid for design, construction and testing.

This document has been approved as suitable support for purchase within framework agreements.

6 Types and design

Type	Covered conductors for overhead lines.
Rated voltage	24 kV
Standard code for covered conductors	Conductors shall be designed according to the following standard codes: - CCST 54-AL1 / 9-ST1A W - CCST 85-AL1 / 14-ST1A W - CCST 159-AL7 W [1] - CCST 241AL7 W
Conductor design	Round stranded. Conductors shall be without welding points.
Conductor screen	Semiconducting conductor screen
Insulation material	PE
Water blocking	Longitudinal water blocked

7 Standards

Cables shall fulfill the following standards according to type (latest version including amendments applies). Additional standards are quoted in text.

General	EN 50397-series Covered conductors for overhead lines and the related accessories for rated voltages above 1 kV a.c. and not exceeding 36 kV a.c.
Conductors	EN 50182 Conductors for overhead lines – Round wire concentric lay stranded conductors

[1] Note that this code has been changed. The old code was 157, but electrical and mechanical data are unchanged.

8 General

Installation temperature	Minimum installation temperature shall not exceed: -10°C under normal conditions of care. -20°C with special care in handling and with only moderate bending radius.
Drums and logistics	The supplier shall indicate type of drums and logistics solution.
Heat treatment of wooden packaging	Wooden packaging, such as drums, shall be approved and marked according to the ISPM 15 standard[2] if the cable and/or packaging are imported from outside the European Union.
European directives and regulations	Cables shall fulfill all applicable European directives and regulations. This includes, but are not limited to: - Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)[3]

[2] International Standards For Phytosanitary Measures No. 15 (ISPM 15) issued by the International Plant Protection Convention (IPPC)

[3] REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

9 Testing

Routine, sample and type test

According to EN 50397-1.

Sample tests shall be conducted on every 20th drum or 10 km.

Vattenfall's representative shall be invited to participate during type testing.

10 Documentation

Language

All documentation shall be in Swedish or English.

Data sheets

Data sheets for each covered conductor type shall be included in tender. The data sheet shall include information on:

- Three dimensional drawing of the covered conductor
- Voltage
- Conductor type
- Conductor screen
- Insulation
- Outer diameter
- Weight
- Minimum bending radius
- Maximum pulling force
- Resistance
- Maximum short circuit current (1 s)
- Minimum temperature for installation
- Maximum continuous temperature
- Standard drum type
- Length per drum

Test protocols

Test protocols from type- and sample tests shall be delivered and accepted before first cable delivery.

Material safety data sheet

A material safety data sheet shall be submitted together with tender for each cable type. The data sheet shall be structured according to REACH (16 sections).

Additional documentation

Additional documentation can be requested during pre-qualification and/or tendering.

11 Communication

This document shall be communicated to Procurement.

1 - 30 kV cables with PVC or cross-linked polyethylene insulation

Technical Description - KG4073

Vattenfall Europe Berlin Aktiengesellschaft & Co. KG
Netzservice
Puschkinallee 52
12435 Berlin

info@vattenfall.de
www.vattenfall.de

TECHNICAL DESCRIPTION KG4073

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COORDINATOR
L-AB / L-AH / NB

PUBLISHER
Volkmar Ulewski

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1 - 30 kV cables with PVC or cross-linked polyethylene insulation

1 Changes and revisions

None

2 General points

This Technical Description (TB) is intended for use as a supplement to the applicable versions of the DIN VDE provisions and the DIN standards.

This version replaces all previous issues of the Vattenfall Europe Berlin, Vattenfall Europe Hamburg and WEMAG requirements for 1 - 30 kV cables with PVC or cross-linked polyethylene insulation.

3 Scope of application

The Technical Description applies to 1, 10, 20 and 30 kV cables with PVC or cross-linked polyethylene insulation.

3.1 1 kV PVC cables

NAYY-J 4 x 35 re

NAYY-J 4 x 95 se

NAYY-J 4 x 240 se

3.2 1 kV cross-linked polyethylene cables

NA2XY-J 4 x 150 se

3.3 10 kV cross-linked polyethylene cables

NA2XS2Y 1 x 240 rm or re / 25

NA2XS2Y 3x1 x 240 rm or re / 25, stranded

NA2XS(F)2Y 1 x 150 rm / 25

NA2XS(F)2Y 3x1 x 150 rm / 25, stranded

NA2XS(F)2Y 1 x 240 rm / 25

NA2XS(F)2Y 3x1 x 240 rm / 25, stranded

3.4 20 kV cross-linked polyethylene cables

NA2XS(F)2Y 1x120 rm / 16

NA2XS(F)2Y 1x240 rm / 25

3.5 30 kV cross-linked polyethylene cables

N2XS(F)2Y 1x150 rm / 25

4 General requirements

4.1 Technical acceptance of cables

The supplier must give due advance notice of the delivery of the cables for acceptance and approval
(Vattenfall Europe Berlin: 3 weeks).

4.2 Transport and storage of cables

The following requirements must be met in addition to DIN VDE 0276, Parts 603 and 620:

The starts and ends of the cables must be sealed with watertight shrink-fit caps which are coated with adhesive and must be sufficiently secured to the shipping drum. The inner cable end must not be routed out of the side of the drum disk but should be secured on a continuous screw. Only drums conforming to DIN EN 46391 are to be used. The following information must be affixed to the shipping drum in a watertight and clearly legible manner: exact cable designation, cross section (conductor, screen), voltage, cable length, drum number and direction of rotation of drum.

5 Technical requirements

5.1 Technical requirements for cables with PVC insulation, rated voltage 1 kV

5.1.1 The cables must conform to DIN VDE 0276-603.

5.1.2 Additional requirements:

Conductor:	Without welding points.
Core sheath:	It must be possible to remove the common core sheath for the extruded version and the fillers from the conductor insulation easily without leaving any residues, including after aging in the warming cabinet according to DIN VDE 0276-603, Table 1. No stripping agents are permitted.
Strand length:	For NAYY-J 4 x 35 re: 0.5 m to 0.8 m For NAYY-J 4 x 95 se: 0.8 m to 1.2 m For NAYY-J 4 x 240 se: 1.0 m to 1.5 m
Filler:	Non-hygroscopic and rubbery-elastic, free from stripping agents; must be removable without tools.

5.2 Requirements for cables with cross-linked polyethylene insulation, rated voltage 1 kV

5.2.1 The cables must conform to DIN VDE 0276-603.

5.2.2 Additional requirements:

Conductor:	Without welding points.
Insulation:	Free from separating agents, capable of adhesion to PUR resins through modification (cf. 5.5.1), stripping possible after thermal aging (cf. 5.5.2), with conductor cross section of 150 mm² max. thickness of insulating wall 2 mm (single value).
Cores:	Winding with tape permissible, must be removable without tools.
Strand length:	With conductor cross section of 150 mm^2 1.0 m - 1.5 m.
Core sheath:	It must be possible to remove the common core sheath for the extruded version and the fillers from the conductor insulation easily without leaving any residues, including after thermal aging in the warming cabinet (cf. 5.5.2).
Filler:	Non-hygroscopic and rubbery-elastic, free from stripping agents; must be removable without tools.

5.3 Requirements for cables with cross-linked polyethylene insulation, rated voltage 10 - 30 kV

5.3.1 The cables must conform to DIN VDE 0276-620.

5.3.2 Additional requirements:

Insulation:	Cross-linked dry, inner screen, insulation and outer screen triple-extruded and permanently bonded.
Longitudinal watertightness:	For versions with longitudinal watertightness: Longitudinal watertightness in the screen area must be verified by testing for conformity with DIN VDE 0276-605, section 2.4.9.3 f, and HD 605, note 3.
Strand length:	On delivery in stranded version 1.2 m - 1.6 m.

Type tests must be carried out according to DIN VDE 0276-620 and the test reports submitted to the customer. The results of the long-term aging tests must be submitted to the customer annually.

5.4 Markings

Outer sheath:	The outer sheath must be marked with the following information: VDE test mark, manufacturer, year of manufacture, model code, rated voltage, cross section (conductor and screen) and embossing of length in metres. In addition, a cable code number that can be used to trace all manufacturing processes must be embossed on the sheath.

5.5 Special tests

5.5.1 Evidence of adhesion capability

Table 1: Test requirements

Seq-uence	Test procedures according to HD 628 S1 and DIN VDE 0278-623	Test statistics	Analysis
1	AC voltage test in air, section 6.6.4	Test voltage: 4 kV Test duration: 1 min.	No breakdown
2	Alternating load test in air, section 6.6.8	Mean heater current 335 A Heating time: 5 hours Cooling time: 3 hours Number of load changes: 63	No breakdown
3	Thermal short-circuit strength, HD 628 S1 section 11	Test current: acc. to HD 628 S1 section 11 Short-circuit current: 14.2 kA/1s Number of short circuits: 2 per conductor	No breakdown
4	Alternating load test in water, section 6.6.8	Mean heater current: 335 A Heating time: 5 hours Cooling time: 3 hours Number of load changes: 63	No breakdown
5	Testing of insulation resistance in water bath, section 6.6.7	Measuring DC voltage Ut= 1000 V	Insulation resistance ≥ 50 MΩ
6	AC voltage test in water bath, section 6.6.4	Test voltage: 4 kV Test duration: 1 min.	No breakdown

Table 2: Cables to be used for testing

Specifications	**Main conductor**	**Branch conductor**
Standard	DIN VDE 0276-603	DIN VDE 0276-603
Cable type	NA2XY-J	NAYY-J
Rated voltage	0.6/1 kV	0.6/1 kV
Material	Aluminium	Aluminium
Waveform	se	re
Cross section	150 mm²	35 mm²
Insulation	Cross-linked polyethylene	PVC
Sheath	PVC	PVC
Number of cores	4	4
Longitudinal watertightness	No	No
Main dimensions of cable	Compliant with VDE 0276-603	Compliant with VDE 0276-603

The test must be performed with **one** of the PUR casting compound housing combinations listed below:

Table 3: Fittings/casting compounds which can be used for testing

Manufacturer	**Fitting**	**Casting compound**
Höhne	HSM 260/130	PU 300
TECE	AM 130/260	PUR 260
Tyco/Jordan	MM5	Rapid 3010

5.5.2 Aging test in warming cabinet

Test requirement

The test cable should be 500 mm long. The test is to be conducted at a temperature of 100°C and for a period of 168 hours in accordance with DIN VDE 0276-603, Table 2A.

Analysis

Once the test cables have cooled down, these must be shortened to a length of 160 mm from the middle of the cable.
To spread the cores, it must be possible to drive in an insulating wedge by hand at an angle of 90° centrically to the longitudinal axis of the cable for working when the cable is in operation.

The test is regarded to have been passed if:

- the core insulation is not damaged;
- the rubbery-elastic filling can be removed without the use of tools and without leaving residues;
- there are no cracks (embrittlement) in the core sheath.

6 Approval

Prior to use in the distribution network, cables must be approved by the relevant departments (Vattenfall Europe Berlin, Vattenfall Europe Hamburg, WEMAG).

	Issued:	Checked:	Approved:
Date:	12.08.2005	12.08.2005	12.08.2005
Name:	Volkmar Ulewski	Dietmar Obst	Frank Michelsen

	Approved:	Signed off:
Date:	12.08.2005	12.08.2005
Name:	Jürgen Lembke	Claus-Georg Henningsen

Appendix dated 03.09.2012

Additions to KG4073

1. General points

This appendix is supplementary to Technical Description KG4073 (Version 1_12.08.2005) and must be applied together with this specification and observed during manufacture!

2. 10 kV cross-linked polyethylene cables

The following 10 kV cross-linked polyethylene cable types (cf. KG4073 section 3.3.) are required:

NA2XS(F)2Y 1 x 150 rm or re / 25

NA2XS(F)2Y 3x1 x 150 rm or re / 25, stranded

NA2XS(F)2Y 1 x 240 rm or re / 25

NA2XS(F)2Y 3x1 x 240 rm or re / 25, stranded

3. Tests on cables

3.1 Routine test

All routine tests on cables must be carried out in accordance with DIN VDE 0276-603 and DIN VDE 0276-620. Contrary to DIN VDE 0276-620, the following applies:

Measurement of partial discharge: Directly after the voltage test

Calibrating pulse 2 pC (calibration prior to voltage test)

Background noise level <= 1pC

Test voltage 3.5xUo (during voltage test)

or 2xUo (prior 20% increase in test voltage, 1 min. to 14.4 kV)

Duration 1 min.

Permissible noise level <= 1pC

Test reports must be submitted to the customer.

3.2 Sample test

All sample tests on cables (10% of delivery lengths) must be carried out in accordance with DIN VDE 0276-603 and DIN VDE 0276-620. The number of sample tests can increase for initial delivery or in the case of

defects. The number of sample tests must be agreed with the customer prior to initial delivery. Test reports must be submitted to the customer.

3.3 Acceptance in the plant

As a general rule, routine and sample tests are conducted on 10% of the delivery lengths in the plant in the presence of the customer. The full delivery length is tested on initial delivery. The number of tests is increased in the case of defects.

The schedule for acceptance and the scope of testing must be submitted to the customer in good time before the acceptance date.

The supplier must give the plant due notice of the delivery lengths scheduled for acceptance prior to delivery. A minimum notice period of four weeks applies in the case of Vattenfall Europe Netzservice GmbH - Berlin department.

4. Approval and delivery

The delivery lengths must be approved by the customer prior to delivery. The request for approval of the delivery or acceptance in the plant must be delivered at least four weeks prior to the planned delivery for Vattenfall Europe Netzservice GmbH - Berlin department.

5. Transport and storage of cables

The following requirements must be met in addition to DIN VDE 0276, Parts 603 and 620:

The starts and ends of the cables must be sealed with watertight shrink-fit caps which are coated with adhesive. The outer end must be secured with a V-shaped bracing so that the outer layers of the cables cannot come loose during transport. The inner cable end must not be routed out of the side of the drum disk but must be secured on a continuous screw.

The coil size must be agreed with the customer. The coil size must be adapted to the requisite delivery length so that damage to the outer cable layer is prevented. At least 1x the diameter of the cable or strand bundle must remain clear for the flange bearing surface.

Coils conforming to DIN EN 46391 must be used.

The following information must be specified on the sheets accompanying the coils on both sides of the flange in a watertight and clearly legible manner: delivery data, exact cable designation, cross section (conductor, screen), voltage, cable length, coil number and direction of rotation of coil.

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Volkmar Ulewski (CD-OHB)	Manager High-Voltage Grid Vattenfall Europe Netservice	Manager technical department SNB	Berlin 1	1 May 2014

110 KV CABLES AND FITTINGS

Summary

This technical description (TD) sets out the requirements that apply to assembly and testing of 110 kV cables with cross-linked polyethylene extruded insulation and their fittings.

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1 Amendments

All amendment notes from older versions are laid out in Annex V in the revision index, Table V-01.

Table 1-01 Overview of amendments

Version	
Section	Topic
Whole document	Converting KG4023 into TD3514

2 Purpose

This technical description sets out the desired nominal state for technical parameters and other equipment properties and should be applied to procedures for equipment procurement and approval.

3 Scope

This technical description shall apply for work within the companies below:

Stromnetz Berlin GmbH

Vattenfall Europe Netzservice GmbH

This TD replaces KG4023 "110 kV cables and their fittings".

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4 Supplementary documents

4.1 Regulations

None

4.2 Standards

This version of the TD should be used to supplement the relevant IEC, EN, HD and DIN VDE rules. The most recent version of the document in question is to be used for all undated references.

DIN VDE 0276-632-3 (+Part 4-D)	Power cables with extruded insulation and their fittings, for rated voltages above 36 kV (Um = 42 kV) up to 150 kV (Um = 170 kV)
DIN EN 60229 (VDE 0473-229)	Electric cables – Tests on extruded oversheaths with a special protective function

5 Copyright

Unless expressly stated otherwise, the contents of this technical description, as well as all images and drawings [tables, diagrams etc.] are copyrighted. They may not be fully or partially copied, distributed, edited or amended without the express prior written permission of Vattenfall Europe Netzservice GmbH and Stromnetz Berlin GmbH.

6 Parameters

Electrical parameters

The TD applies to single-core 110 kV cables with cross-linked polyethylene extruded insulation and their fittings (e.g. sleeves, connection terminals and outdoor cable terminations) with the following parameters:

- U_0/U = 64/110 kV (rated voltage)
- U_m = 123 kV (maximum voltage for equipment)
- U_{rB} = 550 kV (rated lightning surge voltage)
- $U_{??}$ = 230 kV (rated short-term AC voltage)
- I_a = 40 kA/1s (rated short-circuit current / rated short-circuit duration)

- $I_{??}$ = 100 kA (rated surge current)
- $I_{??}$ = 10 kA (earth fault current)

7 Authorisation

110 kV cables and their fittings may only be procured and used after successful completion of testing and approval by the technical department.

Manufacturers must notify the technical department of changes to the components or design of approved products. The testing required to obtain authorisation must be performed for any existing modifications. Any unnotified changes to the authorisation status will invalidate the authorisation.

8 Cable system requirements

8.1 Standard cables for the Berlin network

The conductor should be a stranded, compressed circular conductor.

The nominal cross sections for copper conductors are 300 mm², 630 mm² or 800 mm².

The nominal cross section for aluminium conductors is 1000 mm².

The copper sheath cross section (in the form of a geometric cross section of the shield wires and helix copper tape) is **35 mm²** and may only exceed these dimensions by max. 3.0 mm².

When using fibre optic cables (FOC) in the shield, a cross section of **50 mm²** may be required for structural reasons. In this case, all three conductors within the system (including those without FOC) must have a shield cross section of 50 mm².

Oversheaths with a special protective function

(optional, only provided at the client's specific request)

The cable sheath should be an oversheath with a special protective function according to DIN EN 60229 (VDE 0473-229) and shall be subject to the relevant tests. These tests must be documented and transmitted to the client accordingly.

Electrical tests after installation in line with DIN EN 60229 10 kV/1 min (Annex B to DIN EN 60229 Guidelines).

The oversheath should be an outer sleeve with a black, conductive covering. A graphitised version may not be used.

- Abbreviation: **>C<**

The PE cable sheath must be red (UV stabilised) .

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8.2 General fittings information

Only prefabricated, slip-on sleeve parts or stress cones may be used for cable terminations, connectors or sleeves.

This does not include the non-prefabricated oil side of transition sleeves for connecting XLPE cables with oil cables.

8.3 Standard fittings for the Berlin network

Due to the need to provide fittings and short supply recovery times in the case of a fault, only approved "standard fittings for the Berlin network" may be used in the case of a fault in the Berlin network.

8.3.1 Switchgear connection termination

The switchgear connection termination must have installation dimensions compatible with IEC 62271-209 (from Südkabel company type D) (voltage series 123 kV – 145 kV).

For conductor cross sections of up to 800 mm², the **plug contact** cross section must be **60 mm** (see Appendix 1).

Pure manufacturer systems (plug + socket) must be provided for conductor cross sections of 1000 mm² or over.

8.3.2 Outdoor cable termination with composite insulator

The Berlin Network uses composite insulators made of glass-fibre reinforced plastic (GRP) with cast-on, parallel (rather than screwed on) shields made out of electrical high-quality silicone rubber.

The minimum creepage distance is 2460 mm (equivalent to pollution layer class 2 under VDE 0111-2: 1997-09, Table 1).

8.3.3 Outdoor cable termination in air core design

The use of outdoor cable terminations in air core design with and without support (but with a support insulator) is only permitted with technical department approval and upon gaining type approval.

The minimum creepage distance is 2460 mm (equivalent to pollution layer class 2 under VDE 0111-2: 1997-09, Table 1).

8.3.4 Connection sleeves

Only prefabricated, silicone slip-on sleeve parts (one-piece or three-piece) may be used.

Glass fibre reinforced sleeves with integrated metal diffusion barriers must be used to protect against external damage and to act as water vapour barriers.

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8.4 Modifications to cables or fittings

In principal, no other designs (for cables or fittings) which diverge from that laid out in the type approval may be used. If modifications are necessary after type approval, the client and manufacturer must agree upon said changes before starting any bids for tender or production of equipment. For significant modifications, enough time must be set aside for a new type approval.

In order to avoid an additional type approval after this TD, the required product function checks may be carried out in conjunction with the technical department.

9 Cable design

9.1 Conductor

The conductor must conform with DIN EN 60228 .

The conductor design should be either that of a stranded, compressed circular conductor made from copper or aluminium, or a solid circular aluminium conductor (depending on client authorisation and request). To minimise skin effect, all conductors with cross sections of 1200 mm² or above should have a segmented conductor design with at least five segments.

There must be semi-conductive tape over the conductor.

9.2 Insulation

The insulation must be made out of single-layer extruded and cross-linked polyethylene compound. Only triple extruders may be used. The cross-linking must be dry and peroxydic.

An air separator and magnetic separator must be used when feeding in insulation.

9.2.1 Requirements for conductor insulation for conductor cross section of up to 800 mm²

In insulation for cables with conductor cross sections below or equal to 800 mm², the wall thickness must have a median and nominal value of 18.0 mm.

The minimum value may not be lower than 17.30 mm.

The ratio between maximum and minimum measured values must not exceed a ratio of 1.07 within one sectional plane.

T max / T min ≤ 1.07

9.2.2 Requirements for conductor insulation for conductor cross section of 1000 mm² or above

For cables with conductor materials made from aluminium, a median and nominal value of 16.0 mm applies for all cross sections of 1000 mm² or above.

The minimum value may not be lower than 15.4 mm.

The ratio between maximum and minimum measured values must not exceed a ratio of 1.07 within one sectional plane.

T max / T min ≤ 1.07

9.2.3 Additional insulation requirements

Measurement of individual values for insulation must ensure proper measuring and documentation of the thickest and thinnest point in the insulation. Additional measurements are to be carried out if more than six measurements (with 60° increments) are required in order to obtain these values.

Inner and outer conductive layers must be excluded when calculating the insulation layer thickness.

The insulating cover cross section may not be larger or smaller than the values below (necessary individual values for wall thickness measurement):

Cross section	**Min. diameter**	**Max. diameter**
300 mm²	58.00 mm	62.00 mm
630 mm²	68.50 mm	72.00 mm
800 mm²	73.00 mm	78.00 mm

9.2.4 Irregularities in the insulation

Irregularities in the insulating cover can only be tolerated when isolated (maximum of two per 250 mm sample length – irrespective of size). The following requirements apply:

- There cannot be any irregularities larger than 0.10 mm at their widest point.
- Irregularities smaller than 0.10 mm at their widest point must be inspected in conjunction with the client, then assessed and individually approved (regardless of the inspection results).
- Additional checks (follow-up tests) must be carried out if irregularities are discovered in the insulation. (See 10.4 Repetition of tests)
- Irregularities in the insulating cover must not extend into the inner conductive layer by more than 0.060 mm.

9.3 Conductive layers

Cables must have an inner conductive layer for field boundaries with the conductor, or an outer conductive layer for those with the insulating layer.

The conductive layers must be connected to the insulation via a triple extrusion. The extrusion must have a triple extrusion head.

The conductive layers must be made of an extruded, conductive polymer compound.

The conductive layer wall thickness must not be below 0.50 mm.

The difference between the highest and lowest values for wall thickness measurements must not exceed 0.80 mm (within one sectional plane).

9.3.1 Inner conductive layer

Contact cables under the inner conductive layer must establish electrical contact between the conductor and the inner conductive layer. The inner conductive layer must not extend so far into the outer wire layers of the conductor that they affect the boundary layer with the insulation.

There should not be any significant protrusions or indents on the inner conductive layer. Isolated irregularities can be tolerated if they are in line with the following:

- Irregularities on the inner conductive layer may not extend more than 0.060 mm into insulating cover.
- Irregularities with height h ≥ 0.040 mm must have a difference of ≥ 3 between the base (b) and height (h).
- Irregularities with height (h) smaller than 0.040 mm are not counted.

When exposed to the maximum authorised short-circuit force (Berlin = 40 kA/1s), the inner conductive layer and contact cables must not be affected in any way which would stop the cable from functioning properly.

9.3.2 Outer conductive layer

Shield wires may only extend very slightly into the outer conductive layer. This must not fall below the minimum required wall thickness (0.50 mm).

9.4 Wire

Degasification of manufactured wires must be performed in a suitable heating cabinet and documented. This log must be transmitted to the client. The log must include clear information on the starting point (date, time), end point (date, time) plus the temperature (measurements taken during this period). Furthermore, the relevant degasification work instruction must be provided.

9.5 Shield

The specific resistance for shield components must not exceed the following value: 0.01786 ohm x mm²/m at a temperature of 20°C.

Cables in the shield must be laid in a longitudinally and transversely watertight manner. Use of unbound swelling powder is prohibited. No toxic materials may be used to ensure longitudinal watertightness. The relevant material safety data sheets must be submitted.

The shield must consist of copper wires and one or two helix copper tape(s). The shield must be laid directly over the outer conductive layer binding.

The minimum required diameter for shield wires is 0.50 mm. The minimum thickness for helix copper tape is 0.10 mm. The following requirements apply to the amounts and dimensions of helix copper tape: either a helix copper tape with a diameter of minimum 1.00 mm² may be used, provided that the distance between two neighbouring tapes along the cable longitudinal axis does not exceed 4D, or two helix copper tapes with diameters of minimum 0.50 mm² may be used, provided that the distance between two neighbouring tapes does not exceed 2D (where D = constructed value for diameter under the shield).

The wires should be evenly distributed over the circumference. The average interval (based on measurements of five largest and smallest intervals over a circumference) between individual wires and any other metallic components (e.g. steel tubes for fibre optic cables) may not exceed 4.0 mm. The interval between individual wires and any other metallic components must never exceed 8.0 mm.

Permissible bends in shield wires may be ≥ 150°.

The shield cross section is calculated as a geometric cross section. At least 10% of the wires must be measured. The required shield cross section is calculated by adding the geometric cross sections of individual components (individual wires + helix copper tape; minus aluminium foil on the transversal water barrier).

9.6 Separation layer

There must be a suitable, **conductive** separation layer (semi-conductive tape) between the shield wires and the aluminium foil, acting as a transversal water barrier for the sheath.

When exposed to the maximum authorised short-circuit force, the separation layer must not be affected in any way which would prevent the cable from functioning properly (including impairment of longitudinal watertightness).

9.7 Oversheath

Compliant with DIN VDE 0276-632-3, Table 7, ST_7

9.7.1 PE-copolymer coated aluminium sheath

The oversheath must be an aluminium/polyethylene polymer coated sheath (Al/PE-copolymer coated aluminium = overlapping, metallic foil held in place by a PE sheath). It must be manufactured via an extrusion process. Use of other substances in order to obtain minimum wall thickness is prohibited, as is any removal of the sheath for a second extrusion. **The oversheath should not have a conductive layer unless specifically requested by the client.**

The median wall thickness for the PE-oversheath is 4.0 mm. The layer of aluminium foil should be excluded from the calculation of the oversheath wall thickness. At no point may the thickness be under the minimum limit of 3.3 mm.

The layer of aluminium foil must be excluded from the calculation of the sheath wall thickness.

9.7.2 Metallic foil

A longitudinally inserted layer of aluminium foil of at least 0.2 mm should be used.

The entire surface of the aluminium foil layer must be securely glued to the PE sheath. There must not be any air bubbles or creases.

The aluminium foil overlap must be at least 15 mm and must be securely glued across the whole surface without any creases.

There should not be any detached parts which have peeled off the aluminium foil overlap area. Individual peeled-off parts can be tolerated under the following circumstances:

- if the individual strips are of max. 1 mm
- if the wall thickness (as measured from the tip of the detached strip of aluminium foil on the PE sheath to the outside of the PE sheath) is not below the median wall thickness of the PE sheath.

9.7.3 Labelling on oversheath

Each cable oversheath must display the manufacturer name, the product model, description, date of manufacture, four-digit metre designation, an indication of the semi-conductive cable sheath and a cable code number. Labelling on the oversheath must be repeated at least every 100 cm.

All labelling, including metre designation, should be stamped onto the cable sheath (embossed or stamp-pressed).

Colour printing processes are not permissible. If the contractor justifies use of such a process when no other alternative is possible, then approval must first be obtained from the client's technical department before cable production commences. Proof that print labelling is resistant to abrasion (e.g. under DIN VDE 0276-605) must be assessed and documented so that the durability of printed labelling can be verified.

9.7.4 External diameter

The diameter across the oversheath must not exceed the following dimensions:

Conductor cross section	**Max. diameter**
300 mm²	76.0 mm
630 mm²	85.0 mm

800 mm²	90.0 mm

10 General test conditions

Ambient temperature during testing should be 15 to 25°C, unless agreed otherwise.

More specifically, the **following section of the standard on measuring resistance** should be used:

- **DIN VDE 0276-632-3; Section 10.5 – Measuring the electrical resistance of conductors and metal shields/sheaths.**

11 Tests on cables

11.1 Routine cable inspection and testing

Table 1 of this TD must be used for these tests, in addition to DIN VDE 0276-632-3.

11.2 Screening of cables

Table 2 of this TD must be used for these tests, in addition to DIN VDE 0276-632-3.

11.3 Official acceptance to be carried out with client present

Appointments for these tests must be made and agreed upon **at least eight weeks** in advance.

The client must be present for 30% of all routine inspection and testing.

A technical fact sheet including electrical characteristics must be submitted for approval.

The following electrical tests must be performed:

- voltage testing of cables on the cable delivery drum
- PD measurement
- measuring electrical resistance in the conductor and metal shield
- measuring capacity
- tan δ measurement
- sheath testing, where necessary.

Samples should be taken from cable ends for screening, with the client present. The following non-electrical screening tests are to be performed:

- assembly checks for cables (one sample from cable outer end – 1 m)

  - External diameter
  - coating (adherence)
  - position of shield wires, shield wire intervals, bends in shield wire
  - shield cross section, number of shield wires
  - diameter of outer conductive layer
  - conductor diameter, number of conductor wires
- measurement of conductor wire wall thickness (two samples from both cable ends)
- measurement of oversheath wall thickness (two samples from both cable ends)
- silicone transparency test (for every two axial and radial samples from both cable ends)
- thermal expansion/hot set test (two samples from both cable ends).

11.4 Repetition of tests

As specified in DIN VDE 0276-632-3.

If a sample fails the tests set out in DIN VDE 0276-632-3 and in this TD, the following steps should be taken:

As well as further samples taken from two other parts of the same batch, two additional samples should also be taken from the section which initially failed the tests, and tested according to DIN VDE 0276-632-3.

11.5 Type approvals

11.5.1 Type approval (electrical properties)

See Table 3 for details of tests to be carried out. The tests set out in this table are to be performed on a length of cable in the order specified. The cable length must be at least 20 m long without fittings, or should measure 10 m between the terminal and other fittings.

The cable length between (non-terminal) fittings must be at least 5 m long.

Type approval for cables must be performed as a system test including fittings. Section 12 in this TD also applies to fittings.

The selection of fittings must be carried out and agreed upon before commencing tests. All fittings included in the type approval process must first be subject to routine inspection and testing with the client present (as set out in Table 5) before commencing type approval.

The testing system should normally include two outdoor cable terminations, a CB sleeve and a (Vattenfall-standard) connector solution.

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11.5.2 Type approval (non-electrical properties)

See Table 4 of this TD for details of tests to be carried out.

11.5.3 Repetition of type approvals

As specified in DIN VDE 0276-632-3.

11.6 Silicone transparency test

The silicone transparency tests require sufficiently large, cylindrical beakers and clear, clean silicone oil as well as a suitable light source (evenly illuminated surface). The test is performed in silicone oil.

Axial test samples must be at least 300 mm long (with a minimum of 250 mm for the silicone oil for transparency test + 50 mm for rotation of sample in the oil). The outer conductive layer should be removed in a way which strips away as little insulation as possible. The person performing these tests must have suitable protective clothing made available to them (safety goggles, suitable gloves).

Furthermore, radial test samples with an outer conductive layer and without a conductor must be produced for testing. They must be at least 80 mm long. The visible surface of the insulation should be treated in a way which provides a clear, unobstructed view of the insulation.

Both ends of the cable on each drum should undergo a silicone transparency test, which is to be performed and documented. These logs must be sent to the client's technical department before delivery.

If any abnormalities are observed during the silicone transparency test then further tests must be performed. The client and contractor should agree upon the number of additional tests to be performed. However, at least three additional samples must be taken from the section of cable showing abnormalities for further silicone transparency tests. If abnormalities are still observed in these test samples, then the cable has failed the silicone transparency test and the cable section will not be approved.

12 Fitting requirements

12.1 Sleeve transverse watertightness

The sleeve must be an effective water vapour barrier with integrated metal diffusion barriers.

There must be an electrically conductive interconnection between this water vapour barrier and the cable shield.

12.2 Connecting the transversal water barrier and cable shield

Sleeves and terminals must have a current-conducting connection between the cable's metal (aluminium foil) transversal water barrier and the shield.

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13 Fitting tests

13.1 Routine inspection and testing of fittings

Routine inspection and testing of **all** prefabricated and pre-testable sleeves, cast resin parts and stress cones for terminals or connectors must be carried out with the client present.

Electrical strength and lack of partial discharge must be verified as part of routine electrical inspection and testing of prefabricated sleeves, cast resin parts and stress cones.

Inspection for any mechanical damage to sleeve parts and stress cones following the electrical tests can be carried out by visually checking the cleaned test units. No deviations from desired nominal state can be tolerated.

See Table 5 for details of routine inspection and testing to be carried out.

13.2 Type approval for fittings (electrical properties)

13.2.1 General

All fittings included in the type approval process must first be subject to routine inspection and testing with the client present (as set out in Table 5) before commencing type approval.

See Table 6 for details of tests to be carried out. The tests set out in this table are to be performed on a sample in the order specified.

The fittings are to be fitted onto a length of cable which should conform to "the technical description for 110 kV cables with cross-linked polyethylene insulation". There must be at least 5 m of cable separating the fittings.

Fitting type approval can be carried out at the same time as cable type approval.

In addition to electrical tests, all fittings must be taken apart and evaluated with the client present.

13.2.2 Leak tests using variable pressure and DC voltage tests for the sleeve outer protective jacket

Pressure cycling tests must be used to verify sleeve impermeability, with 20 cycles in the air and 20 cycles in water (water temperature at 70°C). This test can be combined with the pressure cycling tests under Table 6, Section 4.1.

The water pressure part of the test should involve the sleeve being exposed to water pressure in a 1 m water column. The test must be set up so that all sealed parts of the outer casing are subject to water pressure.

Following pressure cycling tests, the test cable length must be allowed to cool down to room temperature. Then DC voltage tests can be carried out, at 25 kV for a duration of 1 minute.

Voltage is applied between the cable shield and a counter electrode placed across the whole surface of the sleeve outer casing.

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13.2.3 Electrical strength of shield break for cross-bonding sleeves

See Table 6 Point 8 for details of tests to be carried out.

DC voltage tests and surge voltage tests must be carried out on the interval between cable shields on the cable ends to be connected (including outer conductive layers) and the outer casing surface, as well as between the conductive layers. Before these tests, the sleeve must undergo pressure cycling tests with 20 cycles in the air and 20 cycles in water (water temperature at 70°C). This pressure cycling test can be combined with the pressure cycling tests under Table 6, Section 4.1.

Surge voltage tests and subsequent DC voltage test are to be performed on the conductive layers and the surface of the outer sleeve casing.

The surge voltage test on the conductive layers (Table 6 Point 7.3.2) requires 10 surges each of both positive and negative polarity. Test voltage must be 75 kV.

DC voltage tests (Table 6 Point 7.3.1) are to be performed at 25 kV for a duration of 1 minute.

The surge voltage test (Table 6 Point 7.3.3) on the conductive layers and surface of the outer sleeve casing requires 10 surges each of both positive and negative polarity. Test voltage must be 37.5 kV. As part of this test, the cable sheath on the test section must also be tested. A suitable counter electrode must be applied to the cable sheath in order to do this.

DC voltage tests (Table 6 Point 7.3.1) are to be performed at 25 kV for a duration of 1 minute.

13.2.4 Repetition of type approvals

If the samples do not pass the tests set out in this technical description, the entire type approval shall be deemed to have been failed and must be repeated.

14 Geometry of the insulation connector

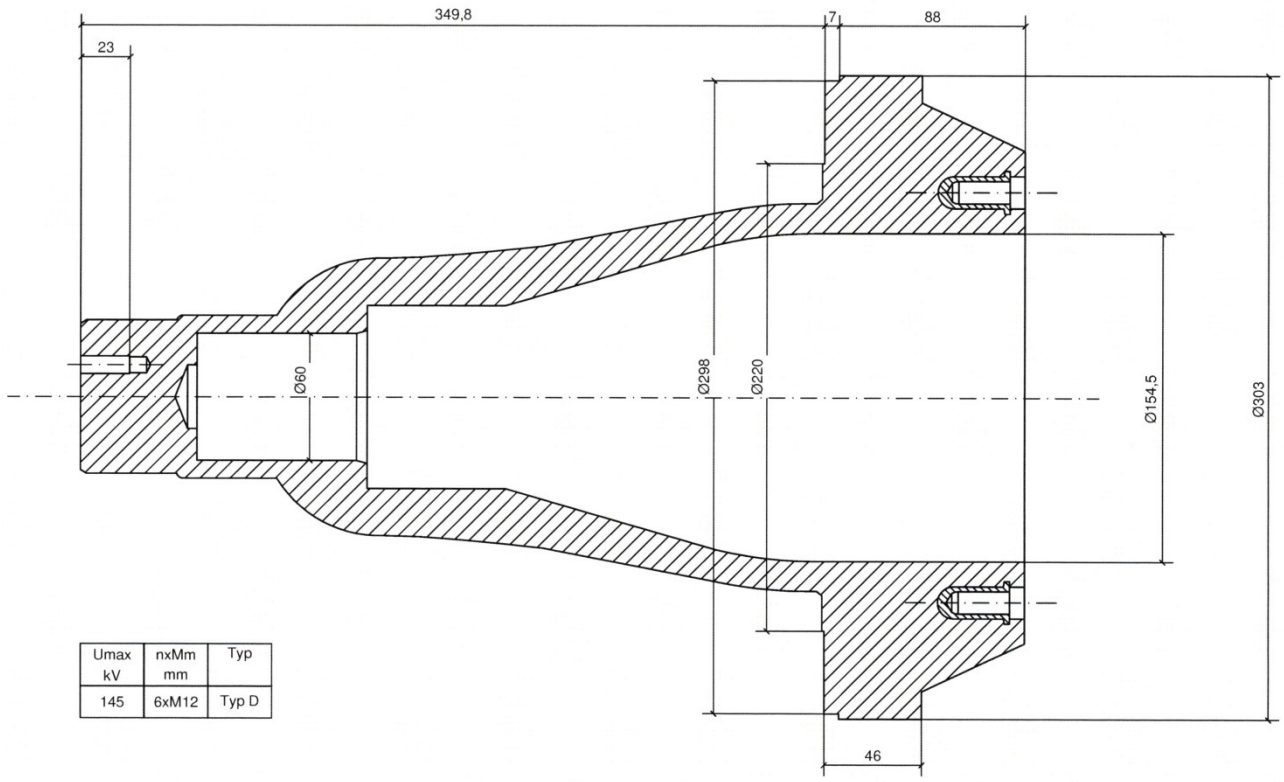


Illustration 14-1 *Geometry of the insulation connector*

Geometry of the insulation connector equipment for 110 kV SF6 switchgears and 110 kV transformers – layout drawing (excerpt from drawing 3-1-0257-1 dated 15 April 2013).

15 Test tables

15.1 Routine inspection and testing of 110 kV XLPE cables

Table 15-1 Routine inspection and testing of 110 kV XLPE cables

	Tests	Requirements	Testing method
1.	Order of tests	Sections 2 to 8 in this table	
2.	Electrical tests on oversheath without conductive layer	No disruptive breakdown	DIN EN 60229 Section 3.2
3.	Voltage test - Sample: delivery length - Test voltage 3.0 U_0 - Duration of testing 30 min.	No disruptive breakdown	DIN VDE 0276-632-3 Part 4-D
4.	Partial discharge test (to be performed immediately after test 3) - Sample: delivery length - Strength of calibration pulse 2 pC - Permissible interference level $\leq$1 pC - Test AC voltage 2.5 U_0	No partial discharge from test specimen observed	DIN VDE 0276-632-3 Part 4-D DIN EN 60885-3
5.	tan **δ** measurement	DIN VDE 0276-632-3 Table 3	DIN VDE 0276-632-3 Section 12.4.5
6.	Conductor resistance - Conductor - Shield	DIN EN 60228 Table 2 Table 2 Current TD, Section 9.5	DIN EN 60228 Section 5.3 Section 5.2
7.	Capacity	Manufacturer fact sheet	DIN VDE 0276-632-3 Section 10.10
8.	Electrical tests on oversheath with conductive layer	No disruptive breakdown	DIN EN 60229 Section 3.1

Note:

Testing for partial discharge test must be carried out immediately following the voltage test and during voltage reduction.

15.2 Screening of 110 kV XLPE cables

Table 15-2 Screening of 110 kV XLPE cables

	Tests	Requirements	Testing method
1.	Conductor - Number of individual wires - Diameter	DIN EN 60228 Current TD, Section 9.1	DIN EN 60228 Visual checks DIN VDE 0276-605
2.	Conductive layers - Wall thickness - Irregularities	 Current TD, Section 9.3 Current TD, Section 9.3	 DIN EN 60811-201 DIN VDE 0276-605 Section 2.1.10.2
3.	Insulation - Wall thickness - Diameter across insulating cover - Minimum wall thickness - Consistency of wall thickness - Irregularities/silicone transparency test - Thermal expansion/hot set test	 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 11.6 DIN VDE 0276-632-3	 DIN EN 60811-201 DIN EN 60811-203 DIN EN 60811-201 DIN EN 60811-201 Current TD, Section 11.6 DIN VDE 0276-605 Section 2.1.10.2 DIN EN 60811-507
4.	Shield - Measures and nominal cross section (geometric) - Shield wire intervals - Specific resistance of shield structure	 Current TD, Section 9.5 Current TD, Section 9.5 DIN VDE 0276-632-3	 DIN VDE 0276-605 DIN EN 60228
5.	Oversheath - Wall thickness - Minimum wall thickness - External diameter	 Current TD, Section 9.7 Current TD, Section 9.7 DIN VDE 0276-632-3 Current TD, Section 9.7	 DIN EN 60811-202 DIN EN 60811-202 DIN EN 60811-203
6.	Labelling	Current TD, Section 9.7	Visual checks

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15.3 Type approval for 110 kV XLPE cables (electrical properties)

Table 15-3 Type approval for 110 kV XLPE cables (electrical properties)

	Tests	Requirements	Testing method
1.	Order of tests - Sample: whole cable	Section 2 to 8 in this table	
2.	Bending testing followed by rated power frequency withstand voltage test and partial discharge test		
2.1	Bending testing - Bending diameter: 20 (d + D) +5% D = outer diameter, actual value d = conductor diameter, actual value		DIN VDE 0276-632-3
2.2	Rated power frequency withstand voltage test - Test AC voltage 230 kV - Duration of testing 1 min.	No disruptive breakdown	
2.3	Partial discharge test (ambient temperature) - Strength of calibration pulse 2 pC - Permissible interference level $\leq$1 pC - Test AC voltage 2.5 U_0	No partial discharges from test subject observed	DIN EN 60885-3
3.	tan δ measurement	DIN VDE 0276-632-3 Table 3	DIN VDE 0276-632-3 Section 12.4.5
4.	Pressure cycling tests followed by partial discharge test		
4.1	Pressure cycling test - Heating the sample via conductor heating - Heating cycle: 24 hours Heat sample for eight hours at 5 to 10 K above the permitted conductor temperature, maintaining this temperature for at least two hours before 16-hour cool-down - Test AC voltage 2.5 U_0 - Number of cycles 20		DIN VDE 0276-632-3 Part 4-D

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4.2	Partial discharge test - Strength of calibration pulse 2 pC - Permissible interference level ≤1 pC - Test AC voltage 2.5 U_0	No partial discharges from test subject observed	DIN VDE 0276-632-3 Part 4-D DIN EN 60885-3
5.	Surge voltage test followed by AC voltage test		
5.1	Lightning surge voltage test (at increased temperature) - Heat the sample at 5 to 10 K above the permitted conductor temperature, maintaining this temperature for at least two hours - Surge voltage amount 550 kV - Number of surges: - 10 surges of positive polarity - 10 surges of negative polarity	No disruptive breakdown	DIN VDE 0276-632-3 Part 4-D DIN EN 60230 DIN EN 60060
5.2	Voltage test - Test AC voltage 2.5 U_0 - Duration of testing 4 hours	No disruptive breakdown	DIN VDE 0276-632-3 Part 4-D
6.	Partial discharge test - Strength of calibration pulse 2 pC - Permissible interference level≤1 pC - Test voltage 2.5 U_0	No partial discharges from test subject observed	DIN VDE 0276-632-3 Part 4-D DIN EN 60885-3
7.	Testing the oversheath - DC Voltage 20 kV/1 min. - Surge voltage 37.5 kV - Number of surges - 10 surges of positive polarity - 10 surges of negative polarity	No disruptive breakdown No disruptive breakdown	DIN EN 60229
8.	Visual checks	DIN VDE 0276-632-3	DIN VDE 0276-632-3

15.4 Type approval for 110 kV XLPE cables (non-electrical properties)

Table 15-4 Type approval for 110 kV XLPE cables (non-electrical properties)

	Tests	Requirements	Testing method
1.	Tests on insulation		
1.1	Mechanical properties a) before ageing b) after ageing in heating cabinet	DIN VDE 0276-632-3	DIN EN 60811-501 DIN EN 60811-401
1.1	Contraction	DIN VDE 0276-632-3	DIN EN 60811-502
1.2	Thermal expansion/hot set test	DIN VDE 0276-632-3	DIN EN 60811-507
2.	Tests on oversheath		
2.1	Mechanical properties a) before ageing b) after ageing in heating cabinet	DIN VDE 0276-632-3	DIN EN 60811-501 DIN EN 60811-401
2.2	Heat/pressure resistance	DIN VDE 0276-632-3 DIN EN 60811-508	DIN EN 60811-508
2.3	Stress-fracture resistance	HD 620, Part 1 Table 4 B, DMP 2	EN 60811-406 Follow testing method B but change duration to 1000 h
2.4	Soot content	DIN VDE 0276-632-3	DIN EN 60811-605
2.5	Contraction test	DIN VDE 0276-632-3	DIN EN 60811-503
2.6	Test on PE-copolymer coated aluminium sheath	DIN VDE 0276-632-3 Annex F Current TD, Section 9.7	DIN VDE 0276-632-3 Annex F
3.	Ageing test on whole cable to verify compatibility of materials	DIN VDE 0276-632-3	DIN EN 60811-401
4.	Tests on whole cable		
4.1	Ageing across whole cable	DIN VDE 0276-632-3	DIN EN 60811-401
4.2	Shore type-D hardness of the PE sheath	HD 620, Part 1 Table 4 B, DMP 2	HD 605 Section 2.2.1

4.3	Water penetration test	DIN VDE 0276-632-3 Annex E **Along a cable length of 3 m rather than 6 m**	DIN VDE 0276-632-3 Annex E
5.	Review of cable assembly		
5.1	Conductor - Number of individual wires - Diameter	DIN EN 60228 Current TD, Section 9.1	DIN EN 60228 Visual checks DIN VDE 0276-605
5.2	Conductive layers - Wall thickness - Irregularities	 Current TD, Section 9.3 Current TD, Section 9.3	 DIN EN 60811-201 DIN VDE 0276-605 Section 2.1.10.2
5.3	Insulation - Wall thickness - Diameter across insulating cover - Minimum wall thickness - Consistency of wall thickness - Irregularities/silicone transparency test	 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 9.2 Current TD, Section 11.6	 DIN EN 60811-201 DIN EN 60811-203 DIN EN 60811-201 DIN EN 60811-201 Current TD, Section 11.6 DIN VDE 0276-605 Section 2.1.10.2
5.4	Shield - Measures and nominal cross section (geometric) - Shield wire intervals - Specific resistance of shield structure	 Current TD, Section 9.5 Current TD, Section 9.5 DIN VDE 0276-632-3	 DIN VDE 0276-605 DIN EN 60228
5.5	Oversheath - Wall thickness - Minimum wall thickness - External diameter	 Current TD, Section 9.7 Current TD, Section 9.7 DIN VDE 0276-632-3 Current TD, Section 9.7	 DIN EN 60811-202 DIN EN 60811-202 DIN EN 60811-203
5.6	Labelling	Current TD, Section 9.7	Visual checks

15.5 Routine inspection and testing of prefabricated fittings and pre-testable fittings parts

Table 15-5 Routine inspection and testing of prefabricated fittings and pre-testable fittings parts

	Tests	Requirements	Testing method
1.	Dimension checks and visual checks	No deviations from desired nominal state detected (e.g. dimensions, bumps, holes, loose parts, blemishes)	Measuring equipment Lamp Endoscope
2.	Voltage test - Test voltage 3.0 U_0 - Testing time 30 min. - Permissible interference level ≤1 pC	No disruptive breakdown	DIN VDE 0276-632-3
3.	Partial discharge test (to be performed immediately after test 3) - Strength of calibration pulse 2 pC - Test voltage 2.5 U_0 - Duration of testing 1 min. - Permissible interference level ≤1 pC	No partial discharges from test subject observed	DIN VDE 0276-632-3 DIN EN 60885-3
4.	Visual checks	- Test subject cleaned and degreased - No deviations from desired nominal state detected (e.g. bumps, holes, loose parts, blemishes)	Lamp Endoscope

Note:

If the test setup for fittings parts produces higher electrical field strengths in voltage testing (compared with readings which would have been obtained if the fittings had been fitted on a cable that conformed to the present provisions), the manufacturer and client's technical department should agree upon a test voltage.

15.6 Type approval for 110 kV XLPE-cable fittings (electrical properties)

Table 15-6 Type approval for 110 kV XLPE-cable fittings (electrical properties)

	Tests	Requirements	Testing method
1.	Order of tests	Sections 2 to 8 in this table	
2.	Rated power frequency withstand voltage test - Test AC voltage 230 kV - Duration of testing 1 min.	No disruptive break-down	
3.	Partial discharge test - Strength of calibration pulse 2 pC - Test voltage 2.5 U_0 - Duration of testing 1 min. - Permissible interference level $\leq$1 pC	No partial discharg-es from test subject observed	DIN VDE 0276-632-3 Part 4-D DIN EN 60885-3
4. 4.1	Pressure cycling tests followed by partial dis-charge test Pressure cycling test - Heating the sample via conductor heating - Heating cycle: 24 hours Heat sample for eight hours at 5 to 10 K above the permitted conductor tempera-ture, maintaining this temperature for at least two hours before 16-hour cool-down - Test AC voltage 2.5 U_0 - Number of cycles in the air 20 Number of cycles in water 20		DIN VDE 0276-632-3 Part 4-D
4.2	Partial discharge test - Strength of calibration pulse 2 pC - Test voltage 2.5 U_0 - Duration of testing 1 min. - Permissible interference level $\leq$1 pC	No partial discharg-es from test subject observed	DIN VDE 0276-632-3 Part 4-D DIN EN 60885-3
5.	Surge voltage test followed by AC voltage test		

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5.1	Lightning surge voltage test - Heat the sample at 5 to 10 K above the permitted conductor temperature, maintaining this temperature for at least two hours - Surge voltage amount 550 kV - Number of surges 10 surges of positive polarity 10 surges of negative polarity	No disruptive breakdown	DIN VDE 0276-632-3 Part 4-D DIN EN 60230 DIN EN 60060
5.2	Voltage test - Test AC voltage 2.5 U_0 - Duration of testing 4 hours	No disruptive breakdown	DIN VDE 0276-632-3 Part 4-D
6.	Partial discharge test - Strength of calibration pulse 2 pC - Permissible interference level $\leq$ 1 pC - Test AC voltage 2.5 U_0	No partial discharges from test subject observed	DIN VDE 0276-632-3 Part 4-D DIN EN 60885-3
7.	Test on sleeve outer protective jacket Authorisation for sleeves without separated shields can be officially accepted once the tests on a cross bonding sleeve have been successfully completed. This test must be performed on a sleeve which has already successfully passed the previous tests from Sections 2 to 6.		DIN VDE 0276-632-3 Annex G
7.1	Storage in water and heating cycles - Water column 1 m - Heating/cooling cycles: minimum 24 hours Heat sample for 12 hours at 15 to 20 K below the permitted conductor temperature, followed by cooling in water at 30 °C - Number of water heating/cooling cycles 20		DIN VDE 0276-632-3 Annex G
7.2	Underwater test on **sleeves without separated shields** - Test DC voltage 25 kV - Duration of testing 1 min.	No disruptive breakdown	DIN VDE 0276-632-3 Annex G

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7.3 7.3.1	Underwater tests on **cross bonding sleeves** Voltage test 1. Test between the shield/metal sheaths at both ends of sleeve 2. Test between the shield/metal sheaths and the earthed surface of sleeve outer protective casing - Test DC voltage 25 kV - Duration of testing 1 min.	No disruptive breakdown	DIN VDE 0276-632-3 Annex G
7.3.2	Surge voltage test between conductive layers - Surge voltage amount 75 kV - Number of surges: - 10 surges of positive polarity - 10 surges of negative polarity	No disruptive breakdown	DIN VDE 0276-632-3 Annex G DIN EN 60230
7.3.3	Surge voltage tests on the conductive layers and the surface of the outer sleeve casing - Surge voltage amount 37.5 kV - Number of surges: - 10 surges of positive polarity - 10 surges of negative polarity	No disruptive breakdown	DIN VDE 0276-632-3 Annex G DIN EN 60230
8.	Analysis of testing procedure	No visible signs of water or corrosion detected	DIN VDE 0276-632-3 Annex G

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Appendix

I. Abbreviations and definitions

TD	technical description
XLPE	cross-linked polyethylene
CB sleeve	cross-bonding connection sleeve

II. List of illustrations

Illustration 14-1 Geometry of the insulation connector

III. List of tables

Table 1-01 Overview of amendments

Table 15-1 Routine inspection and testing of 110 kV XLPE cables

Table 15-2 Screening of 110 kV XLPE cables

Table 15-3 Type approval for 110 kV XLPE cables (electrical properties)

Table 15-4 Type approval for 110 kV XLPE cables (non-electrical properties)

Table 15-5 Routine inspection and testing of prefabricated fittings and pre-testable fittings parts

Table 15-6 Type approval for 110 kV XLPE-cable fittings (electrical properties)

Table IV-01 Revision index

Table IV-02 Overview of document creation, document owners, checking and approval

IV. Revision index

Table IV-01 *Revision index*

Version n	
Section	Topic
Version n-1	
Section	Topic

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TD3514	110 kV cables and fittings	Berlin 1	30 (30)

Table IV-02 *Overview of document creation, document owners, checking and approval*

	Created:	Owned by:	Checked:	Approved:
Date:	8 April 2014			
By:	Volkmar Ulewski	Mr Wunderlich		

KRITERIENKATALOG
Qualifizierungssystem

Verfahren: 2018001641 − CABLE PREQUALIFICATION SYSTEM FOR USE BY VATTENFALL AB

EIGNUNGSKRITERIEN

KRITERIENKATALOG
Qualifizierungssystem

Verfahren: 2018001641 − CABLE PREQUALIFICATION SYSTEM FOR USE BY VATTENFALL AB

LEISTUNGSKRITERIEN

Name	Dateiname	Größe	MIME−Type
PQ questionnaire LV MV HV cables	PQ questionnaire LV MV HV cables .xlsx	372,40 KB	application/ vnd. openxmlformats− officedocument. spreadsheetml. sheet