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Modular Installation Instructions

Helsinki Metropolia University of Applied Sciences
Bachelor of Engineering
Electric Power Engineering
Thesis
Date April 1, 2012

Metropolia

Preface

This study was made for Utility Networks of Ensto Finland Oy. I would like to thank my supervisors M.Sc. Lic. Sc. Jarno Varteva and Product Manager Perttu Lehtikangas for guidance. I would also like to thank Technical Writer Mikko Ainasoja from Ensto Utility Networks for huge work with drawing and updating my installation instructions, and Jaakko Pekkinen from Ensto Utility Networks for tips with installations.

I would also like to thank my family for supporting and my fiancé Anssi Aarnio for helping and understanding in this educative work.

Porvoo, April 1, 2012

Jenna Nieminen

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The main goal of this study was to find out ways to make and update Ensto Finland Oy Undergound unit's installation instructions of underground network accessories more efficiently than at the moment. Similarities were searched for from these installation instructions and with these similarities so called tree models were created. It was possible to find repeating pictures from these tree models and to form entities from these repeating pictures, which were called modules in this study.

Also alternative solutions to update installation instructions were searched in this study, and solutions to show pictures and installation texts, and easier way to make whole new installation instructions, were searched for. Many of these installation instructions need to be translated to several different languages, which causes problems. These translations needed to be considered while working with this study.

Persons who update and create these installation instructions and pictures in them were interviewed. With the opinions of these persons, by studying installation instructions and by taking into account the work of installers, a new installation instruction was created, which does not include any texts in the installation parts. It includes only pictures which are showing what is happening, and it is much easier to update than earlier installation instructions, because there is no need for different language versions.

Keywords	Installation instruction, Heat shrink, Joint, Termination

Tekijä Otsikko Sivumäärä Aika	Jenna Nieminen Modulaariset Asennusohjeet 55 sivua + 3 liitettä 1.4.2012
Tutkinto	Insinööri (AMK)
Koulutusohjelma	Sähkötekniikka
Suuntautumisvaihtoehto	Sähkövoimatekniikka
Ohjaajat	Tuotepäällikkö Perttu Lehtikangas TkL Jarno Varteva

Tässä insinöörityössä oli tarkoituksena löytää keinoja, miten Ensto Finland Oy:n Underground yksikön maakaapeliasennustuotteiden asennusohjeet voitaisiin tehdä ja päivittää tehokkaammin. Näistä ohjeista etsittiin yhteneväisyyksiä ja niiden avulla luotiin niin sanottuja puumalleja. Puumalleista pystyttiin löytämään tutkittavissa asennusohjeissa toistuvat kuvat ja muodostamaan toistuvien kuvien kokonaisuuksia, joita tässä työssä kutsutaan moduuleiksi.

Työssä etsittiin myös vaihtoehtoisia ratkaisuja asennusohjeiden päivittämiseen, niissä olevien kuvien sekä tekstien esittämiseen sekä helpompaa tapaa luoda kokonaan uusia asennusohjeita. Työssä tuli ottaa huomioon se, että monet asennusohjeet käännetään usealle eri kielelle joka aiheuttaa omat ongelmansa ohjeiden päivittämiseen sekä tekemiseen.

Insinöörityössä haastateltiin henkilöitä, jotka työkseen päivittävät ja tekevät kyseessä olevia asennusohjeita ja niissä olevia kuvia. Näiden henkilöiden mielipiteiden, asennusohjeisiin perehtyen sekä asentajien työn huomioon ottaen lopputuloksena kehitettiin uusi asennusohje, jossa itse asennusvaiheissa ei ole lainkaan tekstiä, vain kuvat kertomassa mitä tapahtuu. Tämä uusi niin sanottu kuvallinen asennusohje on helpompi päivittää, koska kieliversioita ei tarvita.

Avainsanat	Asennusohje, Kuumakutiste, Jatko, Pääte

Abbreviations/Acronyms

BT	Building Tecnology of Ensto Finland Oy
HV	High voltage
HIT1.12	Indoor 1-core, 12 kV heat shrink termination for plastic insulation cable
HITHW1.24	Indoor 1-core, 24 kV termination for AHXAMK-W
HITP3.12	Indoor 3-core, 12 kV termination for oil-paper insulation cable
HOTU3	Outdoor termination for universal and copper shield wire 3-core cables
HJ11.12	Heat shrink joint for 1-core plastic insulation cable to 1-core plastic insulation cable, 12 kV
HJP11.24	Heat shrink joint for 3-core oil-paper insulated cable to 3-core oil-paper insulation cable, 24 kV
HJT11.24	Heat shrink joint for 1-core plastic insulation cable to 1-core plastic insulation cable, 24kV
HJT31.12	Heat shrink transition joint for 3-core oil-paper insulated cable to 1-core plastic insulation cable, 24 kV
HJTW11.24	Heat shrink joint for 3-core oil-paper insulated cable to 1-core AHAXAMK-W cable, 24 kV
HOT1.12	Outdoor 1-core, 12 kV termination for plastic insulation cable

i.i.	Installation instruction
IS	Industrial Solutions of Ensto Finland Oy
Kit	Accessories kit which includes necessary items for making a joint or termination
LV	Low voltage
MV	Medium voltage
Oil-paper insulated cable	Cable with oil-paper insulation
PEMxxxx	Code of the installation instruction
Plastic insulated cable	Cable with plastic (for example PVC) insulation
SJE42	Additional joint kit for 3x1 core to 3x1 core 12-24 kV with wire shield
SJEW42	Additional kit AHXAMK-W 3x1 core to 3 core with wire shield
UG	Underground or Underground unit of Ensto Utility Networks
UN	Utility Networks of Ensto Finland Oy
1-core	Cable with one core
3-core	Cable with tree cores

Contents

1 Introduction

This thesis focuses on installation instructions of Ensto Finland Oy. The main purpose of this thesis is to find out how underground cable accessories installation instructions can be updated easier and made easier. Current problems need to be discovered so that the above mentioned objectives could be actualized. One of the problems is for example the existing updating system, which is completely manual. Another problem is the number of different language versions, which makes updating more time consuming.

One key issue is to find out similarities in installation instructions and transform them into a modular entity. A so called tree model from different cable structures is used as aid. The tree model solution is further discussed in the third chapter. When tree models are ready, it should be possible to see how many pictures are needed in the new installation instructions. In the future the modules in the tree models should also help to find out a suitable database system.

These installation instructions are quite new and there are about 400 different installation instructions. The company has not had time or opportunity to improve or standardize all the instructions before. This study will help the company to actualize how much different installation instructions they have, and how these installation instructions could be similar. If the database system will be created, it will save both time and money.

This study focuses on heat shrink medium voltage cable accessories in underground cable networks and only on a few most used cable accessories instructions. This study does not concern cold shrink or low voltage cable accessories. By using these limitations, it is possible to finish this thesis within a time schedule.

To find out what kind of work installers are doing and how installation instructions are working at the moment, this study includes also practical training. Training installation is done with basic heat shrink cable accessories.

2 Background Sections

2.1 Ensto Finland Oy

Ensto Finland Oy is an international family corporation. Development, manufacturing and marketing of electrical systems are industries which Ensto is specialized in. The head office of Ensto is located in Porvoo in Finland, where the company was founded in 1958. Ensto has 1600 employees in 20 different countries, of which 580 in Finland. Company has three business units: Utility Networks (UN), Building Technology (BT) and Industrial Solutions (IS). [1]

This study is made for Utility Networks underground department which is focused on underground cable accessories, such as heat shrink and cold shrink joints and terminations. [1]

2.2 Different Underground Cables and the Cable Structure

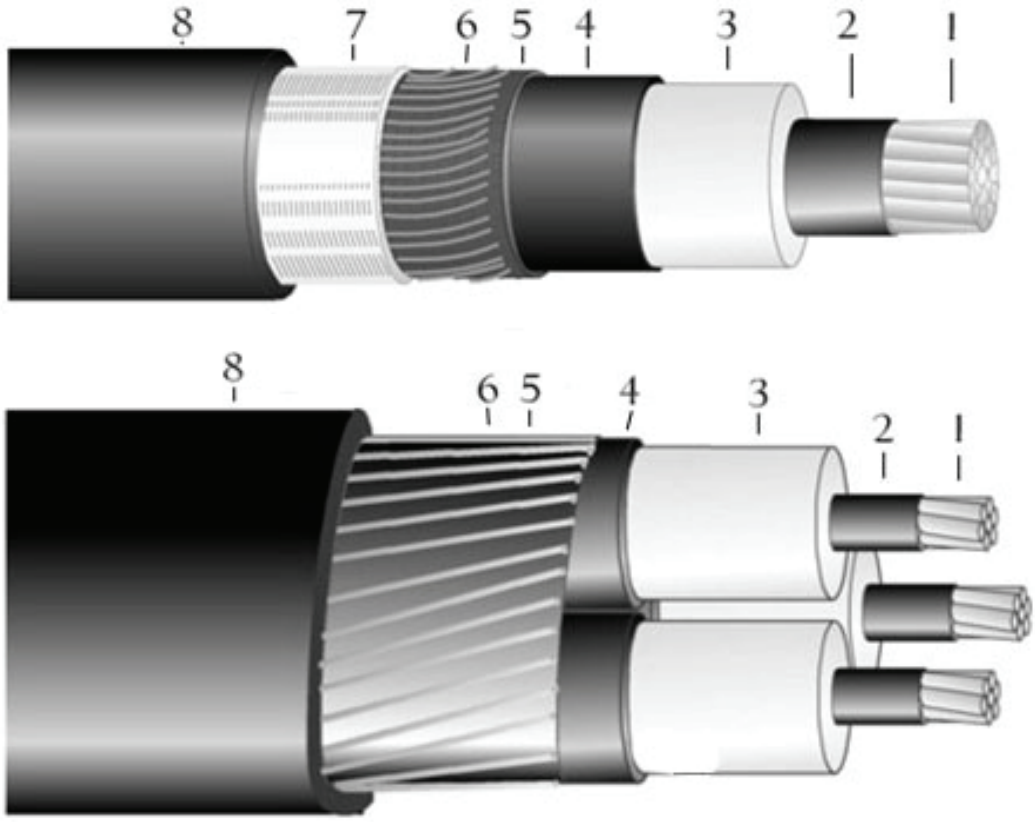
Cables are normally divided in two groups, low voltage (LV) cables meaning voltage level under 1000 V AC and high voltage (HV) cables voltage level over 1000 V AC. To help daily life it is common to speak about also medium voltage (MV) cables which are normally limited from 6 kV up to 36 kV. [2]

Cables used in underground networks are generally either one or three phase conductors and the insulation is either oil-paper or plastic. Oil-paper insulation cables were used until the 1960s and some of them are still used, but they are not commonly produced anymore. After 1960s, plastic insulation cables started to replace oil-paper cables little by little. [3]

When building up a network, cables need to be jointed or terminated, and that is why for example heat shrink accessories were invented. First, at the end of the 1960s, it was possible to make heat shrinkable terminations for both oil-paper and plastic insulation cables and a couple years later also heat shrinkable joints, which are still used. [3]

Medium voltage cable structure consists always of conductor, insulation, insulation screen and cable sheath. Depending on cable type, insulation and insulation screen can

be paper or plastic, there can be more than one outer sheath, armourings, different kind of wire shield etc. An example of typical structures of medium voltage cables is shown in picture 1. [4]



Picture 1. Typical structure of one- and tree-core medium voltage underground cable consists of conductor (1), conductor screen (2), insulation (3), insulation screen (4), swelling tape (5), wire shield (6), aluminium tape (7) which is only in one-core cable and sheath (8). [5]

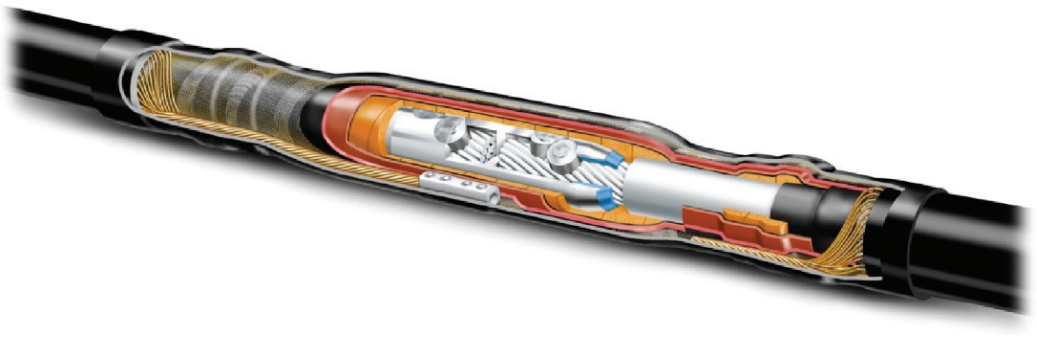
This study focuses only on the installation instructions of medium voltage cables and their heat shrinkable joints and terminations.

2.3 Joint and Termination

Joint is an accessory which is used when there is need to make a connection between two cables to form a continuous circuit. Joints are needed for example when a cable has to be fixed, cable is too short or the old cable networks needs to be repaired. [6, p.36-37; 4, p.39]

There are many different joint types, e.g. straight-joint, see picture 2, transition joint and trifurcating joint. Jointing techniques include heat shrink, cold shrink and resin technique. This thesis concentrates on heat shrink technique. [5,6]

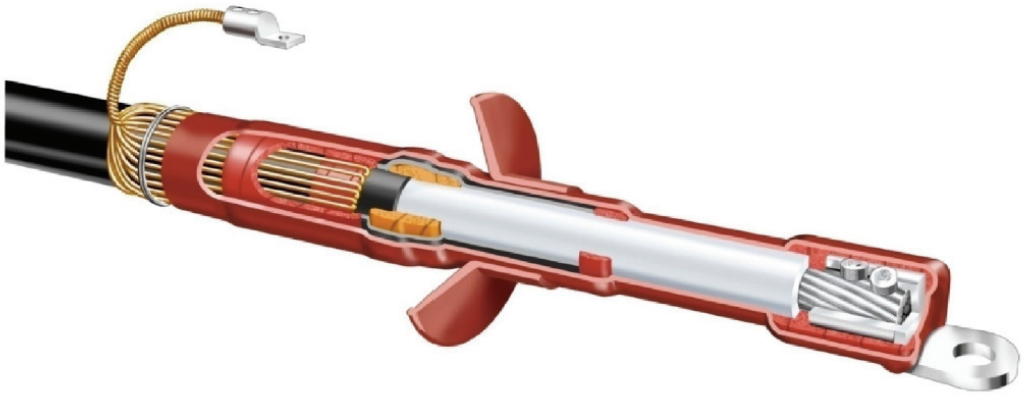
Transition joint connects two different kinds of cables, for example plastic insulation cable to oil-paper insulated cable. Trifurcating joint is an accessory which is making a connection between three single-core cable and three-core cable. [6, p.36-37]



Picture 2. The structure of a heat shrink joint. [5, p.25]

Terminations are distributed into indoor and outdoor terminations. Terminations are needed when a cable needs to be terminated e.g. to transformer or electrical center. An example of the heat shrink indoor termination is shown in picture 3. [4, 7]

There are many different termination types. Examples of these types are: heat shrink terminations and cold shrink terminations. These both different terminations can be installed on both one- and three-core cables. [4, 5]



Picture 3. The structure of a heat shrink termination. [5, p.27]

2.4 Background of the Problem

UG has around 120 different installation instructions (i.i.) written in English. For these there are almost 400 translations. There can be at maximum 15 different language versions of one instruction.

These i.i.s have three main problems: updating existing i.i. including translations (see chapter 2.4.1), updating pictures (see chapter 2.4.2) and making new i.i.s (see chapter 2.4.3). These issues are further discussed at later stages.

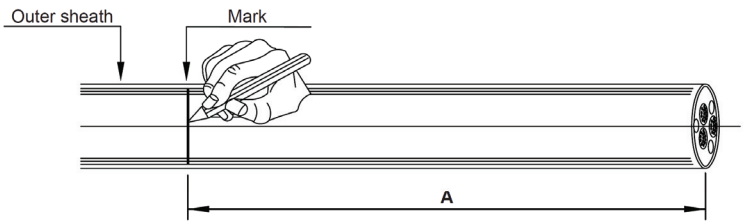
All of Enstos underground i.i.s have almost similar structure. The structure can be divided in to four different sections: 1. cover page, 2. general information and legal notice, 3. assembling and 4. pages for notes.

Cover page introduces what kind of products (joint or termination) the instructions concern. It includes also the code of the installation instruction, for example PEM1076, and code/codes, for example HIT3.12 and HOT3.24, for which the product i.i. is meant for. On the cover page it is also mentioned for which language i.i. is made. [8]

General information and legal notice- page includes always general but important information on what needs to be done when the installer starts, installs and finishes his/hers installation. This kind of information is for example that before he/she starts to install the joint or termination, the i.i. needs to be read carefully. There is also general

knowledge of heat shrink work and a couple words of legal aspects of the installation. [8]

The third part, assembling, includes dimensions of cable preparation and how to prepare the core for installation. See picture 4. [8]



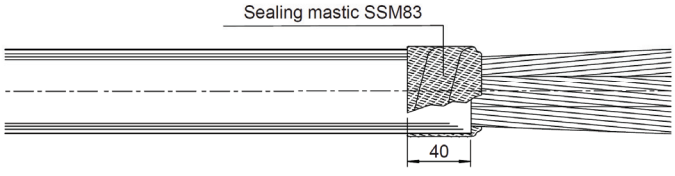
2. Mark the cutting point at the distance of A from the core end.

Table 1.
CABLE PREPARATION DIMENSIONS

KIT	Um kV	Cable size mm²	Outer sheath removal		Semiconductive layer removal
			A min. mm	A max. mm	B mm
HIT3.1202	12	25-95	500	1100	235
HIT3.1203	12	95-240	500	1100	235
HIT3.1204	12	150-300	500	1100	235
HOT3.1202	12	25-95	500	1400	235
HOT3.1203	12	95-240	500	1400	235
HOT3.1204	12	150-300	500	1400	235

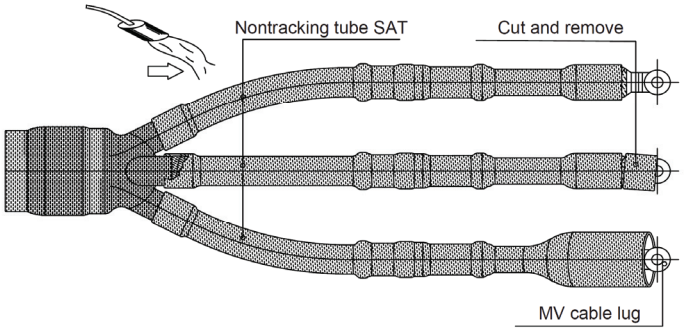
Picture 4. Preparation for the core. [8: PEM1076ENG]

Also the third part contains specific phases of the installation of the product. See pictures 5 and 6 for example.



4. Wrap two layers of sealing mastic SSM83 on the outer sheath. Cover 40 mm distance from the sheath edge. Sealing mastic SSM83 must be wrapped by stretching it a bit.

Picture 5. An example of the i.i. [8: PEM1076ENG]



15. Place the SAT nontracking tubes pushing them as far as possible on the breakout fingers. Shrink the tubes starting from the breakout finger end and, if necessary, cut away the extra length of the tubes to uncover the hole in the palm of the cable lug.

Picture 6. An example of the i.i. [8: PEM1076ENG]

The last part of the installation instruction is the notes –pages. This is the place where the installer can write markings and notes.

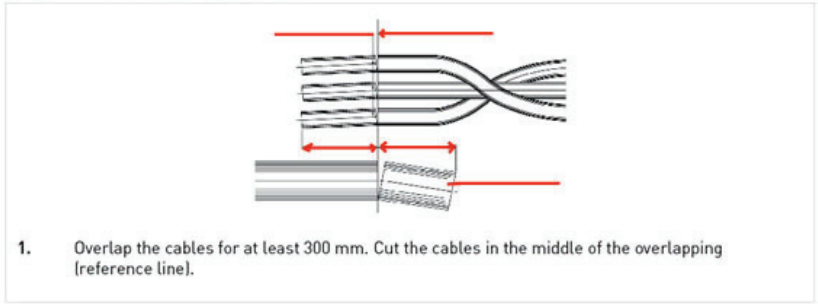
2.4.1 Updating Installation Instructions and Language Versions

Installation instructions have to be updated mainly if something changes in installation procedure or one finds an error in the installation instruction. Updating of the installation instructions includes many different phases. First, a product designer has to find the latest version of instructions and then add to it comments on how she/he wants to change it. In the next part the designer sends this commented instructions to a technical copywriter and he/she reads and fixes these changes. Normally this final updating can take up to two to five hours depending on how long the installation instructions are and how many pictures are included. Test installations to final products are made after or during the updating process. The modified installation instructions have to be approved by product manager. When the updated version is ready, it has to be saved in four different places: 1. in a folder which production have access to, 2. in installation instructions folder used in product development, 3. into IFS to the structures including the old installation instructions and 4. to Procus so the new version is available on web page. Also the old version of it has to be saved in two places. This whole process is quite complicated and time consuming. [9]

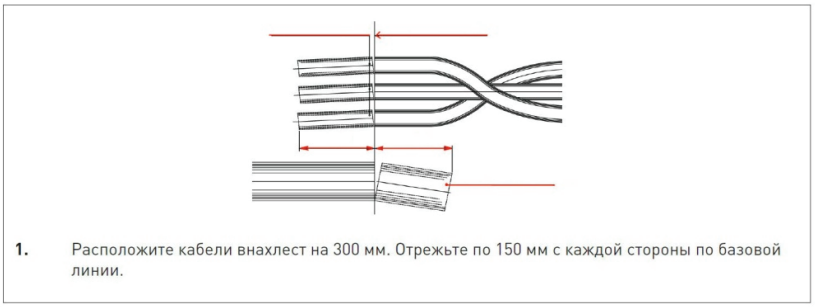
After the updated version is approved, it is ready to be used, but just for one language. The updater has to update also all language versions – in the worst case 15 different versions. This is because there are no standardized phrases to be used. [9]

When the new installation instruction is ready and translated to every language which is needed, it will be included to the product kit and sent to different countries. These countries trust that the installation instruction is translated to the language which they are using. If it is not, it causes more new work, because the installation instructions need to be changed to the right ones to all above mentioned product kits, and if this currently needed language version of the i.i. is not available, it needs to be created.

At the moment, all the pictures consist of lines without text. Some of these lines indicate what points have to be noticed. See pictures 7 to 8. Texts on these lines are separated from the picture so one has to write the text inside text-boxes on the i.i template and then add text-boxes on top of the picture. Then one has to target the lines in the picture to the text on the template. This method is very slow and it has to be done for every language version individually. Also the text´s length can be different and this creates more work because all the texts and the pictures move downwards after more lines are used because of longer text. There are no constant places for pictures and texts in the i.i. Therefore they cannot be easily updated so that any part of the i.i. will not move from its own place. [9]

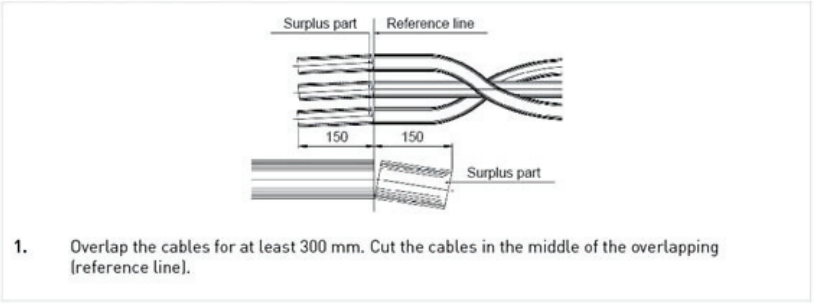


1. Overlap the cables for at least 300 mm. Cut the cables in the middle of the overlapping (reference line).

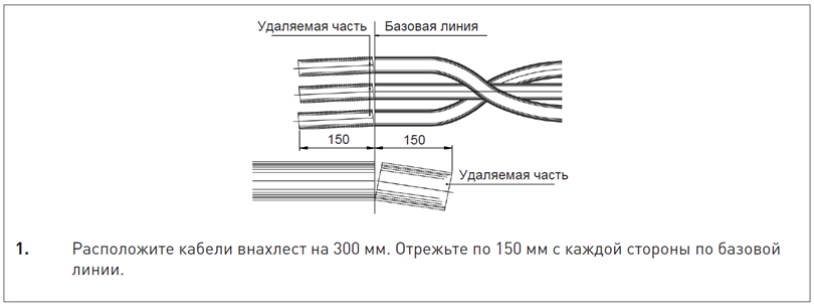


1. Расположите кабели внахлест на 300 мм. Отрежьте по 150 мм с каждой стороны по базовой линии.

Picture 7. Two different language versions of an installation picture. Red lines on the picture mark the point where texts in the picture are added. Note explanation text below the picture. [8: PEM1086ENG, PEM1086RUS]



1. Overlap the cables for at least 300 mm. Cut the cables in the middle of the overlapping (reference line).

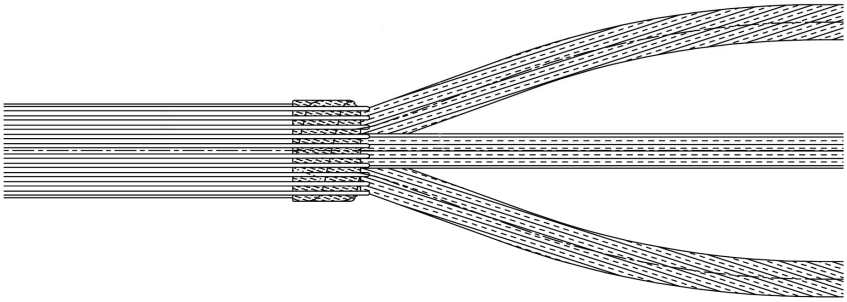


1. Расположите кабели внахлест на 300 мм. Отрежьте по 150 мм с каждой стороны по базовой линии.

Picture 8. A solution where texts and measurements are visible in the installation picture. [8:PEM1086ENG, PEM1086RUS]

2.4.2 Updating Pictures

Existing installation instructions include a lot of pictures. These pictures are made with vector graphic which is a good way to draw pictures but very troublesome to update. That is because every picture consist of many parts and these parts include a lot of lines. If the picture needs to be updated these lines have to be removed first one by one. The update of one picture can take a couple of hours. See picture 9. [9]



Picture 9. Example of the vector graphic -picture [8: PEM1076ENG]

2.4.3 Making of New Installation Instructions

Making of a whole new i.i. is a little different process than updating old ones. First the product designer must draft the body of the i.i. The updater needs to add the texts and the pictures, which the product designer drew, or draw new ones by her-/himself to the i.i. template base. Sometimes the first i.i. needs to be done again or updated right in the beginning a few times. This will slow down the whole product development process and if the i.i. is delayed, production cannot start. If the original version of the current i.i. is fine, it can be taken into use. Normally, if all the pictures are quite ready, making of the new i.i. will take about two to four hours. But it also depends on the length of the i.i. Sometimes the updater needs to update very many i.i.s and sometimes just one or two. After the new version is ready, the next steps are the same as they are when updating an old version. [9]

3 Description of Method and Material

The purpose of this study is to find out similarities and differences between installation instructions so updating and making of installation instructions would be easier. Because there are many (about 400 of which 122 in English) installation instructions in UG, it was decided, that only the most typical installation instructions are studied.

17 different i.i.s. of underground cable accessories were studied. These i.i.s included both joint and termination accessories i.i.s. These accessories were plastic (one and three cores) and oil-paper insulated cables. With these i.i.s. it was possible to create tree models and find out similarities from these i.i.s. These similarities were collected to modules. See chapters 3.2 and 3.4.2. for more information.

Also, with the help of the installation training it was possible to see which parts of installation repeated in different i.i.s and which parts were also same. With these trainings it was also possible to learn how installers use installation instructions and how understandable these i.i.s. are at the moment.

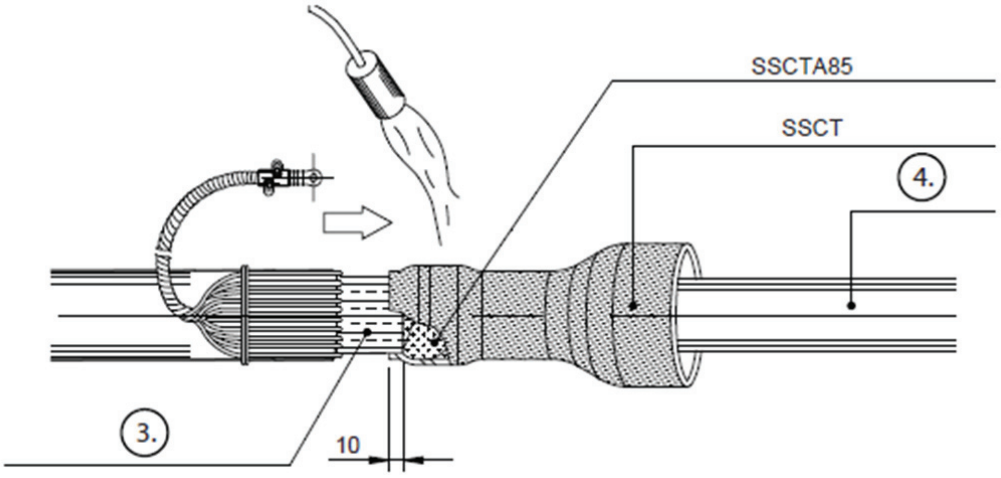
3.1 Problem Solving Solutions

This chapter introduces different solutions for solving the problems discussed earlier in this study.

3.1.1 Problems in the Pictures

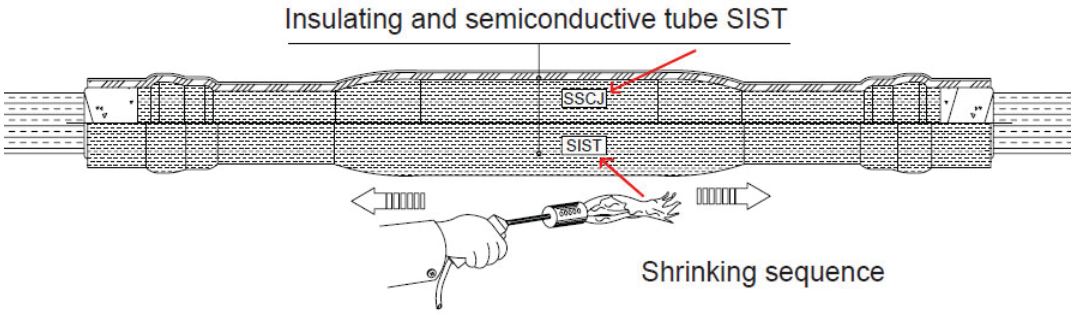
There are a lot of texts in the installation pictures, which is problematic, because each language version has to be updated individually due to different word lengths and language. One possibility is to use some codes or symbols in these pictures to show which part is which. These codes could be for example general letter combinations for some product. See picture 10. All these codes or symbols in the i.i. could be at the beginning of i.i., e.g. after the general information page.

This system is quite easy to create and would enable that the texts in the pictures would not need to be updated to all language versions, only to the code list.



Picture 10. An example of the codes and symbols. [PEMJNiENG, version 1]

In many pictures the name of the tube is included in the box. Therefore a different picture is needed for each tube, even though the installation process is the same. That is why it could be better if all these name boxes could be removed from these pictures, because it is possible to write different names of tubes (or the codes) on the line above the picture, which makes the name boxes unnecessary. This makes possible to use the same picture in many different i.i.s. For an example of this, see picture 11.



Picture 11. Text boxes in the picture [PEM1091ENG]

3.1.2 Using Layers When Drawing Pictures

Drawing pictures with for example Adobe Illustrator is quite simple and pictures will be clear and easy to understand. To make pictures even better, it is possible to use different layers when creating pictures. For example the whole structure of a cable and eve-

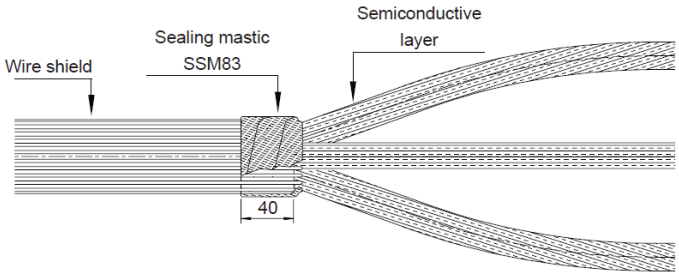
ry installation phase can be drawn to the same Illustrator file, if different phases of installation are drawn to different layers. If each installation phase is on its own layer, by selecting certain layers, all necessary pictures for the installation instruction can be easily created. With the cold shrink accessories installation instructions this is already tested, but it is also possible to use the principle for the heat shrink accessories installation instructions. [10]

When layers are selected to be visible, one has to remember, that layers can go on top of each other and the resulting picture can get very confusing. Therefore unnecessary layers can be toggled to be invisible, so the resulting picture is clearer. Usually when proceeding to drawing the next picture of installation, the previous layer or layers need to be hid. Only one layer can be edited at a time, since other layers can form a mixed up picture that is not understandable. [10]

3.1.3 Instruction Texts

Current instruction text parts are quite long, include unnecessary information and some texts have been written twice in the same part. This causes problems when i.i. needs to be updated to different language versions.

Because of the above mentioned things, text parts could be shorter and simple and it would be possible to use bulleted points. If the instruction texts include some general and repeating instructions such as how to install mastic: "Sealing mastic SSM83 must be wrapped by a stretching it a bit" [PEM1333ENG], these texts could be placed in at the start of the i.i. after the general information –page, or as one can see in the picture 12, they could be put after the main texts with an exclamation mark (!). These kinds of instructions are easier to read and remember.



4. ☐ Fold the copper or aluminium shield wires over the outer sheath.

☐ Remove the possible filling tubes or take care of the possible optical tubes according to the cable manufacturer`s instructions.

☐ Wrap two layers of sealing mastic SSM83 on the copper or the aluminium shield wires. Cover 40 mm distance from the sheath edge. Sealing mastic SSM83 must be wrapped by stretching it a bit.

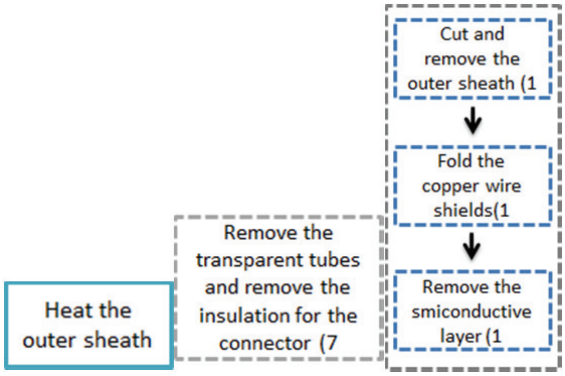
! Do not cut copper or aluminium wires.

Picture 12. An example of using bulleted points. [PEM1333ENG]

3.2 Tree Models

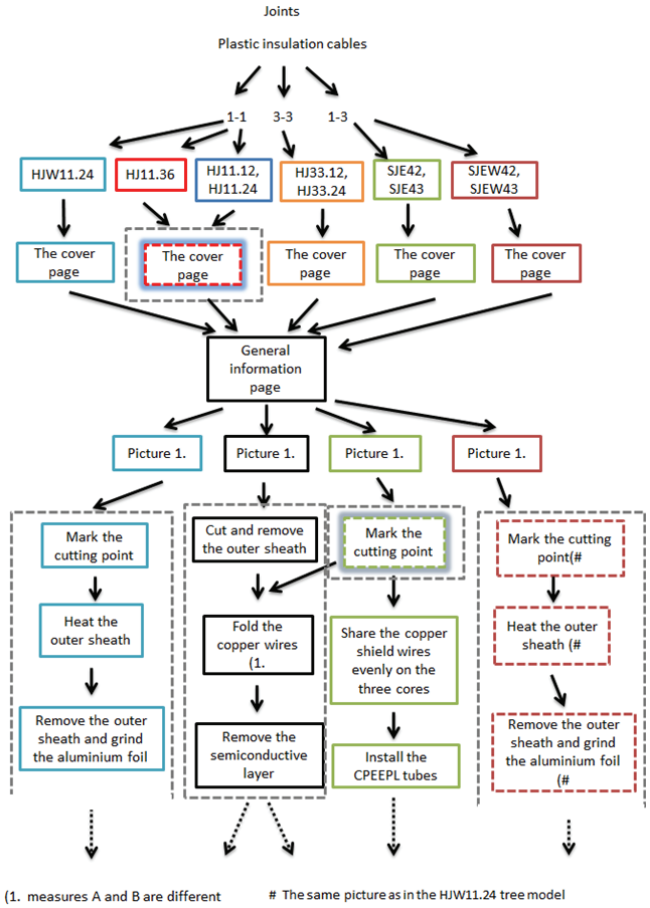
The idea of these tree models is to show how many pictures are needed in the installation instructions. With the help of the tree models it is also possible to create the modules (= parts of the i.i which are same in many i.i.s).

Colored boxes with different colors show different i.i.s. It is quite easy to see how many pictures the most common installation instructions include and which of these pictures are identical. If the box is drawn with dashed line it means that there is already a similar picture in some of these tree models. The modules are shown in the tree models with grey dashed line boxes which are surrounding a couple of pictures which repeat in every i.i. or almost in every i.i.



Picture 13. On the left turquoise box is an example of one picture in tree model. In the middle dashed line box means that this picture already exists in some other tree mode. The last three boxes surrounded by grey dashed line box is an example of a module.

Some orders of the installation phases need to be changed and these changes are in the tree models. Installation of the connector or the cable lug is one example of these kinds of changes. Also tree models include whole new pictures because some of current pictures or installation texts include too much information and that is why it is better if there are more explanatory pictures.



3.2.1 Joints for Plastic Insulation Cables

Six different installation instructions were compared in plastic insulation cable joints: HJW11.24; HJ11.36; HJ11.12, HJ11.24; HJ33.12, HJ33.24; SJE42, SJE43 and SJEW42, SJEW43. Descriptions of these abbreviations are available in the beginning of this study, in the part of Abbreviations.

Light blue boxes surrounded by grey dashed line box are one module. This module repeats itself in the tree model of SJEW42/43, see burgundy boxes surrounded by gray dashed lines.

HJ11.36 and HJ11.12/HJ11.24 have the same picture in the cover page.

Black boxes (pictures) are the same in both HJ11.36 and HJ11.12/24, but the only difference is the measures in one picture, see black box with (1 –mark.

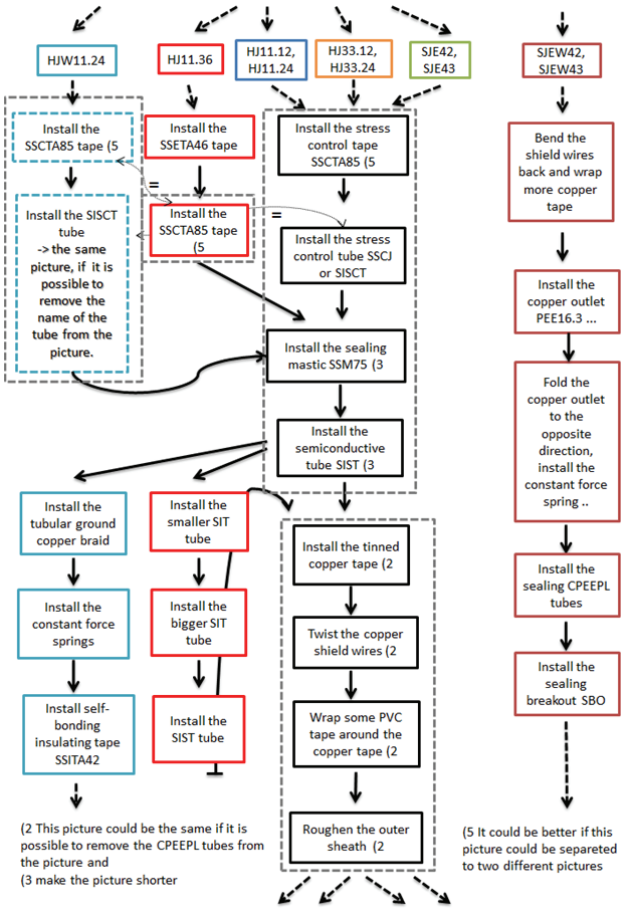
HJ11.12/24 and SJE42/43 have the same "Mark the cutting point" – picture.

Two modules continue from the previous page, see blue and burgundy boxes which are surrounded with gray dashed lines.

"Slip the tubes on the cable" –picture is the same in i.i.s of HJ11.36 and HJ11.12/24, see the black box above the tree model. It is also one module.

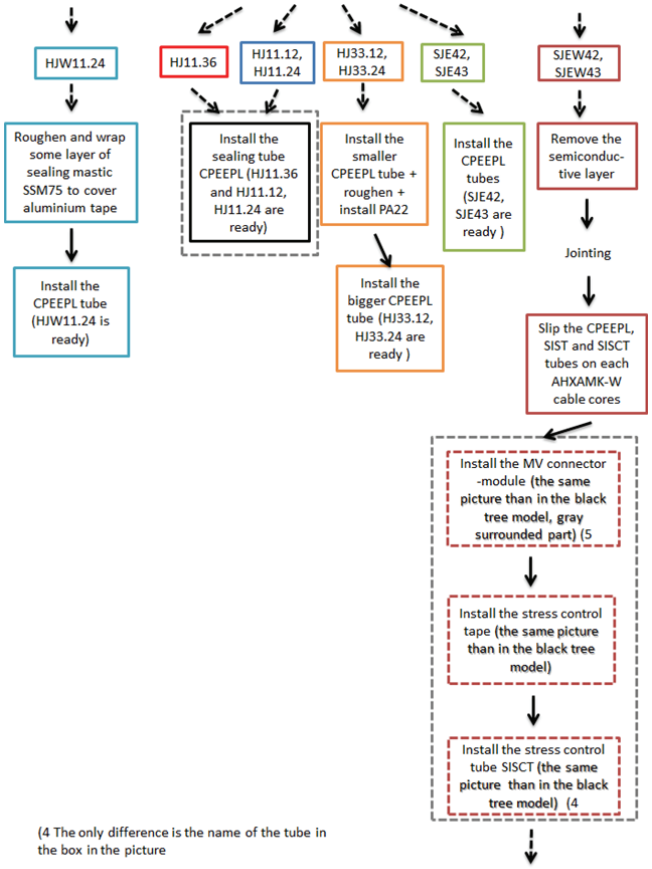
Black boxes which are surrounded by gray dashed line box create one and the most common module in all of the scrutinized i.i.s. This module is also called "cable lug installation" –module later in these tree models.

Green dashed line box surrounded grey dashed line box is also one module and the same picture than in the black tree model.



HJW11.24 and HJ11.36 have one same picture "Install the SSCTA85 tape", see blue dashed line box and red box connected with arrow. These pictures could also be separated to two different pictures, because there is quite much information in these pictures at the moment.

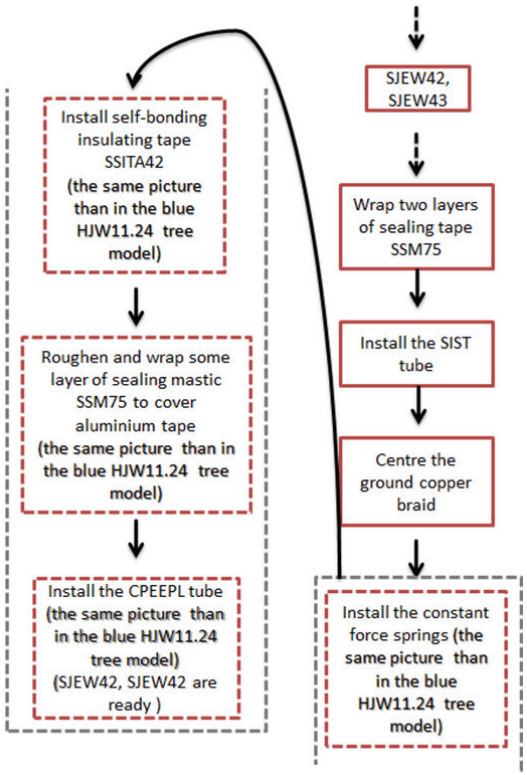
HJ11.36, HJ11.12/24, HJ33.12/24 and SJE42/43 have quite many same pictures, see black boxes in the tree model. Two of these pictures (see boxes with (3 –mark) could be shorter for the purpose that they could be used in all of these i.i.s as a same picture. There are also two modules: black boxes surrounded grey dashed line box. Upper module includes two pictures (black boxes with (3 -mark) which could be shorter. Also this same module includes "Install the stress control tape SSCTA85" –picture, which could be separated into two different pictures, because they include a lot of information at the moment. See picture with (5- mark. The other module under the first one includes four pictures, which all could be modified a little: CPEEPL –tube names could be removed from these pictures.



"Install the stress control tube SISCT" –picture (see burgundy dashed line box with (4 –mark) could be the same also in HJW11.24 i.i. (see light blue dashed line box in the previous page), if it is possible to remove the name of the tube from the picture. This operation could be useful to do in every picture which includes the name of the tubes in the pictures. The name of the tube could be written only on the line below or above the picture.

Burgundy dashed line box with (5 –mark is a picture which is full of information. It could be better to separate this picture to two different pictures: "Fill the gap … and cover the connector…" and "Install SSCTA85…". Last two burgundy colored dashed line boxes are both same pictures than in the black tree model. The only difference is the name of the tube in box in the picture. These tree pictures also create one module.

The other module in this page is the black box surrounded with grey dashed line box.



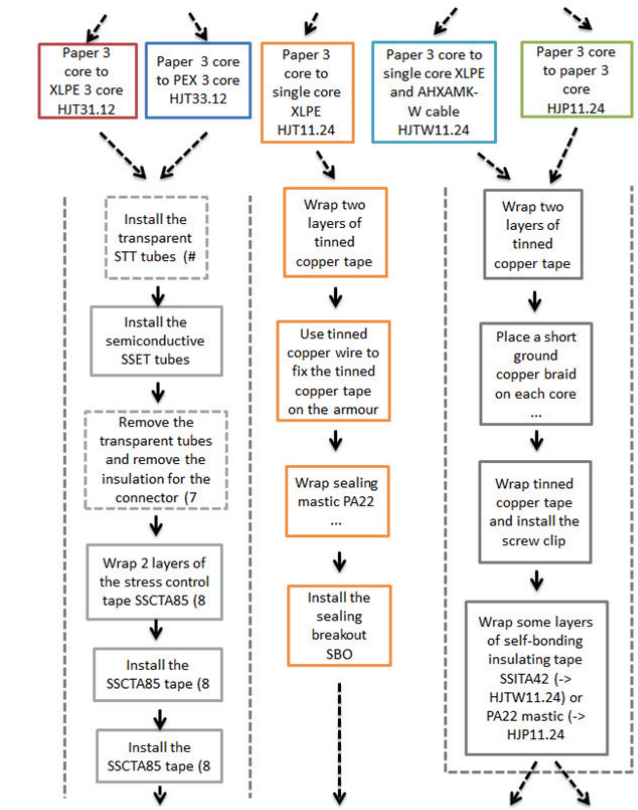
Graph 1. Tree model of the plastic joints [1-1: HJW11.24 PEM1068ENG, 1-1: HJ11.36 PEM1104ENG, 1-1: HJ11.12-24 PEM1091ENG, 3-3: HJ33.12-24 PEM1077, 1-3: SJE42-43 PEM1103ENG, 1-3: SJEW42-43 PEM1094ENG]

Burgundy dashed line boxes are all same pictures as in the i.i. of HJW11.24. These pictures create also a module.

3.2.2 Joints for Transition and Oil-Paper Cables

Four different transition (paper cable to plastic cable) accessory installation instructions were compared to one installation instruction of oil-paper cable to oil-paper cable.

Picture 1. of HJT31.12 is the same as the picture in the tree model of SJEW42-43, see burgundy dashed line box. This picture creates one module. Picture one of HJT33.12 could be the same as in the main tree model of the plastic joints, and the picture 1. of HJT11.24 is the same as e.g. in the tree model of SJE42-43. Both of these pictures are also one module. HJT31.12 and HJT33.12 have same pictures (see light gray boxes) and some of these pictures (light gray box with (# -mark) are also the same as in the i.i. of HITP3.12/HOTP3.12. It could be better if this first picture could be separated to two different pictures. Also these pictures create one module; see grey dashed line surrounding these boxes. HJT11.24, HJTW11.24 and HJP11.24 have same first picture, see the dark grey box in the right side of the tree model.



(1 The same picture as in the main tree model of the plastic joints, only difference is the measure

(# The same picture as in the tree model of HITP3.12/HOTP3.12

(7 This picture could be in the same part as the insulation removing from the XLPE insulated cable

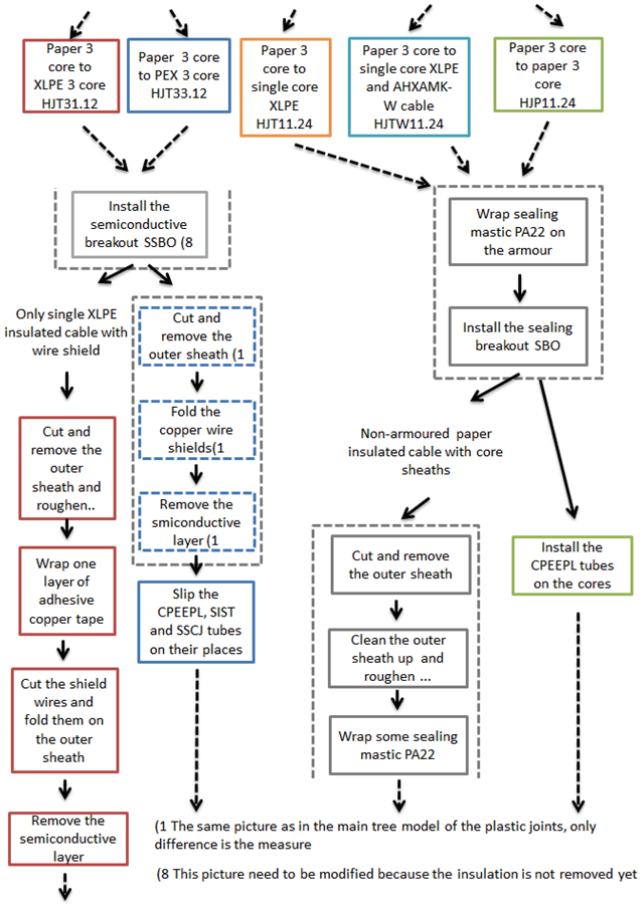
(8 This picture need to be modified because the insulation is not removed yet

HJTW11.24 and HJP11.24 have a few same pictures; see dark grey boxes which are creating a big module. This module starts from the previous page.

Light grey dashed line box with (# -mark is the same as in the main tree model of the plastic joints, the only difference is measures. The other similar box with (7 –mark could be added to the same part as the insulation removing from the XLPE insulated cable.

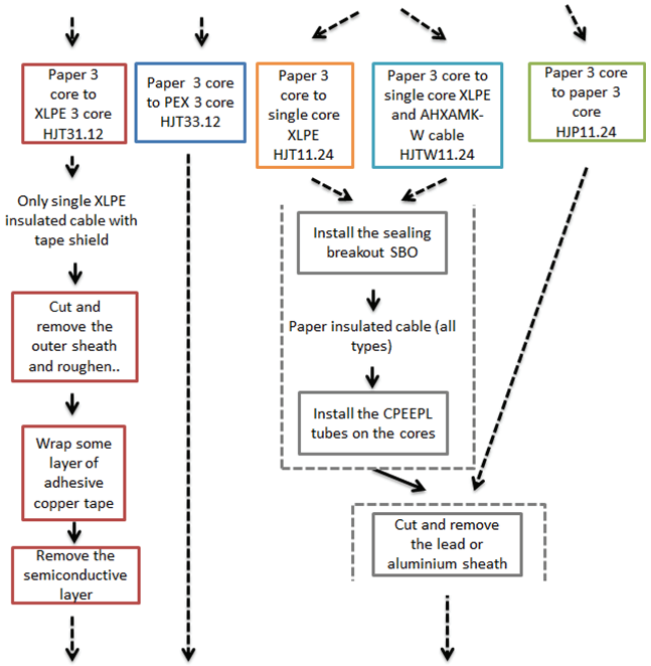
Boxes with (8 –mark represent pictures which need to be modified because the insulation is not removed yet from the end of the cable. That is because the order of the installation phases has changed a little; for more information see "cable lug installation" –module.

These above mentioned pictures at the left side of the tree model create a module which starts from the previous page and continues to the next page.

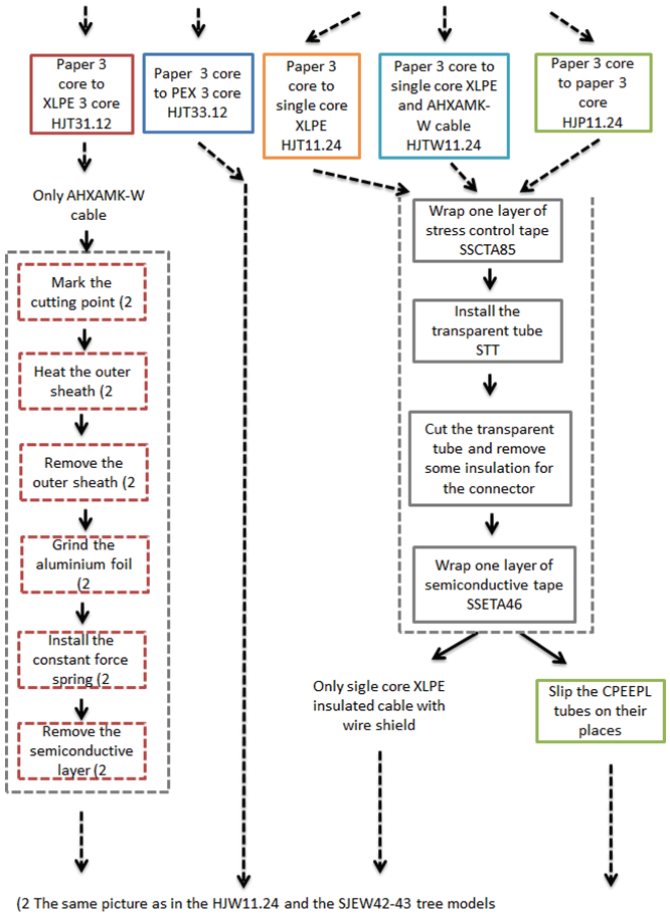


All tree blue dashed line boxes with (1 –mark are the same pictures as in the main (black) tree model of the plastic joints. The only difference between these pictures and the main tree model pictures is measures. These pictures are also a module.

Two dark grey boxes surrounded grey dashed line box (= one module) above the tree model are same with HJT11.24, HJTW11.24, and HJP11.24 i.i.s and last tree dark grey boxes are the same with HJT11.24 and HJTW11.24.These tree pictures create a module which is continued to the next page.

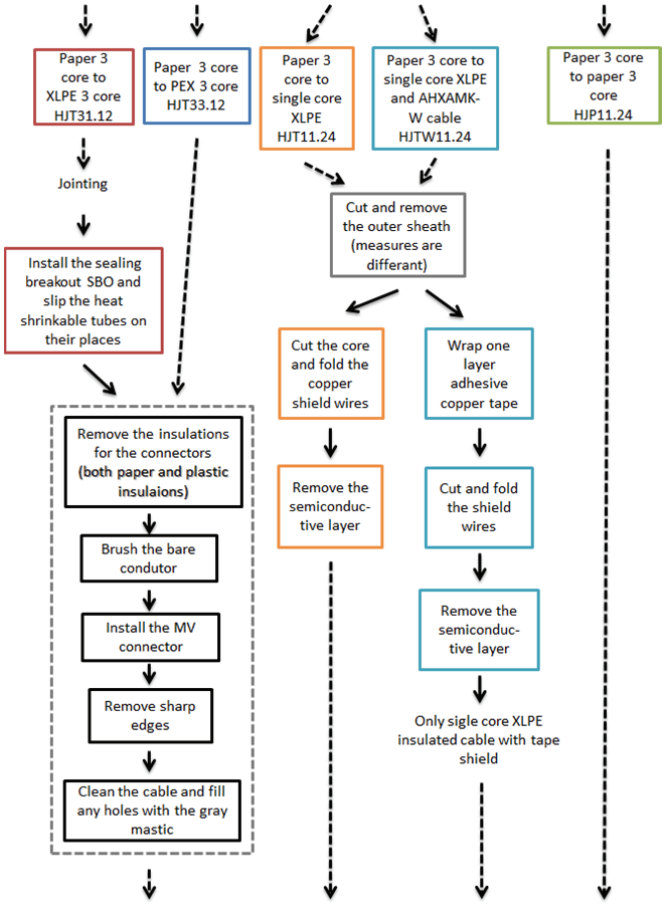


Tree i.i.s (HJT11.24, HJTW11.24 and HJP11.24) have a few same pictures and these pictures form one module, see latter grey dashed line box which continues to the next page.



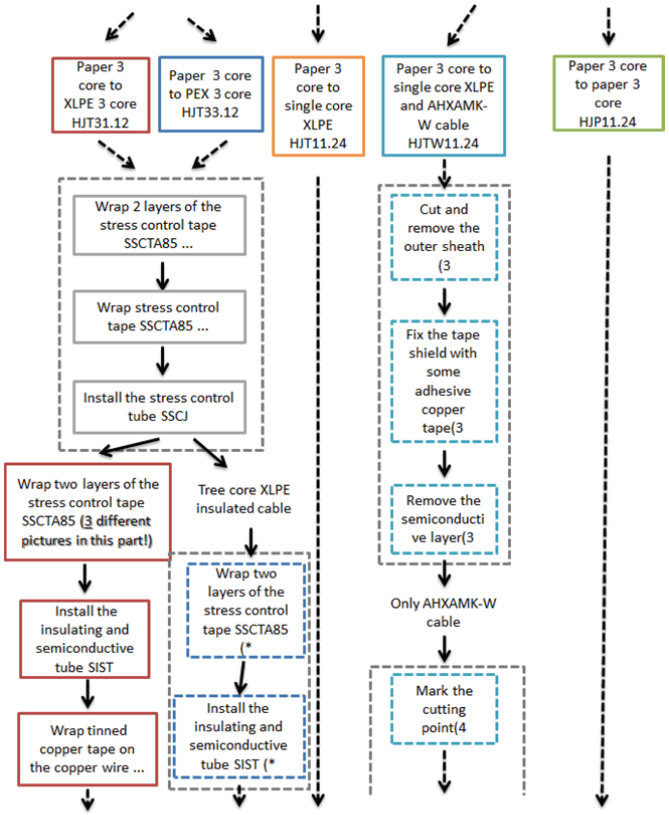
Burgundy dashed line boxes surrounded by gray dashed line box is one module which is the same as e.g. in the i.i. of HJTW11.24 and SJEW42-43.

The other module continues here from the previous page.



Black boxes surrounded grey dashed-line box form one module which is the same as in the main (black) tree model of the plastic joints.

HJT11.24 and HJTW11.24 have the same picture "Cut and remove the outer sheath". Only measures are different in these pictures, see grey box.



* This part/picture of the installation instruction could be the same as in the main (black) tree model of the plastic joints

(3 The same picture as in the tree model of HJT31.12

(4The same picture as in the tree model of HJT31.12 and in all "Wiski"-tree models

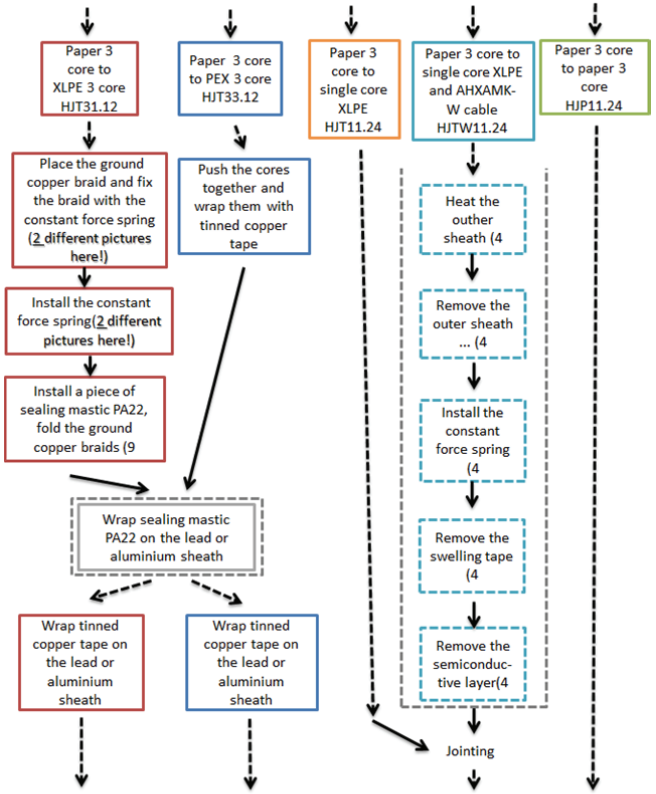
HJT31.12 and HJT33.12 include three similar pictures which are also a module; see the grey boxes in the left side of the tree model.

Picture "Wrap two layers of the stress control tape SSCTA85" (see the burgundy box after grey boxes) includes too much information so it could be better to separate it to at least three different pictures.

In HJT33.12 –tree model the blue dashed-line boxes with (* -mark could be the same pictures as in the main (black) tree model of the plastic joints. Also these pictures are one module.

Boxes with (3 –mark are the same as in the tree model of HJT31.12 and one module.

Turquoise dashed-line box is the same picture as in the HJT31.12 –tree model and also in all "Wiski" –tree models. These turquoise boxes (continues in the next page) are surrounded with grey dashed-line box which means that these pictures form one module.



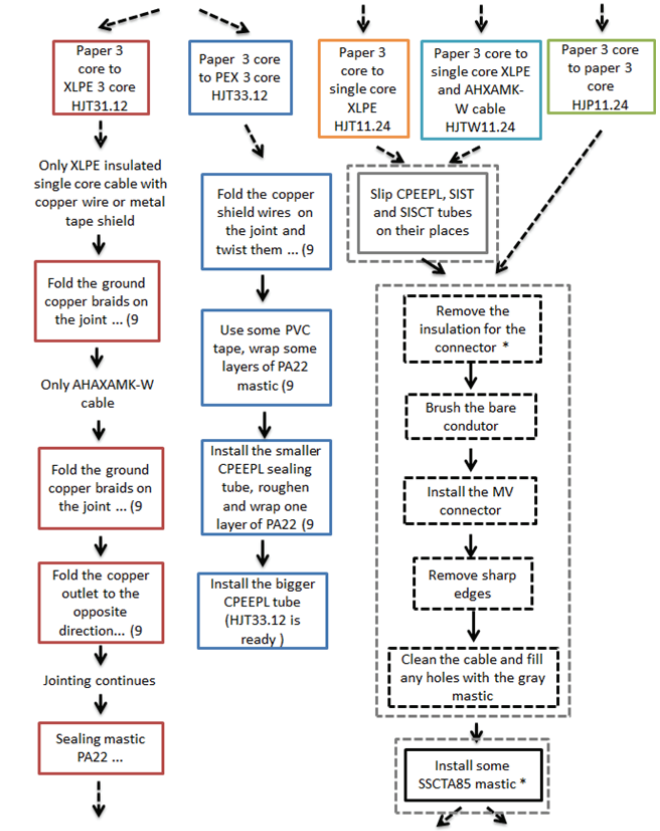
* This part/picture of the installation instruction could be the same as in the main (black) tree model of the plastic joints

(4 The same picture as in the tree model of HJT31.12 and in all "Wiski"-tree models

(9 It could be better if this picture could be separeted e.g. to two different pictures

"Wrap sealing mastic PA22 on the lead or aluminium sheath" –picture is the same in HJT31.12 and HJT33.12 i.i.s. See the grey box surrounded with ligth grey dashed line box.

Turquoise dashed-line boxes with (4 –mark are the same pictures as in the tree model of HJT31.12 and actually in all "Wiski" –tree models.



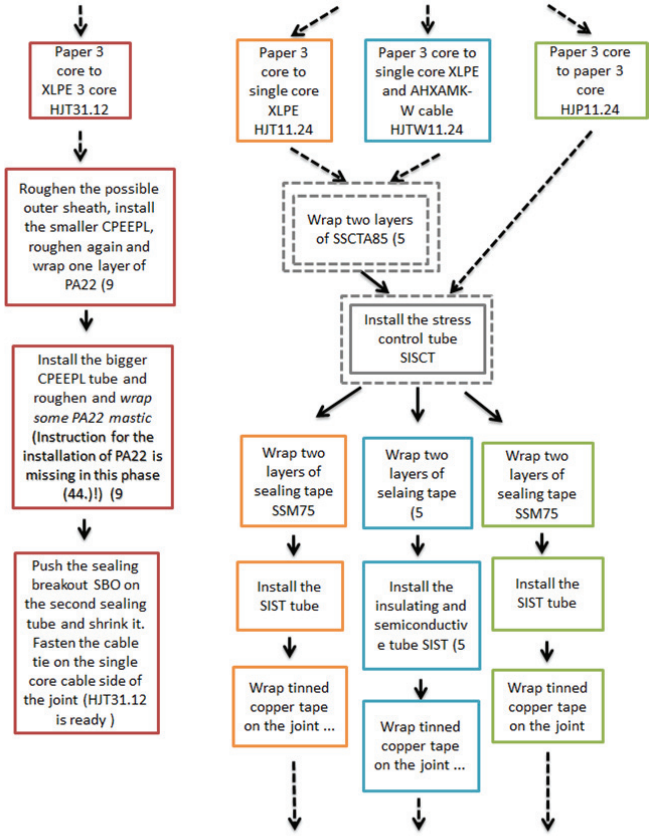
* This part/picture of the installation instruction could be the same as in the main (black) tree model of the plastic joints

(9 It could be better if this picture could be separeted e.g. to two different pictures

HJT11.24 and HJTW11.24 have the same picture: "Slip CPEEPL, SIST and SISCT tubes on their places", and this picture is also a module. Also these two i.i. and HJP11.24 have the other common module which is found in many of i.i.s of Ensto, see black boxes surrounded by grey dashed-line box.

"Install some SSCTA85 mastic" –picture (also a module) could be the same as in the main (black) tree model of plastic joints, see the black box below the grey module.

Many of the pictures (boxes) on this page include a (9 –mark, which means that these pictures could be separated to two different pictures.



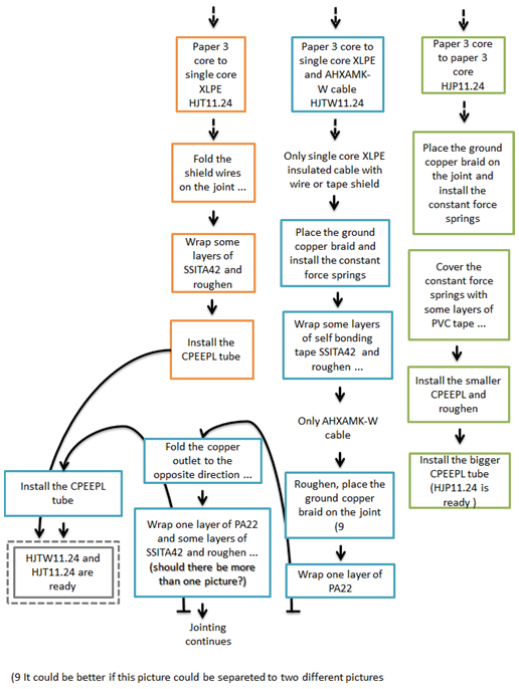
(5 The same picture or could be the same picture as in the tree model of HJT31.12

(9 It could be better if this picture could be separeted e.g. to two different pictures

”Roughen the possible outer sheath ...”- picture (see the burgundy box) could be more clear if it would be separated to e.g. two different pictures, because there is much information in this picture at the moment. The same thing could be done to the middle burgundy box.

“Wrap two layers of SSCTA85” –picture (also a module) could be the same as in the tree model of HJT31.12, see the grey dashed-line box. Also two pictures (blue boxes with (5 -mark) could be the same as in the above-mentioned i.i.

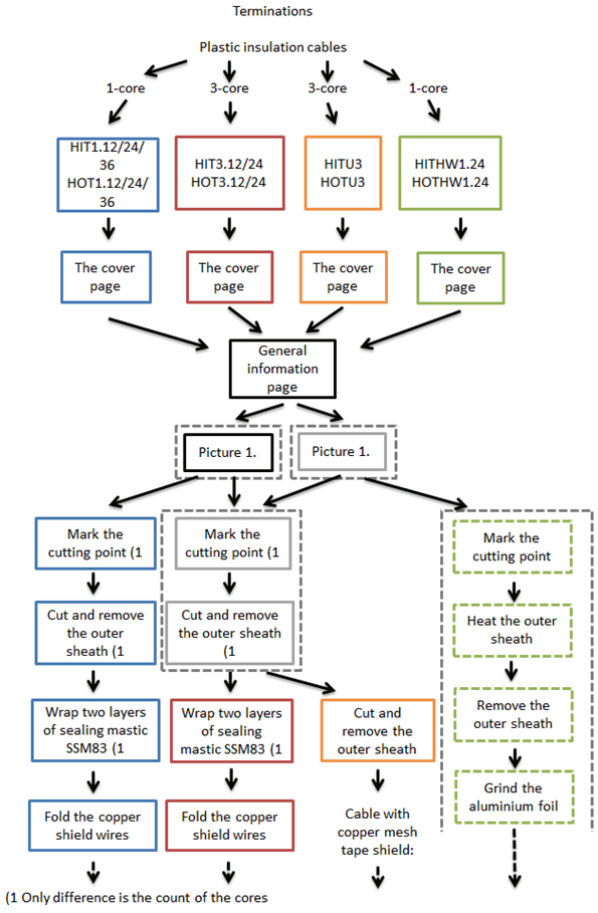
HJT11.24, HJTW11.24 and HJP11.24 are included in the same picture “Install the stress control tube SISCT”, see the grey box which is also a one module.



Graph 2. Tree model of the transition and paper cable joints. [3-3: HJT31.12 PEM1086ENG, 1-3: HJT33.12 PEM1102ENG, 1-3: HJT11.24 PEM1188ENG, 1-3: HJTW11.24 PEM1092ENG, 3-3: HJP11.24 PEM1090ENG]

Turquoise ”Wrap one layer of PA22 and some layers of SSITA42 and roughen ...” –picture includes quite a lot of information and that is why it could be better if this picture would be separated into e.g. two different pictures.

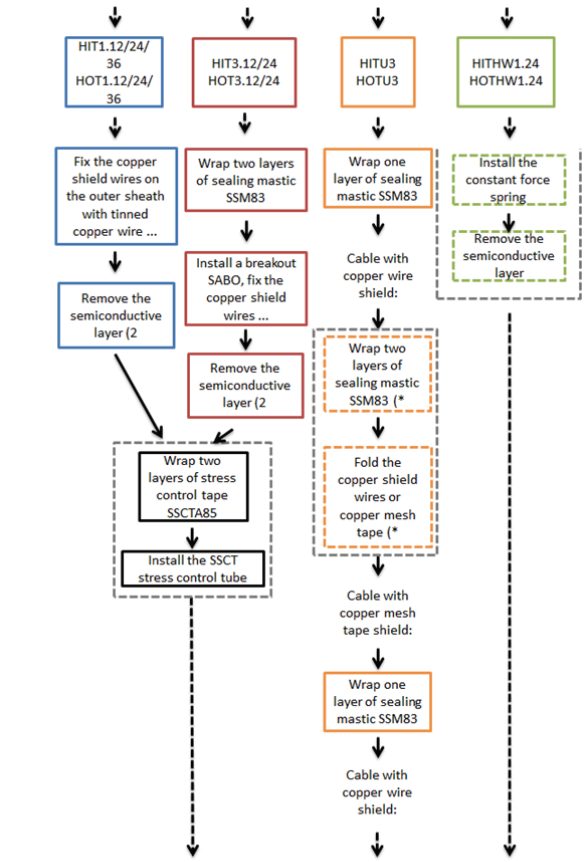
The last picture is the same in both HJT11.24 and HJTW11.24 i.i.s. and this picture is also a module.



3.2.3 Terminations for Plastic Insulation Cables

Four different installation instructions, HIT1.12/24/36 + HOT1.12/24/36, HIT3.12/24 + HOT3.12/24, HITU3 + HOTU3 and HITHW1.24 + HOTHW1.24, were compared in Plastic insulation cables –tree models. Picture 1. is the same in both HIT1.12/24/36 + HOT1.12/24/36 and HIT3.12/24 + HOT3.12/24 installation instructions. Also HITU3 + HOTU3 and HITHW1.24 + HOTHW1.24 have a same Picture 1. These both pictures are also modules.

Blue, grey and burgundy boxes with (1 –mark are almost the same, but the only difference in these pictures is the number of the cores. Some are one core and some are three core version. These pictures could be the same if the number of the cores does not need to be shown in these pictures. The above mentioned grey boxes are surrounded by grey dashed line box and they form a module. The grey dashed line box surrounded by green dashed line boxes, is the module, which is in all the "Wiski"-installation instructions.



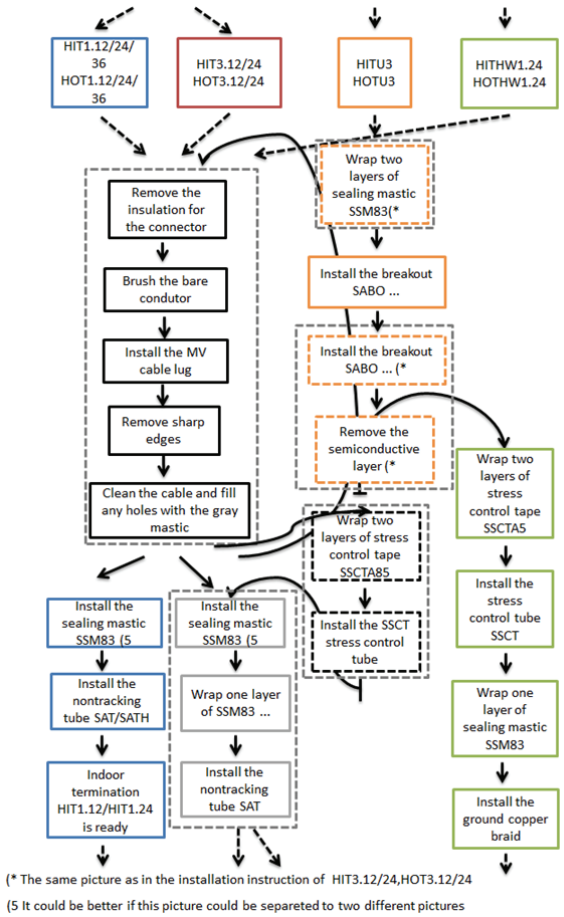
(2 This picture could be same if just one core is shown

(* The same picture as in the installation instruction of HIT3.12/24,HOT3.12/24

"Remove the semi conductive layer" –pictures could be the same, if only one core is shown in these pictures.

After the above mentioned pictures the order of the instruction changed, see the black boxes. These black boxes are a one module.

A couple of the pictures are the same than in the installation instruction of HIT3.12/24 and HOT3.12/24; see the orange boxes with dashed lines. These two pictures create one module.

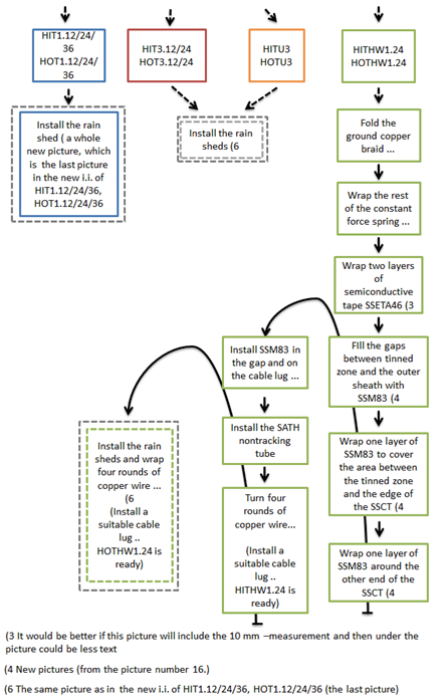


There is a "Install a cable lug" –module which is repeated e.g. in most of i.i.s of the transitions, see the black boxes at the left side of the tree model surrounded with grey dashed line box. HITU3/HOTU3 installation instruction include two different modules in this page, see orange dashed line boxes by surrounded grey dashed line boxes.

"Install the stress control tube SSCT" and "Wrap one layer of sealing mastic SSM83" –pictures (see the green boxes) were first one picture, but it is clearer if they are two different pictures.

"Install the sealing mastic SSM83" –pictures (see the blue and grey tree model alongside) includes very much information, thus it could be better to separate the information into two different pictures.

Three grey boxes are the same both in HIT3.12/24 + HOT3.23/24 and HITU3 + HOTU3 i.i.s and these boxes are also one module. Black dashed line boxes surrounded by grey dashed line box are the same as in the previous page.

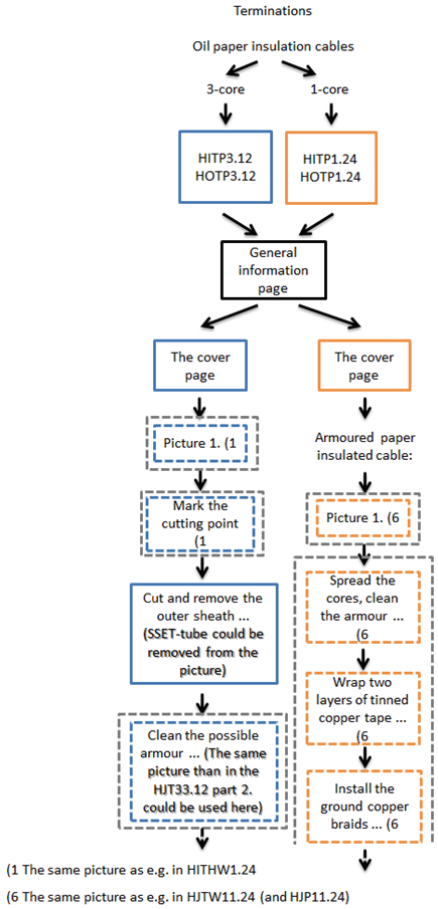


Graph 3. Tree model of termination for plastic ins. cables. [HIT1.12/24/36 and HOT1.12/24/36: PEM1093ENG; HIT3.12/24 and HOT3.12/24: PEM1076ENG; HITU3/HOTU3: PEM1096ENG; HITHW1.24/HOTHW1.24: PEM1318ENG]

"Install the rain sheds" – pictures were the same in the two i.i.s, see grey dashed line boxes, and because the only things which are changing in these pictures are the number of the rain sheds and measures, it is better to connect these pictures to one picture and document information to the table. For clearer information see the last installation picture of the new installation instruction.

Green box with (3 –mark includes text "Continue to cover 10 mm of …", but instead of this text it could be better, if this 10 mm measure could be included in this picture and text could be much shorter.

Green boxes with (4 –mark were first only one picture, but it is much clearer if this picture could be separated to tree different pictures.

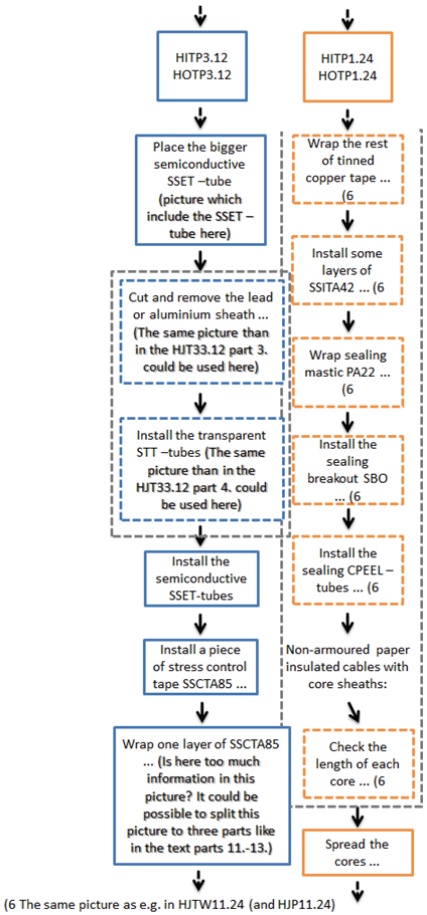


3.2.4 Terminations for Oil Paper Insulation Cables

In this tree model two different oil paper insulation cable terminations were compared to each other and to the other tree models. One was three core termination HITP3.12/HOTP3.12) and the other was one core termination HITP1.24/HOTP1.24. Specified explanations for these abbreviations are located in the part named Abbreviations.

Blue dashed line boxes with (1 –mark are the same as in the i.i. of HITHW1.24, and they are also modules. The last blue dashed line box is also a module and it could be possible to use the same picture as in the i.i. of HJT33.12 part 2.

Orange boxes with dashed-lines are the same as e.g. in the i.i. of HJTW11.24 and also some of these pictures are the same as in the i.i. of HJP11.24. Three of these orange dashed line boxes are surrounded by grey dashed line box, which are continued to the next page, and forms a module.

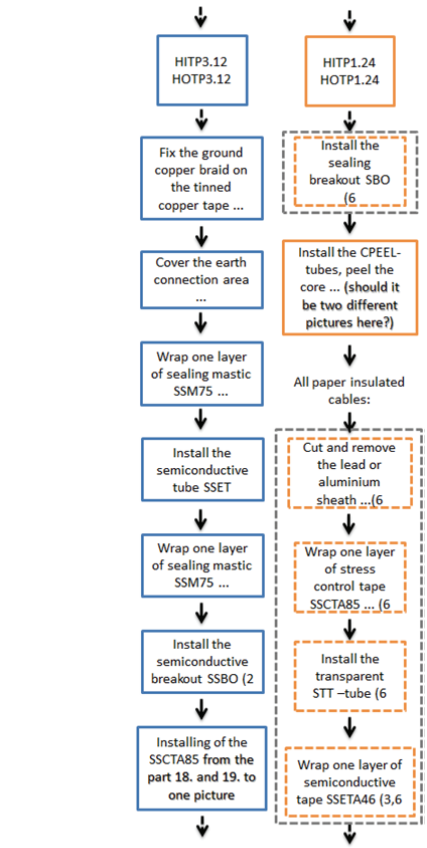


"Place the bigger semi conductive SSET –tube" –part does not include a picture in which this SSET –tube is. That is why it would be better to put here a picture where the tube is. See the blue box on top of the tree model.

Both blue boxes with dashed-lines could be the same as in the i.i. of HJT33.12. These pictures are also a module.

Orange dashed-line boxes with (6 –mark are the same as for example in the i.i. of HJTW11.24. These pictures create a module which is continued from the previous page.

The last blue box is currently a picture which includes a great amount of information and thus it could be better to separate this picture for example into three different pictures like in the text parts 11. – 13. in this HITP3.12 / HOTP3.12 i.i.

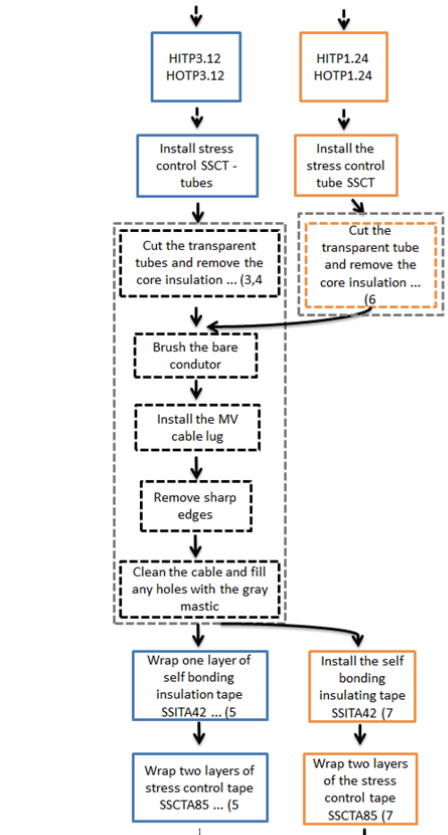


(2 A little modified picture, see next phase (box)
(3 New order
(6 The same picture as e.g. in HJTW11.24 (and HJP11.24)

The last two blue boxes are two different pictures, but it could be better to modify these pictures a little. "Installing the semiconductive breakout SSBO" could be one picture. The other picture could include the second part of the text instruction from the part 18, where this SSBO installing is, and also this same picture could include the 19th part.

Orange dashed line boxes with (6 –mark are still the same as for example in the i.i. of HJTW11.24. The installation phase, described in the last orange box, is moved a little more forward than in the current i.i., because of the new "cable lug installing" –module. Also these orange dashed line boxes create modules, see boxes surrounded by grey dashed line boxes.

"Install the CPEEPL- tubes, peel the core …" –picture could be separated into two different pictures. The first one could be "Install the CPEEPL –tubes" and the other could be "Peel the core …".

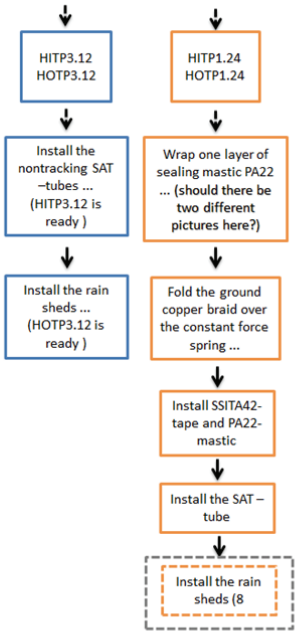


Black dashed line boxes surrounded by grey dashed line box is as mentioned before, "cable lug installation" –module, which has been described before at the other tree models. In this module the order of the pictures is new, and there are also new pictures/installation parts. First of these black boxes is the same picture as in i.i. of HJT33.12 part 6.

Two blue boxes with (5 –mark are one picture (part 22.) at the current i.i., but it would be better if this picture could be separated to two different pictures.

"Cut the transparent tube and remove the core insulation …" –picture is the same as e.g. in HJTW11.24 i.i. and it is also a one module, see the orange dashed line box surrounded by grey dashed line box.

Picture in the part 21. of the current i.i. is separated to two different pictures, because this part is clearer with two pictures. See two orange boxes with (7 –mark.



(8 The same picture as the last picture in the new i.i. of HIT1.12/24/36, HOT1.12/24/36

Graph 4. Tree model of terminations for oil paper insulation cables. [HITP3.12/HOTP3.12 PEM1078ENG, HITP1.24/HOTP1.24 PEM1088ENG]

"Wrap one layer of sealing mastic PA22 …" –picture includes quite a lot of information and it could be better to separate this picture into two different pictures.

Picture "Install the rain sheds" consists of two different pictures in the current i.i., but these pictures could be combined into one picture. This picture could be the same or same kind as in the new i.i. of HIT1.12/24/36 + HOT1.12/24/36.

Also the current installation instruction includes text parts, which includes only one text part e.g. "HITx.xx is ready to use". All of these text parts could be included to the instruction text in the pictures above.

4 Results and Analysis

4.1 Finding Modules

Modules (picture or pictures which is/are repeating in two or more installation instructions) were found quite many. At the moment there are a lot of pictures which are almost the same, but not exactly. That is why i.i.s. were reviewed thoroughly and similar pictures and entities were discovered.

It was decided that both one and many same pictures create one module. All of these modules are shown in the tree models surrounded by light gray dashed line boxes.

In this research quite many repeating pictures were found. The amounts of modules are shown in the table 1. and 2. in the chapter 5.

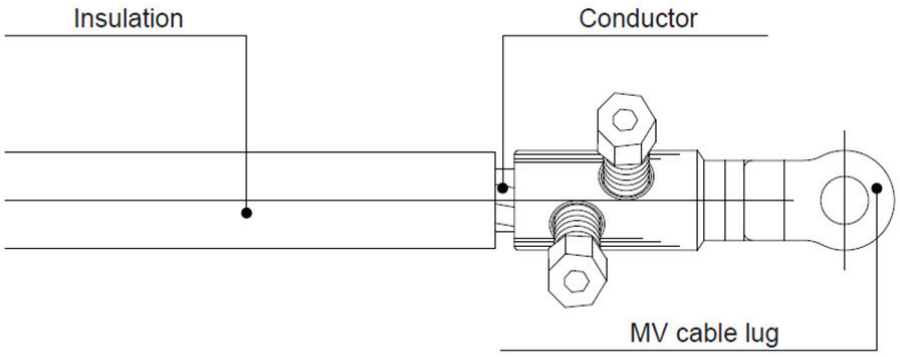
4.2 Solutions for Pictures

There is a great amount of pictures in current installation instructions. One purpose of this study was to find out if there are quite similar pictures which could be replaced with one picture, and also if there are some instruction parts which include a lot of text but just one picture. To these parts were included one or more instructions pictures, which makes possible to shorten the length of the instruction text parts and makes the installation parts easier to understand and follow.

Pictures in the current installations are now grey scaled. It could be also possible to use colored pictures, partly colored pictures or photographs.

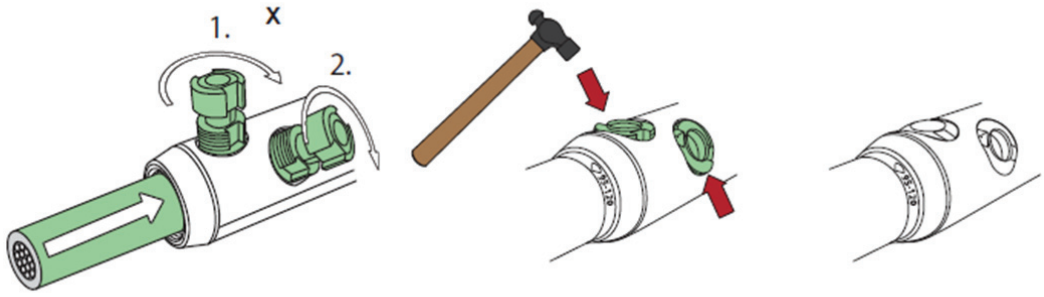
Grey scaled pictures are quite simple and also quite easy to update, because colors are always the same. But as mentioned before in chapter 2.4.2., the vector graphic takes a lot of time to update. One possibility is to draw all these old pictures again e.g. with Adobe Illustrator –program, because Illustrator makes also vector graphic pictures, but with bigger entities and then these pictures are easier to update.

Grey scaled pictures are not very illustrative and that is why there has to be at least a little installation text. Picture 14 is an example of gray scaled picture, and it includes the installation text: "Install a suitable cable lug following the manufacturer's instructions. Remember to orient it correctly and remove any sharp edges. Fill the holes with grey mastic." As one can see, there is a great amount of installation text which needs to be translated and updated for many different languages.



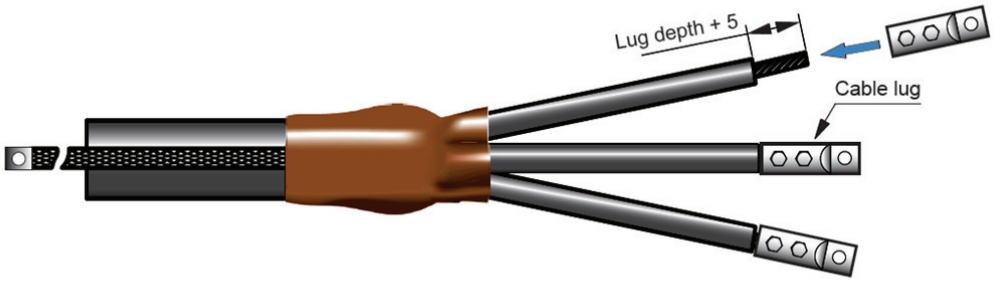
Picture 14. An example of installation of the cable lug using a gray scaled picture. [PEM1093ENG]

Partly colored pictures are modified from the grey scaled pictures, for an example see picture 15. They are also made with the vector graphic, but they are more illustrative than grey scaled pictures. An installer could easily see what part of installation is going on. The updating of these pictures is as simple as updating the old grey scaled pictures, but if it is possible to draw these pictures again with the Adobe Illustrator- program they could be easier to update, because then one picture consist of entities, not just many lines, as it is currently. These partly colored pictures do not need any installation text, and that is why it could be possible to do only graphical installation instruction. These graphical i.i.s are better than i.i.s at the moment, because there is no need for language versions.



Picture 15. The partly colored picture. [PEMJNiENG]

Some of current installation instructions are made with Illustrator-program. These kind of i.i.s have been mostly made for the cold shrink accessories, but a few have been made also for heat shrink accessories. Picture 16 is an example of these pictures. It is quite illustrative and also quite realistic. Updating of these pictures is a little easier than updating gray scaled vector graphic pictures, and it is also possible to draw these pictures with layers, see chapter 3.1.2 for more information of layers. These Illustrator – pictures include installation texts, e.g. picture 16 includes the text: "Remove the insulation for the length equivalent to the bolt cable lug depth + 5 mm. If you use a compression lug, remove the insulation according to the lug manufacturer's instructions. Remember to orient it correctly and remove any sharp edges. Fill the holes with grey mastic." It could be possible to make i.i.s with these pictures without texts if the amount of pictures would be increased.



Picture 16. An example of colored picture. [PEM1332ENG]

Photographs are also one option with different pictures. They are very informative and illustrative. One example of photographed picture is picture 17. Installation texts are not necessary with these photographs, but the example picture includes an installation text: "Install a suitable cable lug following the manufacturer's instructions. Clean the cable insulation and the semi conductive layer with a cleaning tissue starting from the insulation and move towards the semi conductive layer. Orient the cable lug correctly. Remove all sharp edges from the cable lug." Photographs are illustrative and they could be a good option for the installation pictures, but they are not easy to update. If one needs to update some photograph, the only choice is to take a new photograph, and it means that the whole cable accessory needs to be installed until the part which is wanted to be photographed. And if there are many updates, it would be very time consuming.

Picture 17. An example of installation of the cable lug using a photograph. [11]

The best choices for installation pictures are the partly colored pictures or the colored Illustrator- pictures, because they are the easiest to update and also illustrative enough.

4.3 Texts

Almost all the texts in the installation instructions are too long at the moment. The updating of the texts to different languages takes a lot of time, and that is why it could be better if the information in these texts could be moved to the instruction pictures instead of writing a lot of text.

Shortening of the instruction texts, the use of bulleted points (see picture 12) to separate different parts of installations and using exclamation mark to emphasize important phases of installations were decided to be used in new installation instructions.

Instruction texts could be shorter so it would be easier to read and understand the instructions. These text parts would also be easier to update to different language versions. Texts of the installation instruction PEM1093ENG were modified. As an example, the installation text in the part 6. of i.i., where before the installation text was: "Fix the copper shield wires on the outer sheath at 80 mm from the sheath edge with a minimum of 5 rounds of the tinned copper wire. Twist the copper shield wires into a stranded conductor. Install a suitable LV cable lug following the manufacturer's instructions. Remember to orient it accordingly". Now, this same installation text is: "Wrap tinned copper tape around the cable. Twist the copper shield wires. Install LV cable lug". [8]

With the help of better pictures it is possible to make even shorter installation texts and maybe to remove them completely one day.

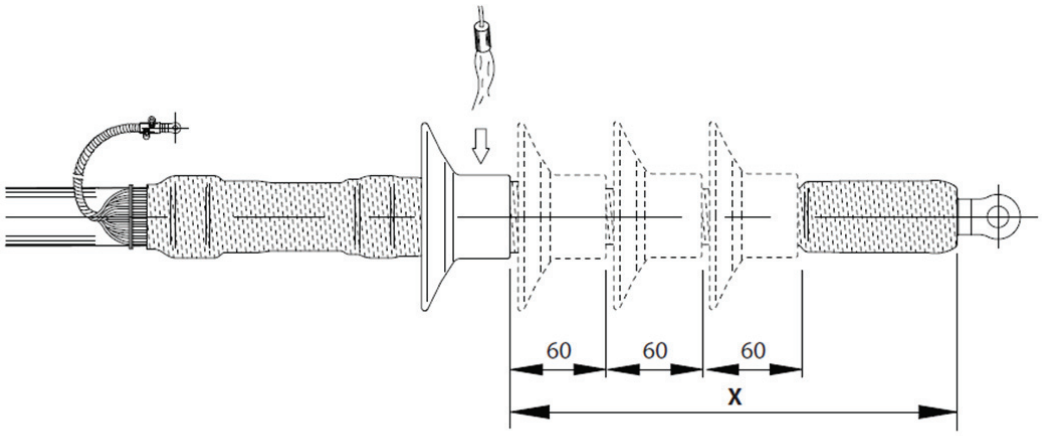
4.4 New Installation Instruction

One purpose of this study was to find out how new installation instructions could be easier to make and how these installation instructions could be as similar as they can be. Pictures, texts and the structure of pages have an effect on this minor problem.

It was decided to make the new installation instruction for the PEM1093ENG i.i., see appendix 2. This is a general i.i. for the heat shrink terminations for single core cables.

First this new installation instruction, version 1., included a new Symbols and markings –page which was placed after General information –page. Texts were a lot shorter than in the current installation instruction and they were written with the bulleted points. Very important texts were written with exclamation mark with the italic font after these main installation texts. A couple of new pictures were added, e.g. "Brush the bare conductor" and "Remove sharp edges". Texts in the pictures were replaced with the surrounded numbers and codes which were explained in the Symbols and markings-page. One new symbol, rounded arrow with the number, was added, to show how many rounds e.g. different mastics need to be installed.

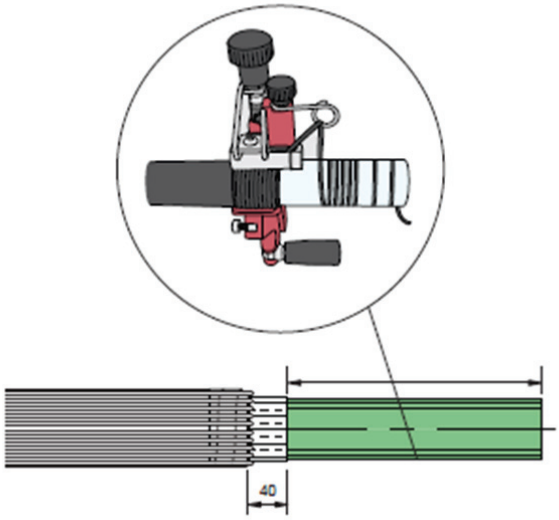
The second version was a little different than the first one. These circled numbers in the first version were little unclear and that is why it was decided to put a picture of the cable structure to the Symbols and markings –page where different layers of the cable were shown. The layers were different and that is why it is easier to see which layer is which. All the layers in the installation pictures were updated and the circled numbers were removed. Now only the cable structure -picture includes these numbers. Some of the pictures in this installation instruction were updated. One example is "Wrap SSCTA85 tightly by stretching it a bit" –picture, in which mastic stretching part was added. Also one big change was rain shed pictures. First there were four different pictures to rain shed installations. In this new i.i. these four pictures were combined to one picture, see picture 18, and under this picture a table where all these products, measurements and the number of rain sheds were shown was added.



Picture 18. New picture for the installation of the rain sheds. [PEMJNiENG, version 2.]

The second version included some mistakes and deficiencies and that is why a lot of pictures needed to be updated. One new picture was added to the third version: wrapping mastic with 50 % overlap. Also grinding the insulation was drawn in the same picture as removing the semi conductive layer. The biggest change between the second and the third version were colors. To the third version green color was added to every picture to show what part of accessory was installed at the moment. If the SSCTA85 mastic was installed, only the SSCTA85 mastic was green and the other parts of the picture were gray scaled. These partly colored pictures are much more illustrative than the only grey scaled pictures. For an example of these partly colored pictures see picture 15.

Because the third version included so illustrative pictures, it was possible to leave all the installation texts away from the pictures. Again a few pictures were added to the fourth version; see picture 19 as an example. The only necessary installation texts were "If semi conductive layer is not strippable by hand, use a suitable tool" and "If necessary, remove any remaining of the semi conductive layer with a piece of glass", and these texts were moved to the General information –page. Also the **x**= see manufacturer's instructions was kept and this explanation was moved to the Symbols and markings –page. Because the tables in this i.i. included also texts, these texts were removed and only international terms ($mm^{2,}$, kV and so on) and product names were left. Table 1 was renamed as T1 and table 2 as T2. Because of these changes it is possible to use this installation instruction in every country where it is needed, and only the first General information- page and the Symbols and markings –page need to be translated to different language versions.



Picture 19. A new picture, removing the semi conductive layer, in the tenth version of the new i.i. [PEMJNiENG]

Updating of this new installation instruction was quite long and in the end there were ten different version of this i.i. Every time there was something little to add or remove and now the last version, see appendix 3, includes texts only in the first two pages and otherwise is graphical i.i. This installation instruction is much easier to update than the old ones, because all translated parts are only on first two pages which are almost same in every i.i.s. That is why it could be possible to use this i.i. in every needed country and only these first two pages change as the language changes.

4.5 Database System

As a solution to make the structures similar in all installation instructions, a standardized template base could be used. These templates could contain boxes/surrounded areas (e.g. in one page two boxes) where the picture and instruction texts will be placed. See appendix 1. The amount of these templates should be maximum three or four so that all i.i.s could preserve the same structure.

All the different languages could have a different number, e.g. Finnish 1.1 (at first the number of the text part in the picture and then the language number), Swedish 1.2 etc. All the instruction texts after these above mentioned bulleted points could have

their own number. In the database system there could be e.g. an excel-table which could include these numbers and instructions texts in different languages. These numbers could be added to pictures in i.i. and these added numbers in the pictures could import the right texts to the right places from the excel-table. See appendix 1.

4.6 Picture Bank

It would be helpful to use a so called picture bank. Picture bank could be a place or a part of the database system where all the pictures of the installation instructions could be stored. It should be easy to go to the picture bank and see if there is a picture which one could use e.g. when one is creating a new i.i.

All these pictures in this picture bank have to be standardized. If all the pictures in this picture bank could be made with e.g. Pro Engineer –program, they could be easily imported to the installation instructions from the picture bank.

One problem in this picture bank is who can edit these pictures, and update the whole system. If all the designers have the freedom to do above mentioned things, the picture bank can get mixed up. That is why there should be only one or two persons who would update this system or very clear rules to updating and using this picture bank.

Also the documentation and the form of the picture bank should be quite simple, so that everybody who want to use this bank could easily find the right picture he or she wants to use.

5 Discussion and Conclusions

Almost 20 different installation instructions were studied in this study. As a result the amount of pictures in these i.i.s increased, but because of the modules the total amount of these pictures decreased. The amounts of these pictures and modules in separated i.i.s are shown in table 1, and the amounts of pictures in tree models are shown in table 2.

Product	Installation instruction	The amount of pictures before	The amount of pictures after	The amount of modules
HJW11.24	PEM1068ENG	21	24	5
HJ11.36	PEM1104ENG	19	24	8
HJ11.12, HJ11.24	PEM1091ENG	17	21	7
HJ33.12, HJ33.24	PEM1077ENG	18	22	4
SJE42, SJE43	PEM1103ENG	21	25	5
SJEW42, SJEW43	PEM1094ENG	30	28	3
HJT31.12	PEM1086ENG	49	64	6
HJT33.12	PEM1102ENG	29	35	7
HJT11.24	PEM1188ENG	34	40	11
HJTW11.24	PEM1092ENG	52	53	13
HJP11.24	PEM1090ENG	27	33	7
HIT1.12/24/36 + HOT1.12/24/36	PEM1093ENG	18	19	4
HIT3.12/24/36 + HOT3.12/24/36	PEM1076ENG	18	21	6
HITU3, HOTU3	PEM1096ENG	21	25	9
HITHW1.24+HOTHW1.24	PEM1318ENG	21	27	3
HITP3.12 + HOTP3.12	PEM1087ENG	20	30	5
HITP1.24+ HOTP1.24	PEM1088ENG	27	35	7

Table 1. The amount of pictures and modules in the installation instructions.

Tree model:	The amount of pictures before	The amount of pictures after	The amount of modules
Joints: Plastic insulation cables	126	69	15
Joints: Transition - oil-paper cable	191	120	24
Terminations: Plastic insulation cables	78	51	14
Terminations: Oil-paper insulation cables	47	31	11

Table 2. The amount of pictures before and after this study and the amount of modules in the tree models.

In the end the amount of the pictures in the individual installation instructions grew up about 20 %. On the other hand same pictures can be used directly in many different i.i.s and that is why the total amount of all pictures in the studied i.i.s has decreased about 40 %. Because of this updating process of i.i.s will be much quicker and simpler.

5.1 Final Result

The goal of this study, was to create a new installation instruction.

The process of making a new i.i. was quite long. The amount of different versions of this new i.i. was ten in the end. First it was decided to remove texts from the pictures and replace those with codes and symbols, which could be same in all different language versions. Also instruction texts needed to be shorter than they were. Instruction phases and order were founded from the tree models.

While working on this new i.i., many parts of it changed. For example some missing parts were added to pictures, instruction texts were shortened and tables were added. Also some new pictures were added, and one big change was to change the instruction pictures to partly colored pictures, so it would be easier to follow the installation. In the end pictures were so informative that it was decided to remove all the instruction

texts and use only pictures in the i.i. The only texts in this i.i. stayed in the General information and legal notice -page and Symbols and markings -page.

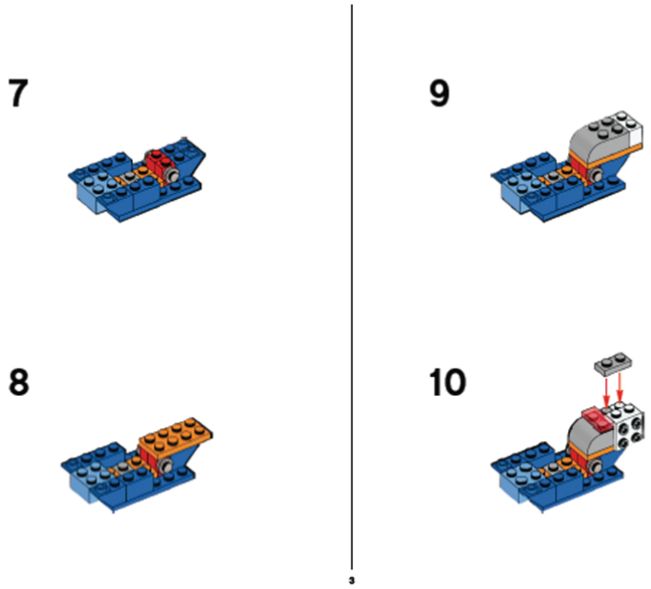
The final result of this study was a graphical installation instruction. This i.i. is now much easier to update and also more cost-efficient, because there is much less work to do with this i.i.

5.2 Future

This study gave some different options to draw pictures, use texts and make or update installation instructions. In the future these i.i.s could be done better than now and use e.g. more colors when showing different phases of installation.

In the future it should be studied how pictures used in these i.i.s could be easier to update or create and how the pictures in i.i.s could be scaled much easier to different types of cables. To help this updating and developing work, some kind of database system with picture- and text bank could be created with the help of the tree models and standardized template pages. As a patch it could be possible to color current installation pictures partly to make i.i.s easier to follow, but maybe it is better to draw all the pictures again to better format than use the old ones anymore.

There are also many different choices for appearance of these i.i.s. They could be for example same kind as i.i.s of LEGOs. One part of these i.i.s is shown in the picture 20. These i.i.s are whole without texts and very simple to follow because new part of installation is shown clearly and with real colors of legos.



Picture 20. An example of installation instruction of LEGO. [12]

Someday it could be possible that every installer has a tablet computer and they could follow installation instruction from it. Then videos or 3D –models from different part of installation could be useful.

6 Summary

This study consisted of many different phases. First many different installation instructions were studied. Many problems were found from these installation instructions: updating these with different language versions, updating pictures and making whole new installation instructions. In this study different solutions to solve these problems were discussed.

From these above mentioned installation instructions four different tree models were created. These models included explanations from all the pictures from the above mentioned installation instructions, and also similar and repeating pictures which created different modules.

At the same time when tree models were created, some installations were made using installation instructions which were used in this study. With the help of these installations, it was easier to understand what kind of work installers are doing and how they can see these installation instructions and possible problems in them.

When this researching part was done, it was possible to start to create new installation instruction. Many different versions were made and different solutions were tested. In the end it was decided to remove all instruction texts from the pictures, which were now partly colored so that they are easier to follow. A few new pictures and tables were added, and the result was the graphical installation instruction. Only first two pages include some texts which need to be translated.

As a summary I can recommend that these five main principles are good to follow:
There should be no text, only product codes in the pictures. New added things in the pictures should be always with a color. In a picture only one phase, for example installing of only one type of mastic, tube etc. should be explained. There should be more pictures to ensure enough information for the installer. If a text is used to describe installation, it should be short and exact.

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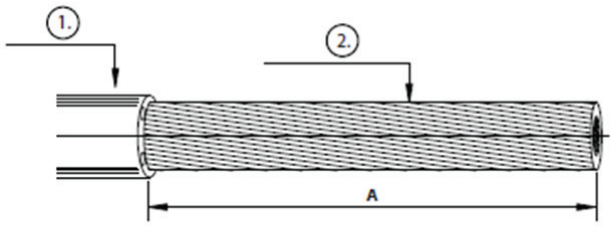
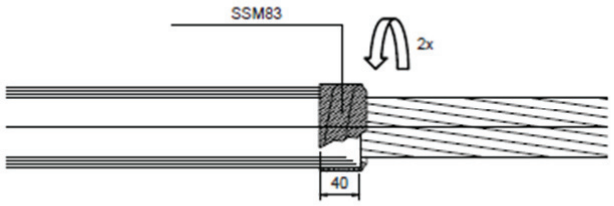
12 The LEGO group, (2012), http://creative.lego.com/en-us/downloads/default.aspx?icmp=COUS9HomeRE3BricksandMore (Accessed Mar 5, 2012)

Template of the Installation Instruction Page

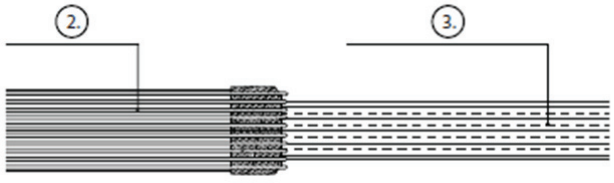


3. ☐ Cut and remove the outer sheath and tapes from A.



4. ☐ Wrap SSM83 tightly by stretching it.

! Wrap with 50% overlap



5. ☐ Fold copper shield wires over the outer sheath. Do not cut them!

ENSTO

INSTALLATION INSTRUCTION

PEM1093ENG
2011-03

HEAT SHRINK TERMINATIONS FOR SINGLE CORE CABLES
INDOOR TERMINATIONS HIT1.12, HIT1.24 AND HIT1.36
OUTDOOR TERMINATIONS HOT1.12, HOT1.24 AND HOT1.36

ENGLISH

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36

GENERAL INFORMATION

- Check that the kit is suitable for the cable type.
- Check the materials listed in the bill of materials for completeness.
- Read the installation instructions carefully before starting the installation.
- Install carefully and make sure the materials are clean during the installation.
- Clean the working place after the installation.

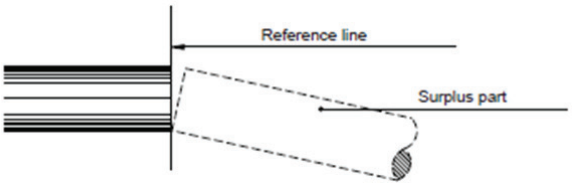
GENERAL INSTRUCTIONS FOR HEAT SHRINKING

- Please note that in some working places a hot work permit is needed.
- Use a propane burner with a flame length of approx. 20-30 cm. Do not use too large or sharp flame.
- Move the flame all around the cable on the shrinking direction. Move the flame continuously to avoid overheating.
- Make sure that the ventilation is good and there are no flammable materials around.
- Clean the cable surfaces before shrinking.
- When shrinking, always follow the installation instructions and the relevant sequence to avoid trapped air.
- Check that the tube has shrunk evenly around the cable before you continue shrinking.
- If the tube turns around at the end of shrinking, straighten the tube by directing the flame inside the tube from the opposite direction.
- After shrinking the tubes should be smooth and even following the shape inside.

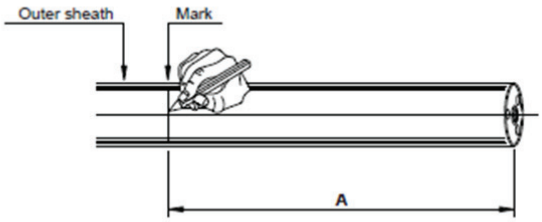
LEGAL NOTICE

- The product must be installed only by a competent person with sufficient training in installation practices and with sufficient knowledge of good safety and installation practices in respect of electrical equipment. If local legislation contains provisions in respect of such training or sufficient knowledge in respect of installation of electrical equipment such provisions shall be fulfilled by the said person.
- Ensto accepts no liability concerning claims resulting from misuse, incorrect installation or ignored national safety regulations or other national provisions.
- WARNING: Failure to follow the installation instructions may result in damage to the product and serious or fatal injury.

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36



1. Check the length of each core according to the final installed position.



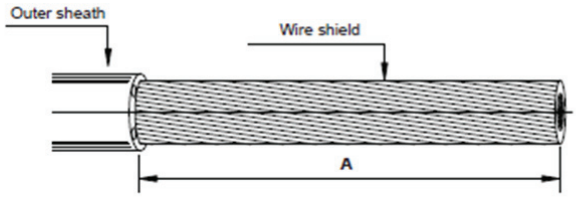
2. Mark the cutting point at the distance of A, see table 1, from the core end.

Table 1
CABLE PREPARATION DIMENSIONS

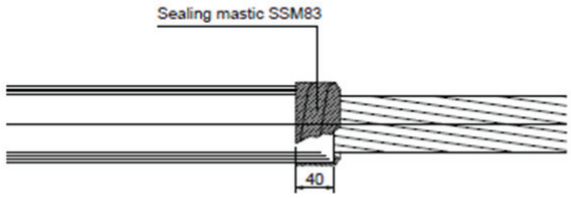
Kit	Um kV	Cable size mm²	Outer sheath removal A mm	Kit	Um kV	Cable size mm²	Outer sheath removal A mm
HIT1.1202	12	25-95	260	HIT1.3601	36	25-95	450
HIT1.1203	12	95-240	260	HIT1.3602	36	95-150	450
HIT1.1204	12	150-300	260	HIT1.3603	36	120-300	450
HIT1.1205	12	400-630	330	HIT1.3604	36	400-630	480
HIT1.1206	12	800-1000	360	HIT1.3605	36	800-1000	510
HOT1.1202	12	25-95	260	HOT1.3601	36	25-95	450
HOT1.1203	12	95-240	260	HOT1.3602	36	95-150	450
HOT1.1204	12	150-300	260	HOT1.3603	36	120-300	450
HOT1.1205	12	400-630	330	HOT1.3604	36	400-630	480
HOT1.1206	12	800-1000	360	HOT1.3605	36	800-1000	510
HIT1.2402	24	25-95	310				
HIT1.2403	24	95-240	310				
HIT1.2404	24	150-300	310				
HIT1.2405	24	400-630	380				
HIT1.2406	24	800-1000	410				
HOT1.2402	24	25-95	310				
HOT1.2403	24	95-240	310				
HOT1.2404	24	150-300	310				
HOT1.2405	24	400-630	380				
HOT1.2406	24	800-1000	410				

PEM1093ENG 2011-03

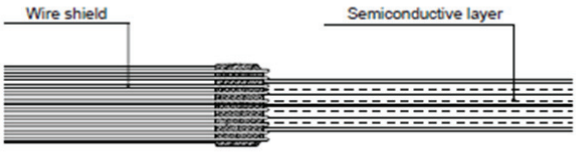
HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36



3. Cut and remove the outer sheath and the possible tapes from the marked dimension.

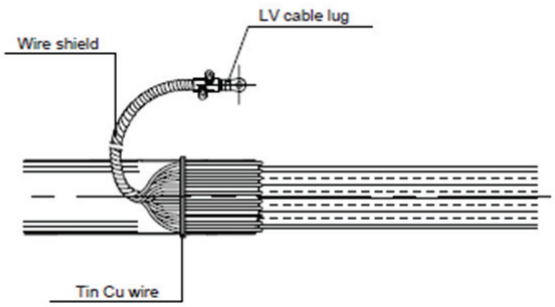


4. Wrap two layers of sealing mastic SSM83 on the outer sheath. Cover 40 mm distance from the sheath edge. Sealing mastic SSM83 must be wrapped by stretching it a bit.

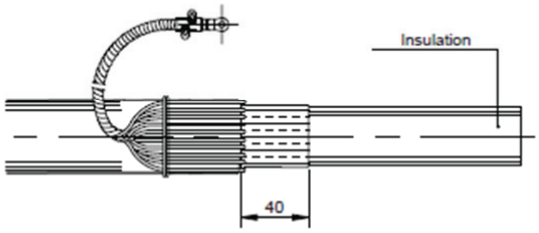


5. Fold the copper shield wires over the outer sheath. Do not cut them!

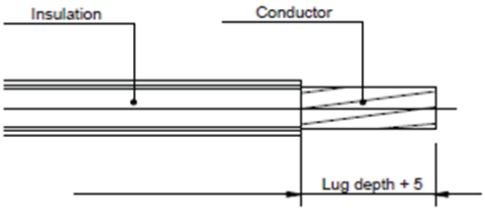
HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36



6. Fix the copper shield wires on the outer sheath at 80 mm from the sheath edge with a minimum of 5 rounds of the tinned copper wire. Twist the copper shield wires into a stranded conductor. Install a suitable LV cable lug following the manufacturer's instructions. Remember to orient it accordingly.



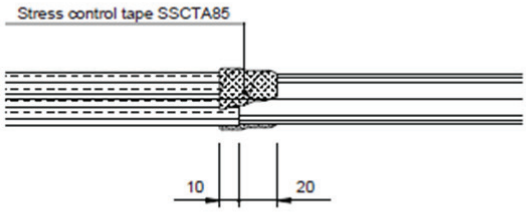
7. Remove the semiconductive layer leaving 40 mm measured from the outer sheath. If the semi-conductive layer is not strippable by hand, use a suitable tool. If necessary, remove any remain-ings of the semiconductive layer with a piece of glass. Use the grinding papers included in the kit to smooth the insulation.



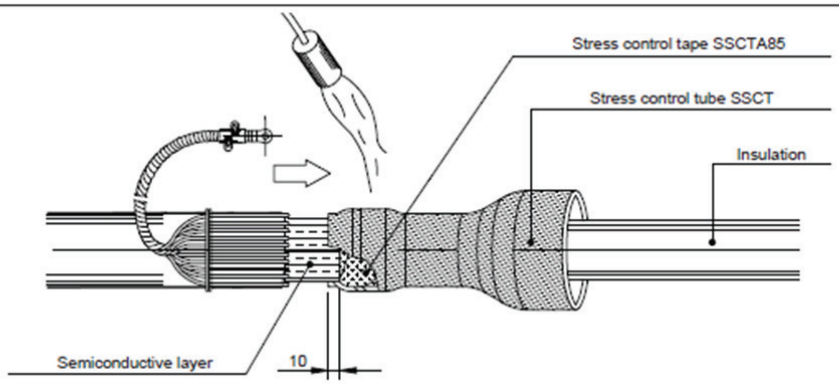
8. Remove the insulation for the length equivalent to the bolt cable lug depth + 5 mm. If you use a compression lug, remove the insulation according to the lug manufacturer's instructions. Be careful not to nick the conductor.

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36

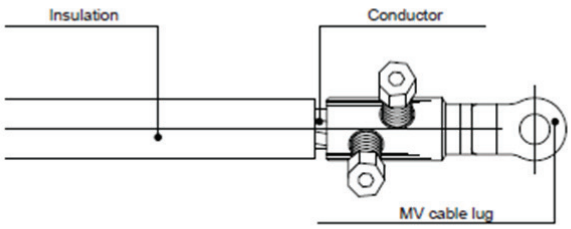
9. Clean the cable insulation with a cleaning tissue. Go towards the semiconductive layer and finally, clean the semiconductive layer without touching the insulation. Thus that no semiconductive particles are deposited on the insulation. Clean the conductor.



10. Wrap two layers of stress control tape SSCTA85 over the edge of the semiconductive layer. Wrap the tape for 10 mm on the semiconductive layer and 20 mm of the insulation. Start from the semiconductive layer. Stress control tape SSCTA85 must be wrapped with a 50 % overlap and by stretching it to half of its original width.

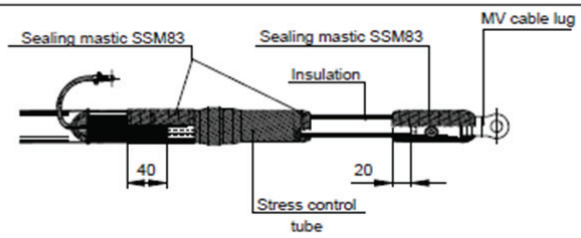


11. Place the SSCT stress control tube so that it overlaps 10 mm of the semiconductive layer. Start shrinking the tube from the end on the semiconductive layer and continue towards the other end.

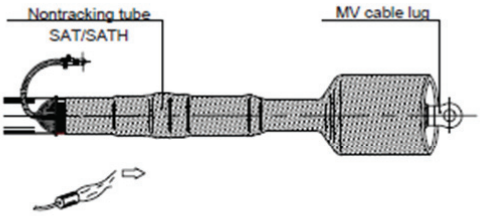


12. Install a suitable cable lug following the manufacturer's instructions. Remember to orient it correctly and to remove any sharp edges. Fill the holes with grey mastic.

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36

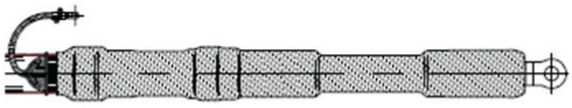


13. Fill the gap between the end of the cable lug and the insulation with sealing mastic SSM83. Then apply two layers of sealing mastic SSM83 to cover 20 mm of insulation and the barrel of the cable lug. Wrap one layer of sealing mastic SSM83 around the top end of the SSCT stress control tube to fill and smooth the transition between the tube and the insulation. Wrap two layers of sealing mastic SSM83 starting from the end of the SSCT stress control tube. Cover the semiconductive layer and continue 40 mm on the copper shield wires. Sealing mastic SSM83 must be applied by stretching it a bit.



14. Place the SAT/SATH nontracking tube so that it covers the cable lug barrel completely. Shrink the tubes starting from the cable sheath end.

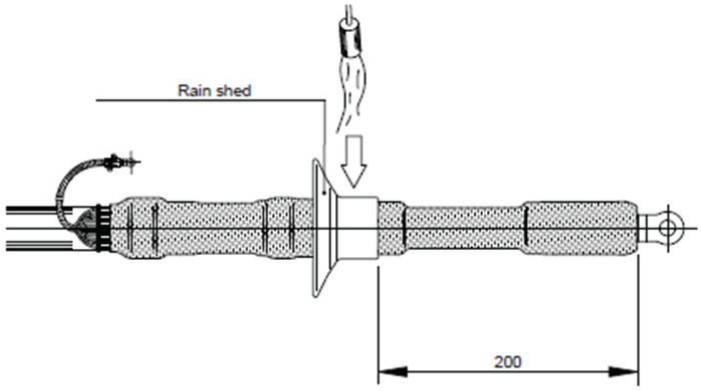
12/24 kV INDOOR TERMINATION HIT1.12/HIT1.24



15. Indoor termination HIT1.12/HIT1.24 is finished and ready to use!

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36

12 kV OUTDOOR TERMINATION HOT1.12

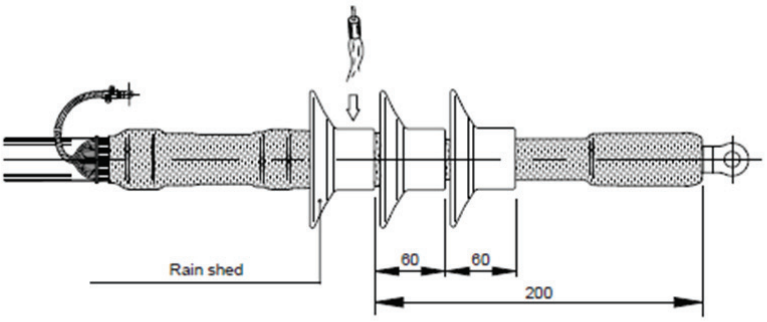


16. Place the rain sheds immediately after shrinking the SAT/SATH nontracking tubes so that the shed neck edge is at 200 mm from the nontracking tube end. Shrink the rain shed directing the heat only to its neck.

17. Outdoor termination HOT1.12 is finished and ready to use!

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36

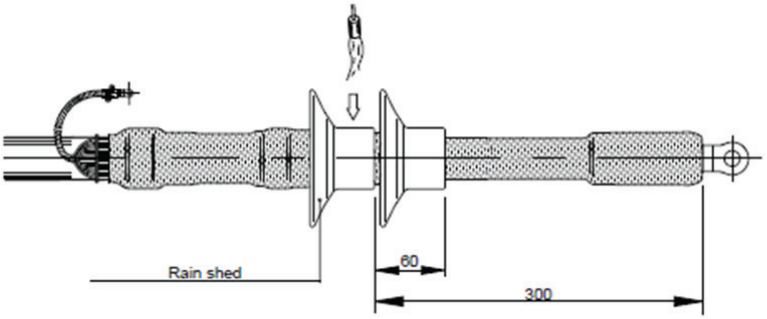
24 kV OUTDOOR TERMINATION HOT1.24



18. Place the rain sheds immediately after shrinking the SAT/SATH nontracking tubes so that the shed neck edge is at 200 mm from the nontracking tube end. Shrink the rain shed directing the heat only to its neck. Shrink the other two rain sheds so that they are spaced 60 mm.

19. Outdoor termination HOT1.24 is finished and ready to use!

36 kV INDOOR TERMINATION HIT1.36

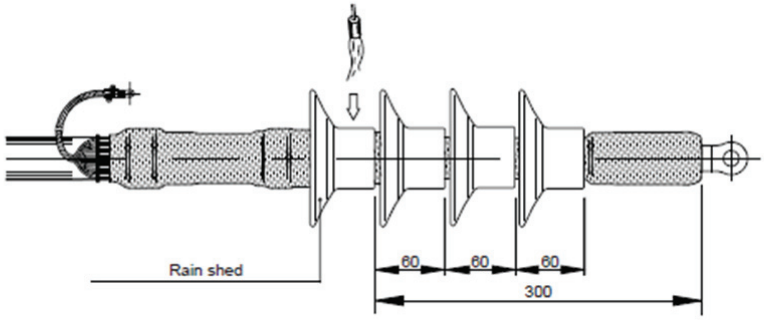


20. Place the rain sheds immediately after shrinking the SAT/SATH nontracking tubes so that the shed neck edge is at 300 mm from the upper edge of the nontracking tube end. Shrink the rain shed directing the heat only to its neck. Shrink the other rain shed so that it is spaced 60 mm.

21. Indoor termination HIT1.36 is finished and ready to use!

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36

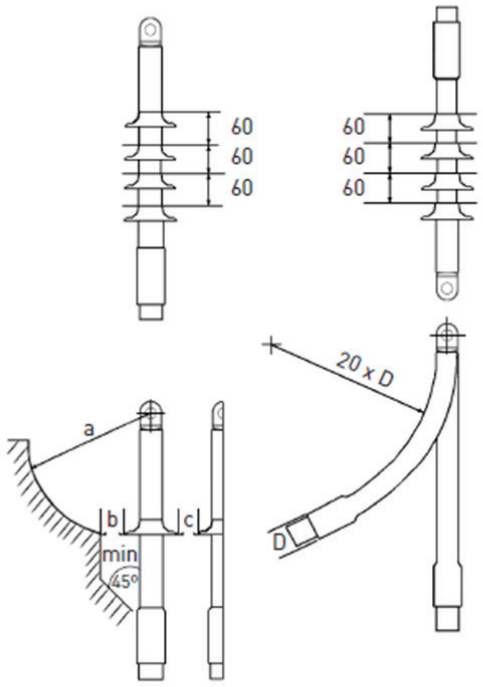
36 kV OUTDOOR TERMINATION HOT1.36



22. Place the rain sheds immediately after shrinking the SAT/SATH nontracking tubes so that the shed neck edge is at 300 mm from the nontracking tube end. Shrink the rain shed directing the heat only to its neck. Shrink the other three rain sheds so that they are spaced 60 mm.

23. Outdoor termination HOT1.36 is finished and ready to use!

HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36



a = according to local requirements

Um kV	b min mm	c min mm
12	15	10
17,5	20	15
24	25	20
36	35	25

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INSTALLATION INSTRUCTION PEMJNiENG
2012-05

ENGLISH

HEAT SHRINK TERMINATIONS FOR SINGLE CORE CABLES
INDOOR TERMINATIONS HIT1.12, HIT1.24 AND HIT1.36
OUTDOOR TERMINATIONS HOT1.12, HOT1.24 AND HOT1.36

GENERAL INFORMATION

- Check that the kit is suitable for the cable type.
- Check the materials listed in the bill of materials for completeness.
- Read the installation instructions carefully before starting the installation.
- Install carefully and make sure the materials are clean during the installation.
- Clean the working place after the installation.

GENERAL INSTRUCTIONS FOR HEAT SHRINKING

- Please note that in some working places a hot work permit is needed.
- Use a propane burner with a flame length of approx. 20-30 cm. Do not use too large or sharp flame.
- Move the flame all around the cable on the shrinking direction. Move the flame continuously to avoid overheating.
- Make sure that the ventilation is good and there are no flammable materials around.
- Clean the cable surfaces before shrinking.
- When shrinking, always follow the installation instructions and the relevant sequence to avoid trapped air.
- Check that the tube has shrunk evenly around the cable before you continue shrinking.
- If the tube turns around at the end of shrinking, straighten the tube by directing the flame inside the tube from the opposite direction.
- After shrinking the tubes should be smooth and even following the shape inside.

GENERAL INSTRUCTIONS FOR PEELING

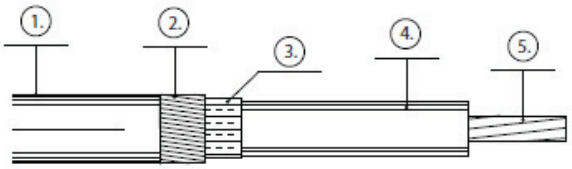
- If semiconductive layer is not strippable by hand, use a suitable tool.
- If necessary, remove any remainings of the semi conductive layer with a piece of glass.

LEGAL NOTICE

- The product must be installed only by a competent person with sufficient training in installation practices and with sufficient knowledge of good safety and installation practices in respect of electrical equipment. If local legislation contains provisions in respect of such training or sufficient knowledge in respect of installation of electrical equipment such provisions shall be fulfilled by the said person.
- Ensto accepts no liability concerning claims resulting from misuse, incorrect installation or ignored national safety regulations or other national provisions.
- WARNING: Failure to follow the installation instructions may result in damage to the product and serious or fatal injury.

SYMBOLS AND MARKINGS

CABLE



1. = Outer sheath
2. = Wire shield
3. = Semiconductive layer
4. = Insulation
5. = Conductor

SYMBOLS

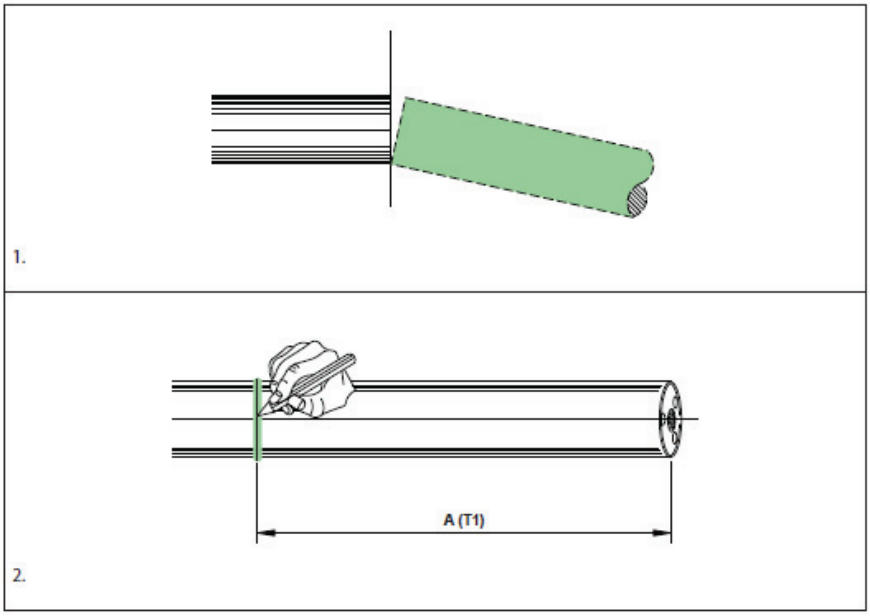
 = Wrap x rounds of indicated component.

 = Shrink to the directions pointed by the arrows.

X = See manufacturer's instructions

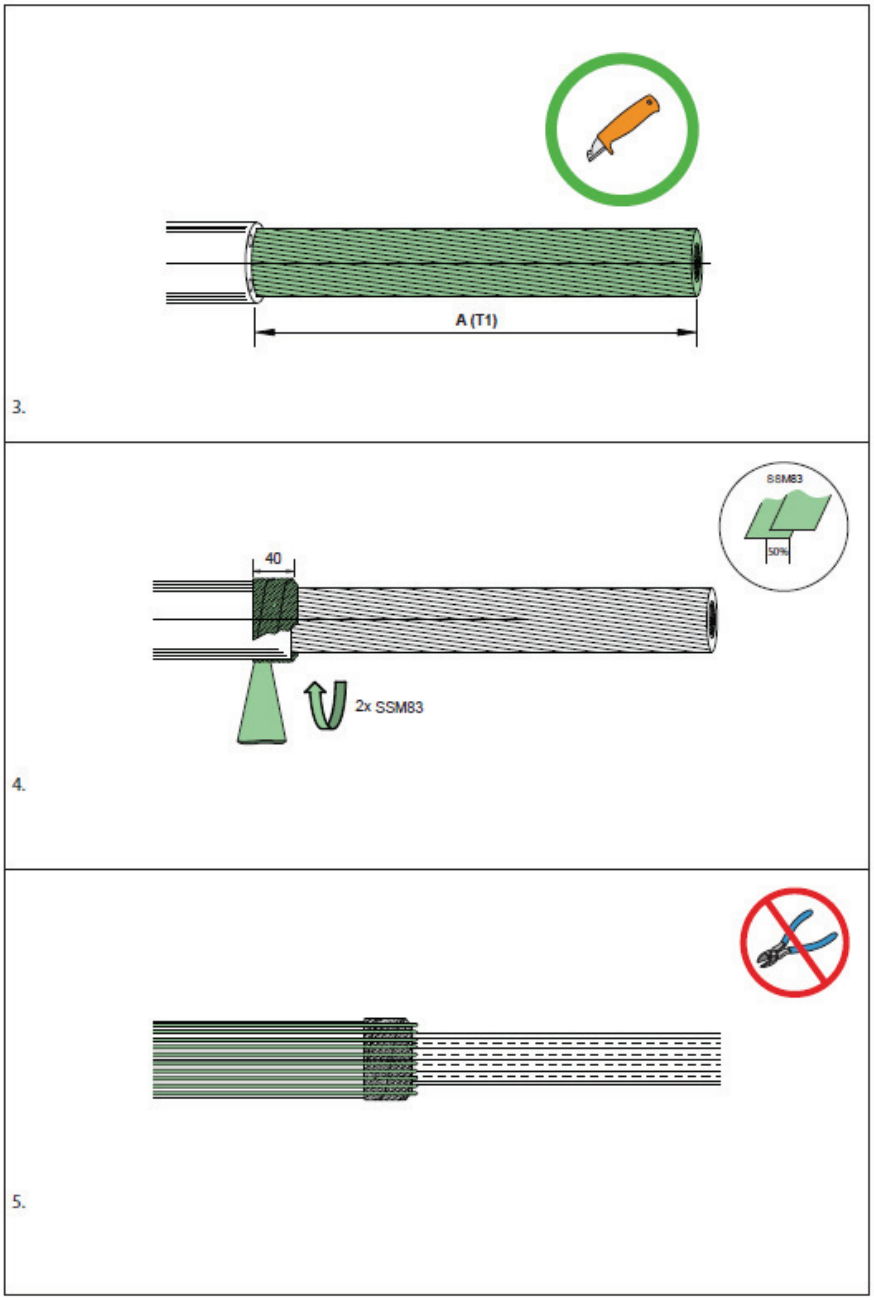
 = Peeling device required

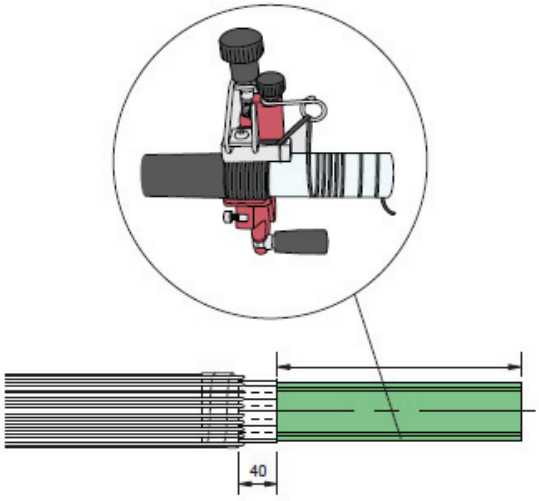
HIT1.12, HIT1.24 & HIT1.36
HOT1.12, HOT1.24 & HOT1.36



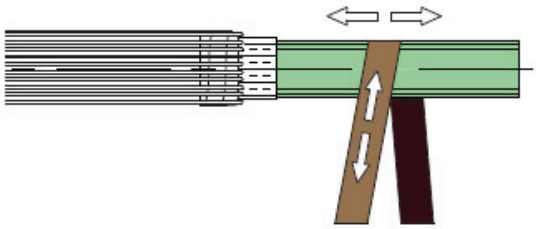
T1

	Um kV	mm²	A mm		Um kV	mm²	A mm
HIT1.1202	12	25-95	260	HIT1.3601	36	25-95	450
HIT1.1203	12	95-240	260	HIT1.3602	36	95-150	450
HIT1.1204	12	150-300	260	HIT1.3603	36	120-300	450
HIT1.1205	12	400-630	330	HIT1.3604	36	400-630	480
HIT1.1206	12	800-1000	360	HIT1.3605	36	800-1000	510
HOT1.1202	12	25-95	260	HOT1.3601	36	25-95	450
HOT1.1203	12	95-240	260	HOT1.3602	36	95-150	450
HOT1.1204	12	150-300	260	HOT1.3603	36	120-300	450
HOT1.1205	12	400-630	330	HOT1.3604	36	400-630	480
HOT1.1206	12	800-1000	360	HOT1.3605	36	800-1000	510
HIT1.2402	24	25-95	310				
HIT1.2403	24	95-240	310				
HIT1.2404	24	150-300	310				
HIT1.2405	24	400-630	380				
HIT1.2406	24	800-1000	410				
HOT1.2402	24	25-95	310				
HOT1.2403	24	95-240	310				
HOT1.2404	24	150-300	310				
HOT1.2405	24	400-630	380				
HOT1.2406	24	800-1000	410				

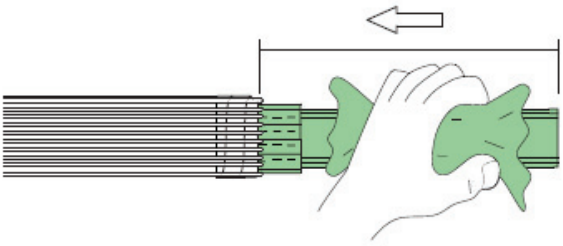

A (T1)
3.
SSM83
50%
40
2x SSM83
4.
5.



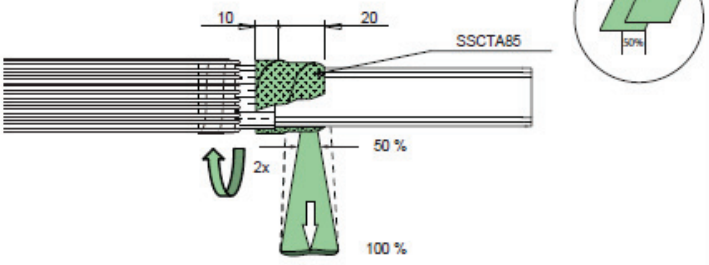
6.



7.



8.



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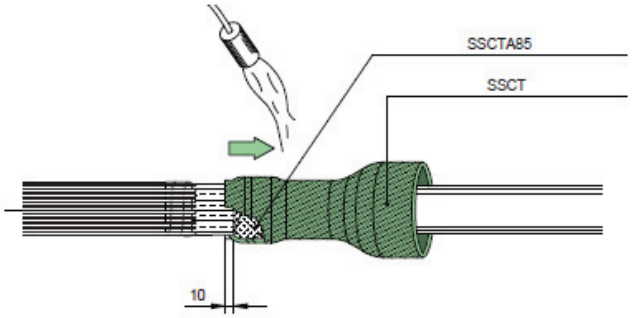
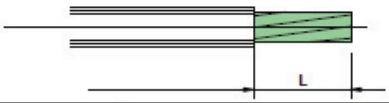
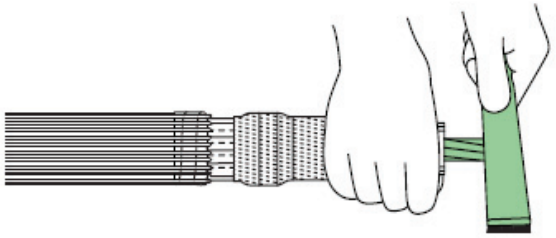


10.



	mm²		L mm
SMJ1.27	10-50	25-35	35
	70-95	50-70	33
SMJ2.47	95	-	65
	120-150	95-120	63
	185-240	150	59
SMJ3.47	120	-	72
	150-185	120	69
	240-300	150-240	65

11.



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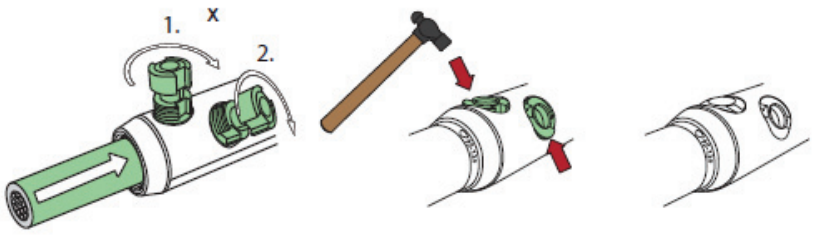

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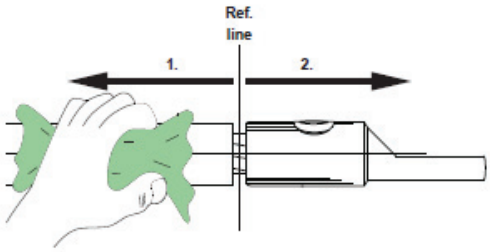
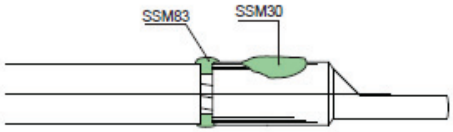
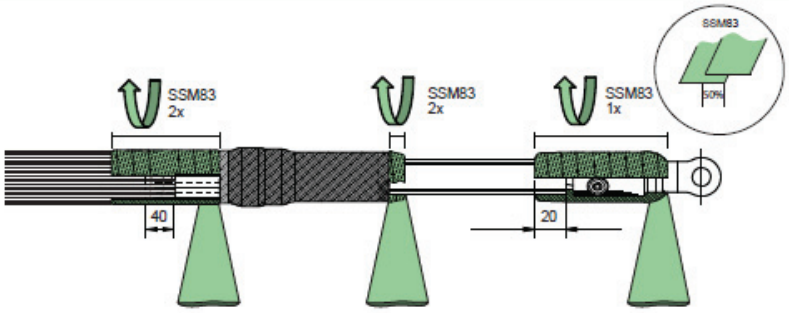


14.



15.

16.



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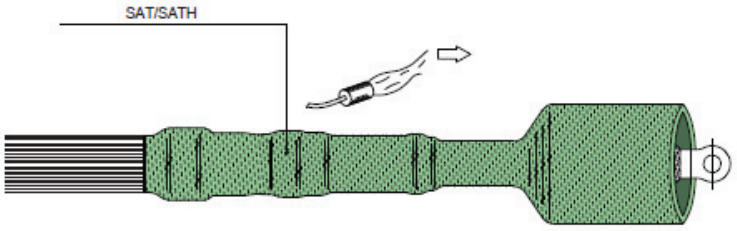

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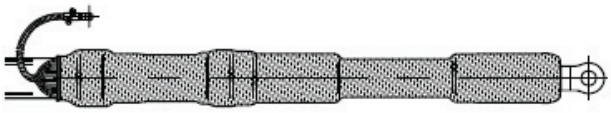
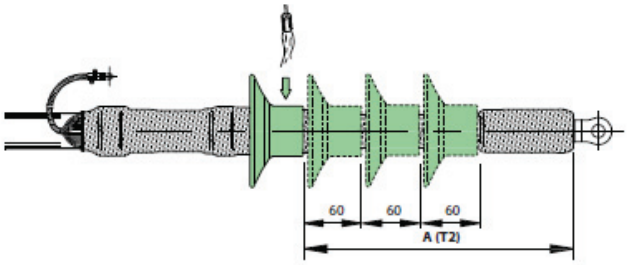


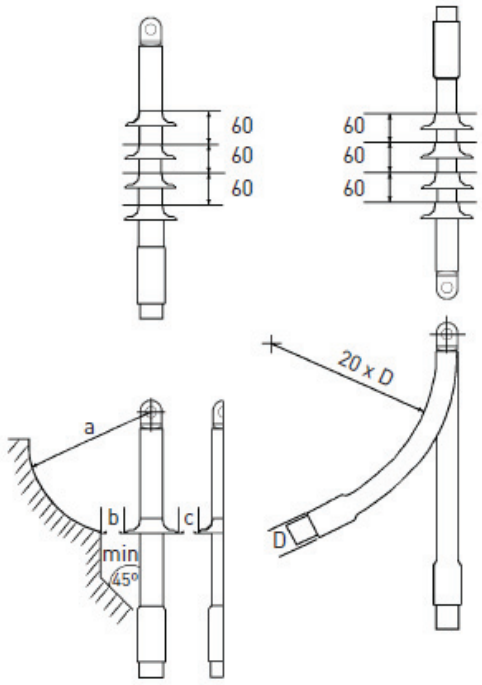
19.



T2

	kV	A [mm]	[pcs]
HIT1.12	12	-	-
HIT1.24	24	-	-
HIT1.36	36	300	2

	kV	A [mm]	[pcs]
HOT1.12	12	200	1
HOT1.24	24	200	3
HOT1.36	36	300	4



a = according to local requirements

Um kV	b min mm	c min mm
12	15	10
17,5	20	15
24	25	20
36	35	25

NOTES

PEKUNIENO / Issue 2012-05-14

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