12/24 kV medium voltage installation with switchgear type AX1

MANUAL
Installation
Commissioning
Operations and Maintenance
Environment and recycling

WARNING and **NOTE**

This document contains W**ARNING** and **NOTE** information where appropriate to point out safety related or other important information. It is of the utmost importance that the specifically marked warning texts are observed.

OPTIONS

Standard as well as extra equipment are described in this Manual. Non standard equipment is described as an option in the text. Parts included as standard may change and are evident from the applicable order documents.

TRADEMARK

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This product complies with the demands in accordance with the EU-diretive 89/336/EEC + 92/31/EEC (EMC-directive) as well as 72/23/EEC + 93/68/EEC (low voltage directive).

1. INTRODUCTION

2. SAFETY WHEN WORKING WITH AX1

3. INSTALLATION

4. COMMISSIONING

5. OPERATIONS AND MAINTENANCE

6. ENVIRONMENT AND RECYCLING

1. INTRODUCTION

1.1 General

1.1.1 What is described in this Manual

The contents of this Manual follow the procedures for working with AX1. This means that sections in the Manual follow the sequence in which work should be carried out starting with the Installation chapter. The Installation chapter deals with transport and unpacking and then procedures follow in the correct order.

The thought behind this form of presentation is to assist those working with AX1. Other important considerations were that the quality of work should be the best possible and the risk of forgetting anything should be minimised. The arrangement of the Manual also makes it possible to easily introduce improvements when updating and to refine the description of work stages.

It has been our ambition to describe the work process stage by stage, but as reality is frequently different with many activities taking place at the same time the descriptions may not always correspond with the method you select. Despite this, it is a logical description method that should assist all personnel coming into contact with AX1.

The Manual includes the following sections:

- Introduction (this section)
- Safety when working with AX1
- Installation
- Commissioning
- Operations and Maintenance
- Environment and recycling

1.1.2 Writing conventions

The following writing conventions have been applied throughout this Manual:

- Abbreviations are explained the first time they appear in the chapter or section.
- Text appearing on signs on the product are reproduced exactly where possible.
- Accepted English technical terms have been used instead of less known Swedish terms, e.g. the term “time-out“ has been used instead of a Swedish term.

1.1.3 Associated documents

In addition to this Manual, the following are included in the delivery of the medium voltage installation AX1:

- Line diagrams/assembly diagrams
- Hole pattern drawing for the floor
- Operating diagram
- Circuit diagram (IEC 1082)
- Equipment list
- Wiring table
- Cable harness list
- Manual for the bay computer REF
- REF graphical configuration
- REF list of variables
- Manual for battery carriage (if included in the delivery)
- Test protocol for operating test and site test

1.1.4 Product information and references

Medium voltage switchgear AX1 is described in many different publications and even in a multimedia presentation on CD-ROM. All material can be ordered from ABB Kraft AB on telephone int. + 46 (0)21-320800 or ABB Distribution AB (Arboga) on telephone int. + 46 (0)589-85100.

Product information and reference material:

- Brochure, 1VET 954300-912
- Product catalogue, 1VET 954300-903S, ver 2.0
- Environment publication, “Questions and Answers about SF_6“.

1.2 What is AX1?

The switchgear system AX1 is system for the distribution of medium voltage in power and industrial installations. It is a complete switchgear system, prepared and operations tested on delivery.

A switchgear consists of a number of switchgear cubicles with connecting equipment and one or more support cubicles. The support cubicle can be fitted with equipment for power supply and computer equipment as well as terminals for regulation and control equipment. The support cubicle is the interface between the switchgear and the master control equipment. The support cubicle can be placed anywhere in the switchgear line, but should be placed as the outside left cubicle to facilitate future expansion.

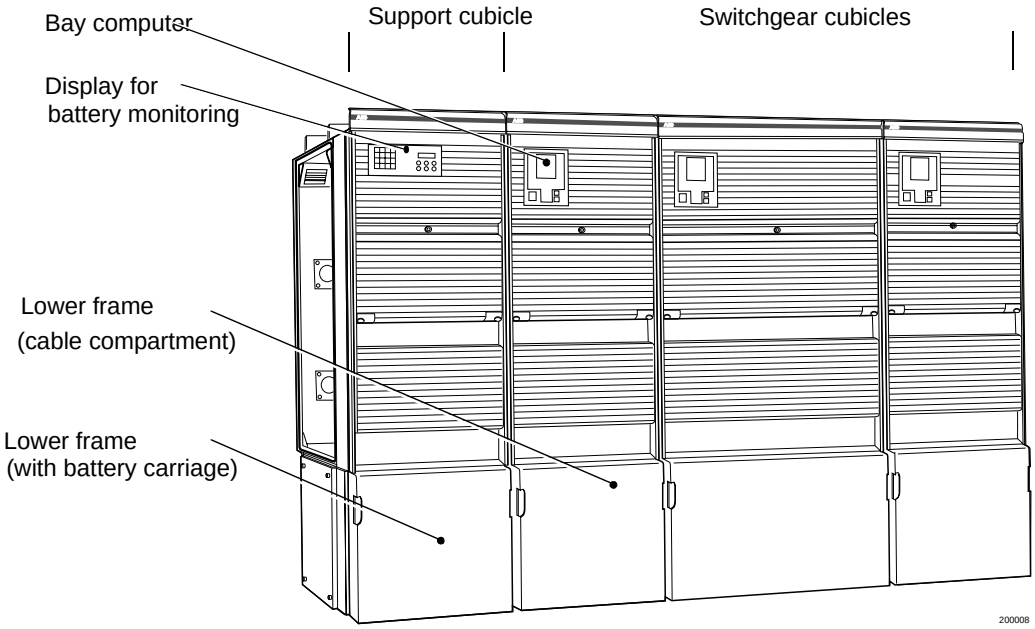


Figure 1-1. Medium voltage switchgear AX1 with three switchgear cubicles and a support cubicle to the far left.

AX1 is modular based and primary encapsulated. The switchgear is divided into three enclosure modules:

- Main-circuit enclosure for main-current paths and connection equipment.
- Operating enclosure for operating devices and bay computer including low voltage cables.
- Lower frame that also makes up the enclosure for power cable termination.

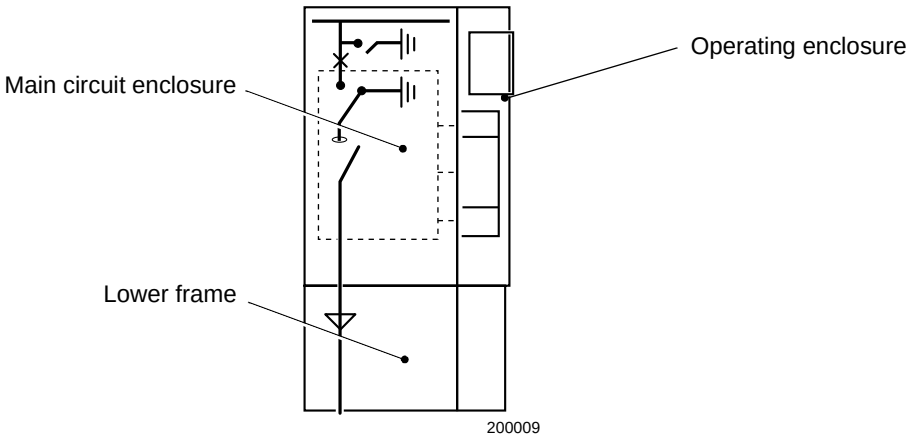


Figure 1-2. The switchgear's encapsulated modules.

1.3 Brief description of the switchgear AX1

The medium voltage switchgear AX1 is not just a medium voltage cubicle, but also a complete switchgear system/installation. From a definition point of view AX1 is a primary encapsulated and air insulated switchgear. This means that all high voltage parts are housed in the encapsulated main circuit enclosure and are inaccessible from the outside. The primary operations: current breaking, disconnecting and earthing all take place fully protected in the SF_6 environment in a common equipment enclosure, which results in high operating and personal safety.

1.3.1 Main circuit enclosure

Tubular busbar system

AX1 has tubular busbars formed in a triangle. This design gives uniform dielectric fields and permits short phase clearance and a compact design, at the same time as the magnetic field has been reduced.

Encapsulated switching devices

The switching devices are integrated in one and the same enclosure with SF_6 gas, as the insulation and protective gas against external environmental impact.

- Disconnector/earthing switch
  The disconnection and earthing operations are combined. The earthing switch complies with the higher standard demands of five closing operations against the short-circuit current as the switch is used for connection to earth. The disconnector/earthing switch has one electrical operating mechanism per phase.
- Circuit-breaker
  The circuit-breaker is of the auto-puffer type and is a further development of ABB's tried and tested SF_6 circuit-breaker. The circuit-breaker has a 3 pole spring-loaded operating mechanism.

Active arc eliminator

AX1 is equipped with active arc protection in the form of an arc eliminator. It is located in the incoming feeder cubicle and protects the switchgear and any personnel in the service passage from arc damage/injury. The arc is short-circuited to earth within 5 ms. This prevents pressure and thermal damage from occurring and toxic arc gases from forming. Pressure relief systems in the switchgear or switchgear room are not required, which give immense freedom when setting up the switchgear.

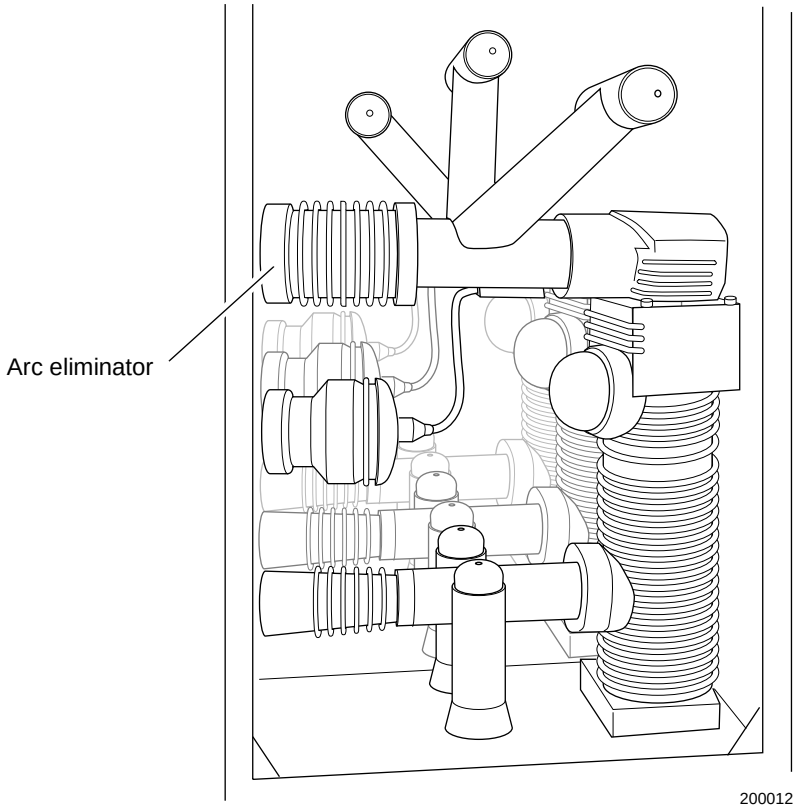


Figure 1-3. The switchgear's primary enclosure

Coil spring contacts

Coil spring contacts are used on all dismountable connection points in the main-current circuits and on moving current transmission points inside the switching devices. The technique is based on tried and tested ABB-patent.

Coil springs contacts can be found in the following areas:

- Tubular busbar system (as connectors for the busbar).
- Upper connection on the switching device.
- Lower connection on the switching device.
- Cable connections (with snap-in connections).
- Operating current contacts on the circuit-breaker.
- Operating current contacts on the disconnector/earthing switch.

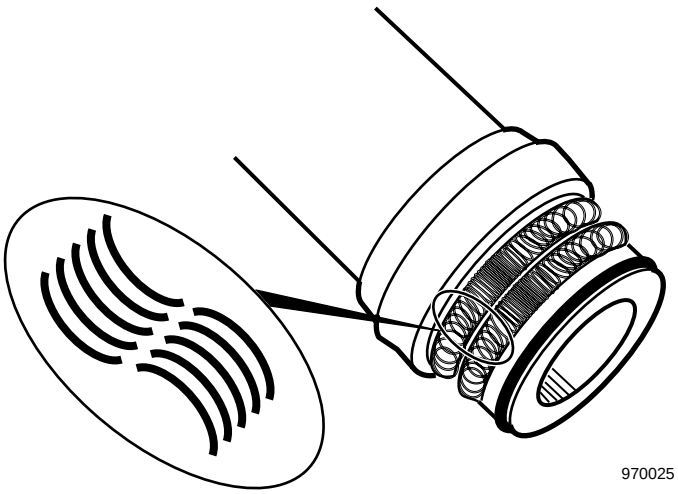


Figure 1-4. Spring coil contact

The spring coil contact has been given its name because current transmission takes place via springs. As the springs have many coils there are a large number of current transmission points, which gives among others a lower transmission resistance. Two or more springs (independent of the current strength) with opposite coil directions are placed in each spring groove so that they do not engage when turned.

1.3.2 Operating enclosure

Operating mechanism

The operating mechanisms for the switching devices are located in the operating enclosure.

- Disconnector/earthing switch
  Disconnector/earthing switch is operated by an electrical operating mechanism per phase. The operating mechanism is replaceable in the earthed position.
- Circuit-breaker
  The circuit-breaker is operated by a spring operating mechanism which is common to all three phases. The closing spring is loaded by an electric motor. The tripping spring is automatically loaded when the circuit-breaker is closed. The operating mechanism can be removed, even when in use.
- Arc eliminator
  The arc eliminator's operating mechanism is integrated in the arc eliminator. Tripping is activated by a very fast magnet and a capacitor. The tripping pulse comes from an arc guard via the arc eliminator's monitoring unit.

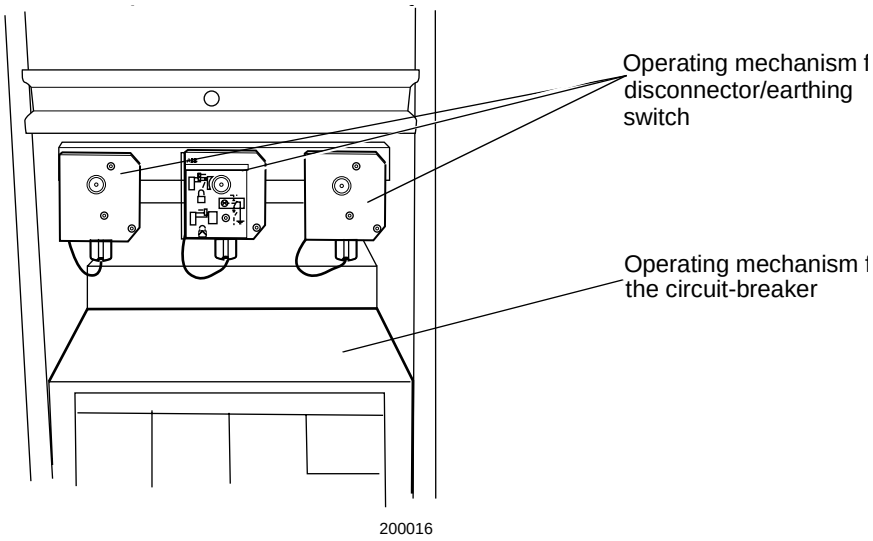


Figure 1-5. Placement of the operating mechanisms in the operating enclosure.

Bay computer

The bay computer REF contains the functions for object control, protection, measuring and monitoring. The front houses function keys and a display which shows single line schematics, alarms measurement values and text messages. The bay computer in the switchgear cubicle can be connected radially (star) via an opto-cable to a star coupler in the support cubicle (with LON communications as a type of local network for data transmission).

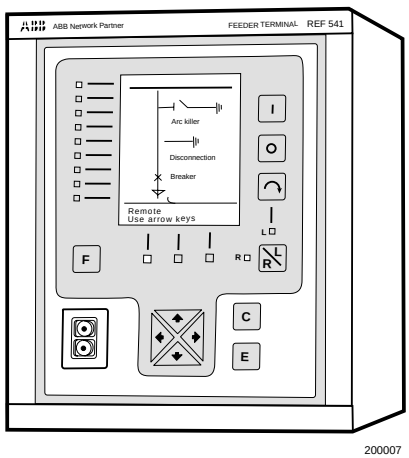


Figure 1-6. Bay computer REF

1.3.3 Lower frame

The lower frame is an individual enclosure separate from the switchgear cubicle and can therefore be assembled on site in advance. The cable assembly can be completed before the switchgear cubicle is fitted to the lower frame by using a dummy assembly. The lower frame can easily be adjusted so that it stands level as the entire weight of the cubicle is not loading the adjustable feet.

Cable connection <1250 A

Cable connections are from ABB Kabeldon, type SOC 630. They have an outer layer of a conductive material, which is earthed, or are fitted with an earthed metal sheath. The cable connections are single phase encapsulated, which means that an insulation fault only results in an earth fault. The switchgear cubicle's connector is a 630 A standard cone designed for 1250 A. SOC 630 is only available in two sizes, for cables greater than or less than 150 mm^2, which makes the choice of connection and assembly very easy. SOC 630 can take cables up to 300 mm^2.

Other cable connectors that can be used are, for example, Elastimold, Pirelli, Raychem and ABB Energiekabel. Note that even these must be of a type that has a conductive outer layer and that in some cases it is only possible to use two parallel cables due to the size.

Cable connection >1250 A

Cable connections are from ABB Kabeldon, type SWA. They are fitted with an earthed metal sheath. The cable connections are single phase encapsulated, which means that an insulation fault only results in an earth fault. The connectors in the switchgear cubicle are intended for snap-in cable connectors for currents over 1250 A up to 3150 A.

SWA/.... are intended for cross-sections 500, 630, 800, 1000 and 1200 mm^2. They are also suitable for a smaller (<500 mm^2) or a greater (>1200 mm^2) cross-section, but this must be checked in each specific case.

SWA/.... is available in two models. SWA/Cu for cables with copper conductors and SWA/Al for cables with aluminium conductors.

Measurement

A new technique is used in AX1 for current and voltage measurement. Conventional instrument transformers have been replaced by sensors integrated in the circuit-breaker or in the cable connectors. However, it is fully possible to supplement with standard current transformers of the ring core type if required.

The measurement technique with sensors offers a number of benefits:

- Linearity is achieved across the entire measurement range (no saturation).
- The number of variants is limited. One size covers the entire measurement range, from a few ampere up to short-circuit currents.
- No reconnection between different measurement ranges.
- Nominal currents, burdens, accuracy classes do not need to be defined.
- Current and voltage sensors can be integrated in a unit.
- Low operating losses.
- Smaller footprint and lighter than conventional instrument transformers, which means a more compact cubicle design.

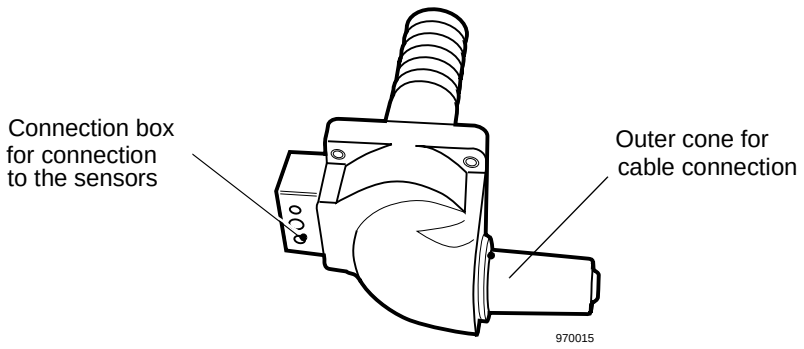


Figure 1-7. Cable connector with integrated measurement sensors

Current measurement using Rogowski coil

A Rogowski coil is used for current measurement. It is a circular coil wound on a core of non-magnetic material. The material is temperature stable. The measurement, as on a conventional current transformer, is isolated from the primary current.

The Rogowski coil in AX1 can measure currents from a few ampere up to short-circuit current, which gives great measurement accuracy even with high fault currents. The same measurement signals are used for protection and measurement functions.

Each sensor, including the connection cable to the bay computer, is co-tested and the measurement error is defined in the form of a correction factor on the sensor. Compensation for any measurement error is made in the bay computer by means of the correction factor. It is therefore important to ensure that the right connection cable is connected to the right sensor.

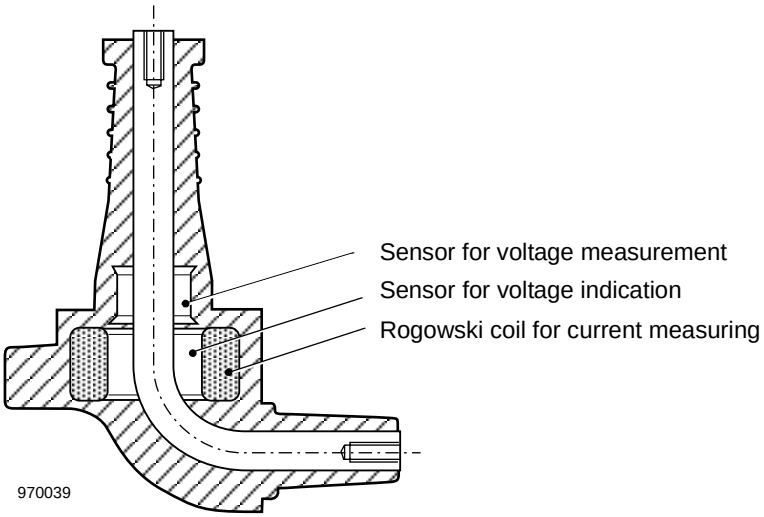


Figure 1-8. Current and voltage sensors in the cable connector

Voltage measurement using capacitive voltage dividers

Sensors for voltage measurement can withstand voltages up to 24 kV. There is a voltage sensor for measuring and protection and a separate sensor for indicating.

These are located in the cable connector or in the lower post insulator for the busbar.

1.4 Cubicle types

The medium voltage switchgear AX1 consists of the following cubicle types:

- Incoming feeder (circuit-breaker) cubicle. Standard design with cable connections from the front at the bottom (options for cable connections from the rear at the bottom).
- Outgoing feeder (circuit-breaker) cubicle. Standard design with cable connections from the front at the bottom (options for cable connections from the rear at the bottom).
- Disconnector cubicle.
- Support cubicle (low voltage cubicle). Makes up the interface to the master control and protection equipment. Available with or without voltage transformer.
  - Support cubicle without voltage transformer requires a longer busbar joint if placed in the centre of the line.
  - With conventional voltage transformers, auxiliary voltage supply 110 V DC.
- Support panel for wall mounting.

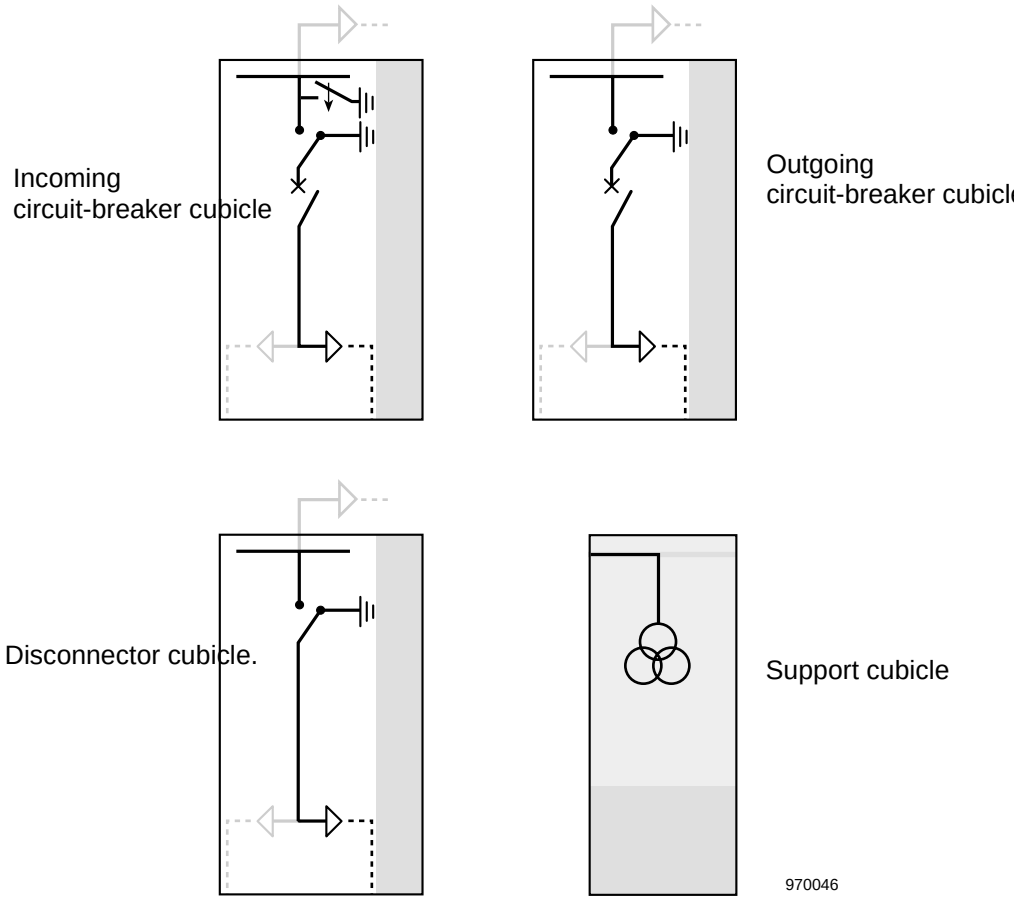


Figure 1-9. Cubicle types in the AX1 family

1.4.1 Sectioning

Sectioning is done with a sectioning cubicle or by connecting a circuit-breaker cubicle and a disconnector cubicle on the lower side using an interconnecting joint.

Sectioning

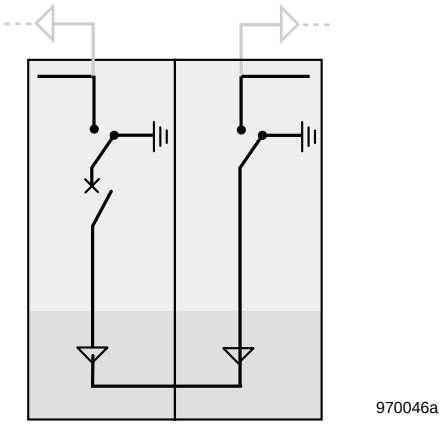


Figure 1-10. Sectioning with a circuit-breaker cubicle and a disconnector cubicle.

1.5 Technical data

Table 1-1. Technical data for AX1

Rated voltage	12 kV	24 kV
Insulation level (BIL)	75 kV	125 kV
Rated current	630 - 3150 A	630 -2500 A
Short-circuit current 3 s	16 - 40 kA	16 –31.5 kA
Arc test 1 s	16 - 40 kA	16 - 40 kA

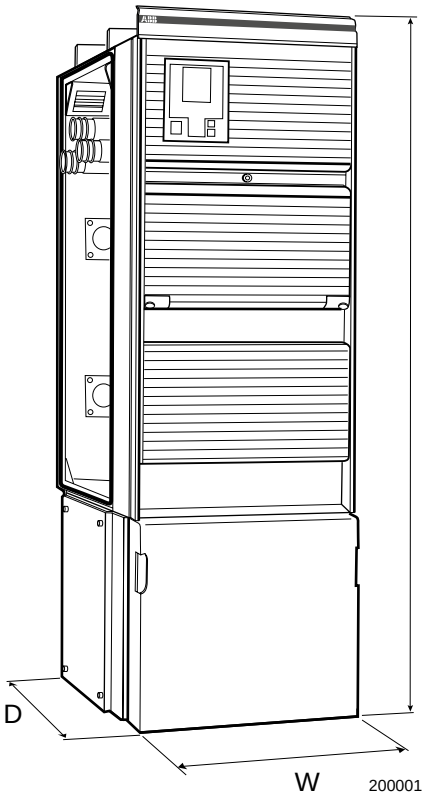
AX1 has been tested and complies with all six criteria for arc testing in accordance with (the more stringent) older Swedish standard SS 436 21 03 appendix a. AX1 and in doings so more than meets the criteria in IEC 298.

N.B. Also see the rating plate on each switchgear cubicle.

Table 1-2. Type of connection and cable cross-sections

Rated current A	Rated voltage kV	Cubicle width mm	Connection	Cable cross-section
630 - 1250	12 and 24	650	Outer cone	max. 3//300 mm^2 *)
2000	12 and 24	650	Snap-in	max. 2//300 - 1200 mm^2
2500 -3150	12	975	Snap-in	max. 4//300 - 1200 mm^2
2500	24	975	Snap-in	max 4//300 - 1200 mm^2

*) For some types of connections that are not an ABB brand, max 2//630 mm^2.



H.
Height 2240 mm with 800 mm high lower frame
Height 2040 mm with 600 mm high lower frame

W.
Width 650 mm or 975 mm
(additional 140 mm with end plate)

D.
Depth 1050 mm

Weight 650 mm cubicle: 400-450 kg max 20 kg/cm^2
Weight 975 mm cubicle: 500-550 kg max 20 kg/cm^2

Figure 1-11. Switchgear cubicle AX1

1.6 Standards

The medium voltage switchgear AX1 complies with standards as set out in table 1-3.

Table 1-3. Standards

Standard	Title/Scope	Date of issue
IEC 60056	Circuit-breakers	1992, amd 2 1995
IEC 60129	Disconnector and earthing switch	1984
IEC 60137	Cable glands above 1000 V	1973
IEC 60185	Current transformers	1987
IEC 60186	Voltage transformers	1987
IEC 60298	AC metal-enclosed switchgear	1990, amd 1 1996
IEC 60529	Degree of protection (IP-code)	1989
IEC 60660	Insulators of organic material	1979
IEC 60694	Common clauses for switchgear	1996
IEC 60932	Enclosed switchgear to be used in severe climatic conditions	1988
IEC 60044-8	Electrical current transducers	1999 CDV
IEC 60044-7	Electrical voltage transformers	1999-12

2. SAFETY WHEN WORKING WITH AX1

2.1 General

Working on a switchgear installation always involves a safety risk, both personal and to the equipment.

During **assembly and installation** when there is no high voltage in the switchgear, risks are usually when lifting or due to pinch injuries, nevertheless electrical safety must be observed as power tools, among others, are used during the installation work. However, the greatest risk is when work is carried out in a switchgear room where there may be equipment already commissioned in operation.

When **commissioning** the risks, both personal and to the equipment, are great bearing in mind the installed equipment is voltage fed for the first time.

During **operations and maintenance** the risks mention above exist, but there is also a risk of damaging the equipment fed from the switchgear, for example, process equipment or the personnel working on the process.

When **recycling** or disposing of material in the switchgear the impact on the environment can be negative if the equipment is not handled in the proposed manner.

However, the most obvious danger when working with the medium voltage switchgear is the mortal danger involved when working with an electrical installation if the applicable electrical safety regulations are not followed and if the personnel carrying out the work lack the requisite training and knowledge of the electrical installation.

Reference literature:

- High current regulations ELSÄK-FS 1999:5 issued by Elsäkerhetsverket. (Elsäkerhetsverkets regulation’s on the design and maintenance of electrical high current installations).
- High current guide published 2000 issued by Elektriska Installatörsorganisationen EIO, Elsäkerhetsverket, Svenska Elektriska Kommissionen SEK and Svenska Elverksföreningen (Guide to high current regulations).
- Applicable standards, see table 1-3.

2.2 Warnings

In this Manual there is WARNING and NOTE information where appropriate to point out safety related or other important information. It is of the utmost importance that the specifically marked warning texts are observed. Warning texts have the following appearance with a general warning symbol in the margin. In some cases the general symbol has been replaced by a special symbol.

WARNING

This is how a warning text is marked. This gives a warning that extra care must be exercised to avoid personal injury or damage to the equipment.

N.B. Observation texts are marked in this way. This gives important information that can facilitate the work or to remind about things that can be easily forgotten.

WARNING

The general symbol has been replaced by a symbol with an arrow that symbolises electrical flashover in warning text directly related to electrical safety.

2.3 Personal safety

The following should be observed:

- Only use approved lifting equipment.
- Use cautious lifting techniques and exercise care so that back and pinch injuries are avoided.
- Only use double insulated power tools.
- Only wear approved flameproof protective clothing.
- Follow all instructions on electrical safety and work earthing.
- Exercise great care when working in or next to an energised switchgear.
- Bear in mind that a switchgear in remote mode can be operated from another position or via protective and automatic operations.
- Bearing in mind that a switchgear in the vicinity can be operated by protective and automatic operations.
- It is recommended that emergency stop buttons are located by each output from the switchgear room. Responsibility for setting up and placement rests, according to applicable provisions, completely on the owner of the installation.

WARNING

Always disconnect the voltage and earth the busbar and possible rear feeds when working in the main-circuit enclosure.

2.4 Equipment safety

The following should be observed:

- Avoid static discharge when working with the bay computer REF. An earthed wrist strap (ESD-protection) must be worn and the supplier's instructions observed if, for some reason, you need to open a bay computer.
- Exercise care so that no tools or equipment that can cause short-circuiting are used or forgotten after installation.
- Do not change the protection settings and blocking without be completely aware of the consequences. A changed protection setting can affect the protection’s selectivity and jeopardise the operation of the entire installation.

2.5 To bear in mind during installation and when working on the switchgear

- During work on the switchgear all essential cordoning off and signs must be arranged to prevent unauthorised persons from coming into contact with the switchgear.
- Always draw up a list of procedures to be approved by the supervisor or safety officer before work on the switchgear is started.
- Always point out safety risks discovered while working with the switchgear to your supervisor or safety officer.

3. INSTALLATION

3.1 General

A delivery of a medium voltage switchgear AX1 normally takes place in two stages. First the lower frame for each AX1-cubicle is delivered to the site in kit form, and then 1 to 2 weeks later the switchgear cubicles are delivered. This allows the installation site to be prepared through assembling the lower frame, levelling and anchoring. Requisite holes for cables in the concrete floor should be made before setting up the lower frame, see section 3.3 page 31.

On delivery the switchgear cubicle and other equipment is assembled on the completed lower frame.

N.B. We recommend, even with simultaneous deliveries of the lower frame and switchgear, that the installation should be performed in the lower frame, for cable connection and the assembly of any cable current transformers, before the switchgear cubicle is assembled on the lower frame. The working space will then be better and this will have a favourable effect on the quality of the work.

3.2 Transport and unpacking

The switchgear cubicle is supplied covered in plastic and strapped vertically to a pallet. All equipment, for example, the operating mechanisms and the bay computer are assembled in the cubicle on delivery. The switching devices are locked in the disconnected position during transport for reasons of safety. Use a fork lift truck when unloading. There are no lifting eyes, but lifting beams can be fitted to the cubicle's ends if the plastic sheet is opened. Alternatively, lifting straps can be used if these are placed under the bottom of the pallet so that the pallet bears all the weight of the AX1-cubicle when lifting.

When unloading inspect for signs of transport damage. Also check the number of packages against the delivery note and order documents.

Allow the packaging to remain in place as long as possible. If the switchgear is to be stored before installation the following applies:

- The switchgear may be stored outdoors under a rain cover/roof with undamaged/unopened transport packaging for a maximum of three (3) days.
- Storage shall take place in a tempered (warmer than 15 °C) and dry indoor building when storing for longer than three days.
- When storing equipment packed for export in plywood or wooden crates this should be done under a rain cover/roof. Storage/storing can then be done for a maximum of 12 weeks.
- A tempered and dry indoor building (warmer than 15 °C) is recommended for storage periods greater than 12 weeks.
- Option. Against an extra charge the switchgear can be quoted packed in a fully welded aluminium bag and export packed in a plywood or wooden crate. Storage/storing can then be done for a maximum of 60 months (5 years).

If the storage directives are not followed the equipment can be exposed to corrosion which means a risk of impaired operation. The warranty undertaking no longer applies with incorrect storage.

Contact the supplier if there is uncertainty about an appropriate storage environment.

The switchgear cubicle stands on a transport pallet on a cellular foam bottom block so that the protruding cable glands (external cone connectors) are not damaged.

WARNING

The cable glands will be damaged if the cubicle is lifted from the pallet with the bottom block and then placed on a flat surface.

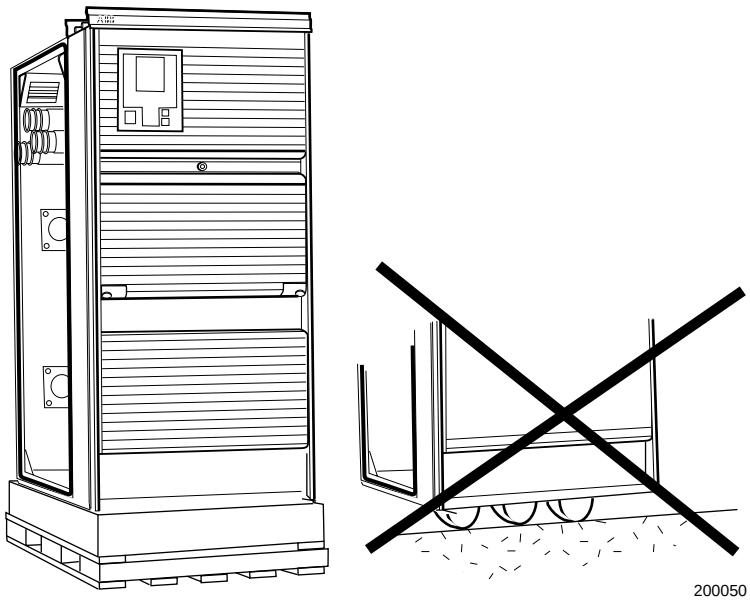


Figure 3-1. The switchgear cubicle must not rest on the cubicle's cable glands.

If, for some reason, the switchgear cubicle cannot be transported vertically, for example due to confined doors or elevators, it should be placed **on its back** on the transport pallet.

Complaints about missing or damaged components should be made to the supplier as soon as possible.

3.3 Demands on the switchgear room

The room where the switchgear will be setup should comply with building standard demands made on electrical rooms as soon as the installation is start. Due to the switchgear's unique characteristics the room does not need to be equipped with special devices for pressure relief or for the evacuation of flue gases. The room shall be ventilated in accordance with building standards. The floor should be of the following type:

- Concrete floor with a flatness according to building standards (class B as set out in BYGGAMA).
- Switchgear floor/raised floor (intermediate floor type ISO Floor or the like) that withstands the weight of the switchgear) approved for electrical rooms.

Plan the type of fire seals to be used on cable lead-throughs in the floor, walls or ceiling at an early stage. Bear in mind that a sealing system also protects against water, gas, smoke, pressure and small animals. Many sealing systems can also be ordered with EMC protection (Electromagnetic compatibility) and protection against electromagnetic pulses and interference (EMP/EMI).

Most sealing systems require rectangular metal frames or round metal sleeves for embedding or building-in, which makes it necessary to plan and prepare the cable lead-throughs before the switchgear is installed.

Concrete floor

Holes for power cables should be made as small as possible so as not to weaken the floor more than necessary. The holes should be sealed if necessary once the cables have been installed to protect against fire and small animals.

Bear in mind it is not permitted to route single phase cables in individual holes with reinforcement steel between the holes. This allows eddy currents to be formed in the reinforcement steel, which can have a negative effect on the strength of the floor.

N.B. If single phase cables are routed through holes with reinforcement steel between them, a slot should be made between the holes so that a gap is obtained to separate the reinforcement steel.

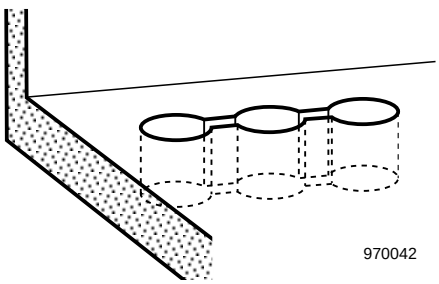


Figure 3-2. Cable holes with slots in the concrete floor

Switchgear floor on framework

If the room has an intermediate floor, a switchgear floor, the lower frame's support feet must be placed so that they rest on the sections in the floor's framework. Place the lower frame directly on the floor and then have a "bottom" where the cable lead-throughs must made. It can be appropriate to use a sealing system with build-in frames that are bolted in position for lead-throughs in the intermediate floor

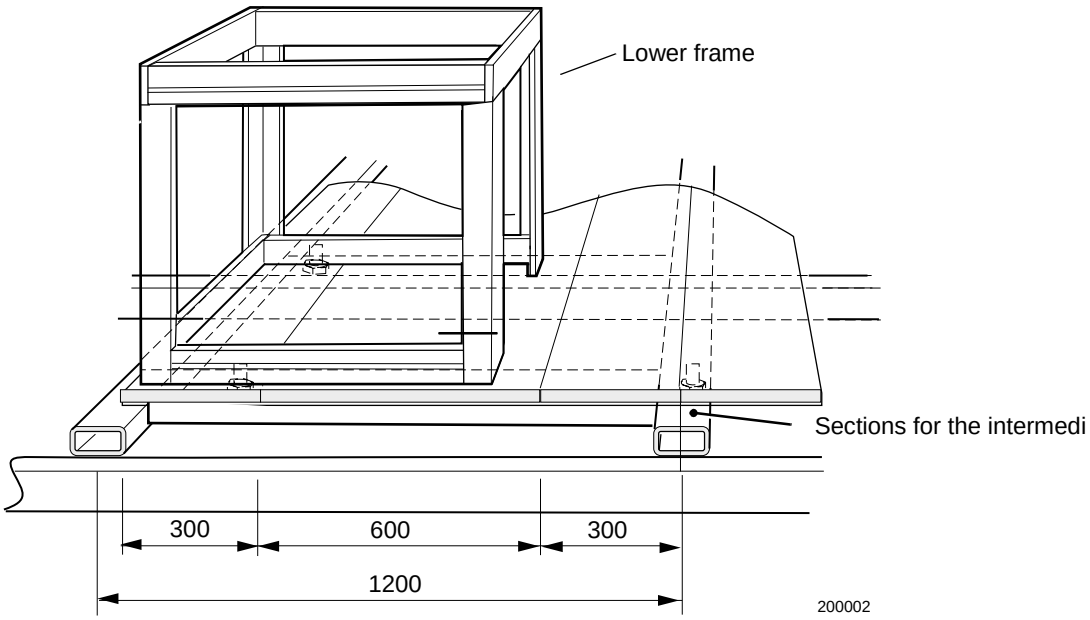
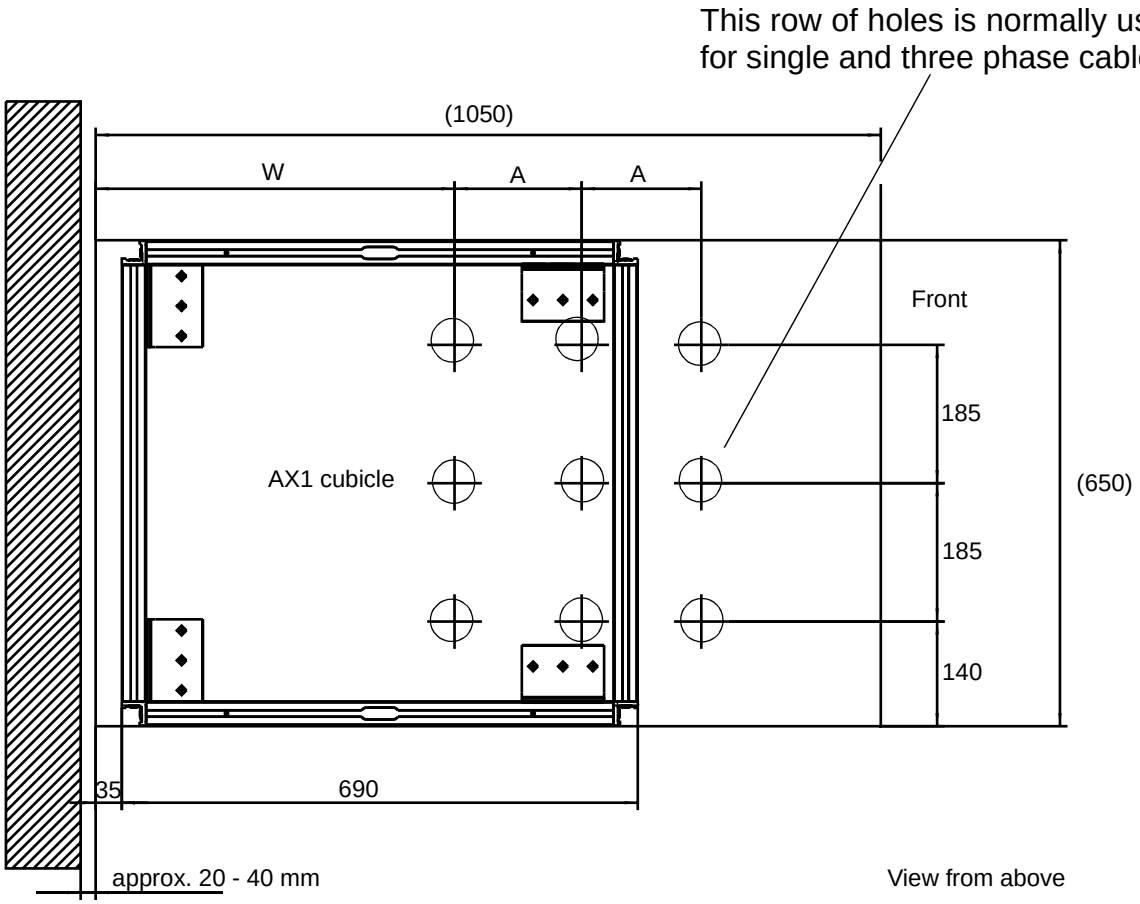


Figure 3-3. Placement of the lower frame on the switchgear floor



A	W	Connection
120 mm	218 mm	Snap-in type
170 mm	480 mm	Outer cone type SOC 630

Measurements only apply for cable connectors type SOC 630. Other measurements may apply for other types of cable connectors.

Figure 3-4. Holes in the floor for cables.

3.4 Switchgear placement

The switchgear can be positioned with its rear against a wall or free-standing on the floor. With a free-standing arrangement switchgear can be separated and positioned back-to-back.

- The service area in front of the switchgear should comply with applicable standards and provisions.
- There must be a ceiling clearance of at least 0.4 metres to permit installation and future maintenance.
- There should be a clearance of at least 0.5 metres at one end of the switchgear. If possible this amount of clearance should be left at both ends of the switchgear.

When assembling applicable installation drawings should be followed.

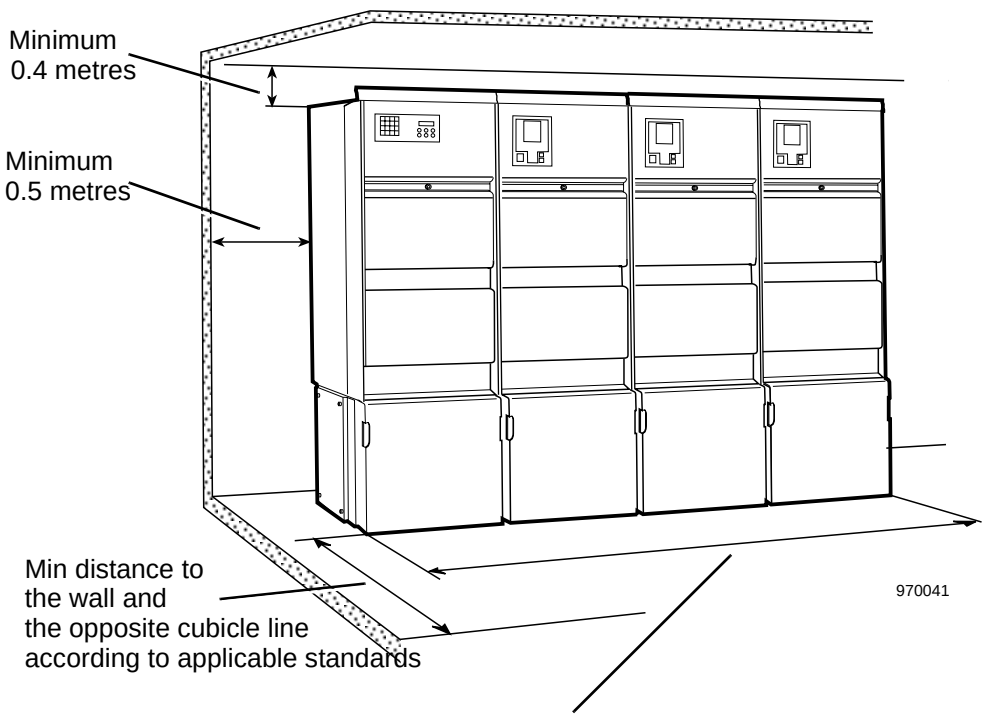


Figure 3-5. Example of the AX1 assembly

3.5 Assembling the lower frame

Each lower frame is supplied in kit form as a flat-pack.

The lower frame (packaging) is available in a number of variants:

- lower frame for outside left cubicle
- lower frame for outside right cubicle
- lower frame for cubicles in the cubicle line

The lower frame is available in two standard heights, 600 mm and 800 mm, and in two standard widths, 650 mm and 975 mm.

Assemble the lower frame as set out in the supplied instructions.

Essential tools are TORX screwdrivers.

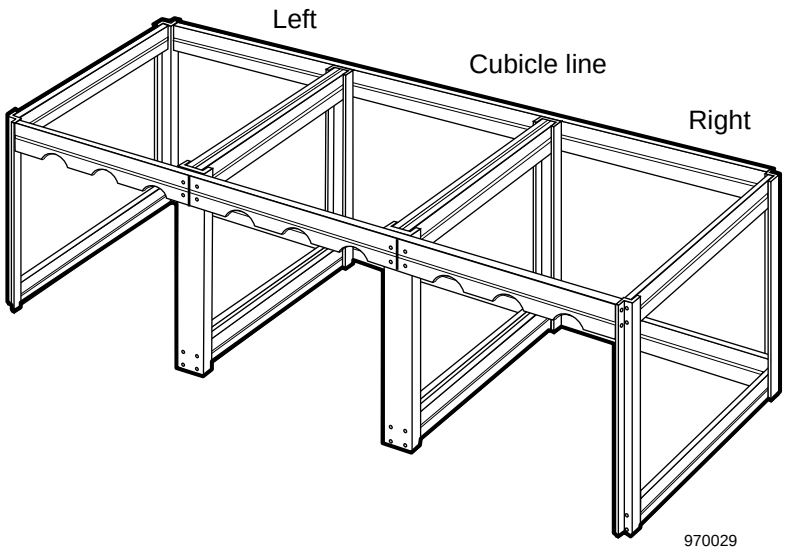


Figure 3-6. Lower frame for three switchgear cubicles

Assembly on the concrete floor

1. Measure and mark out the low frame's (switchgear's) position on the floor using chalk.
2. Make any holes required for cable lead-throughs and fit any embedment frames or metal sleeves following the instructions provided by the manufacturer of the sealing system.
3. Fit the anchoring brackets on the lower frame. Do not tighten the bolts.

N.B. The number of anchoring points is dependent on the floor. Four-six (4-6) anchor points is usually sufficient even for a line with up to five (5) cubicles.

4. Adjust the frame's support feet so that the lower frame stands horizontal. Adjustment range 0-15 mm.

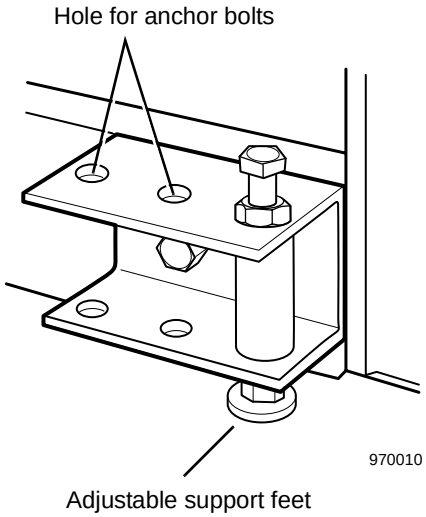


Figure 3-7. Anchoring bracket with adjustable support feet

5. Check using a spirit level that the frame is flat.
6. Mark out where the expansion bolts for anchoring the lower frame need to be placed.
7. Fit the anchor bolts (expansion bolts) in the concrete floor.
8. Bolt the lower frame to the concrete floor. Do not tighten the nuts.
9. Tighten the locking nuts on the feet.
10. Tighten the nuts on the anchor bolts.

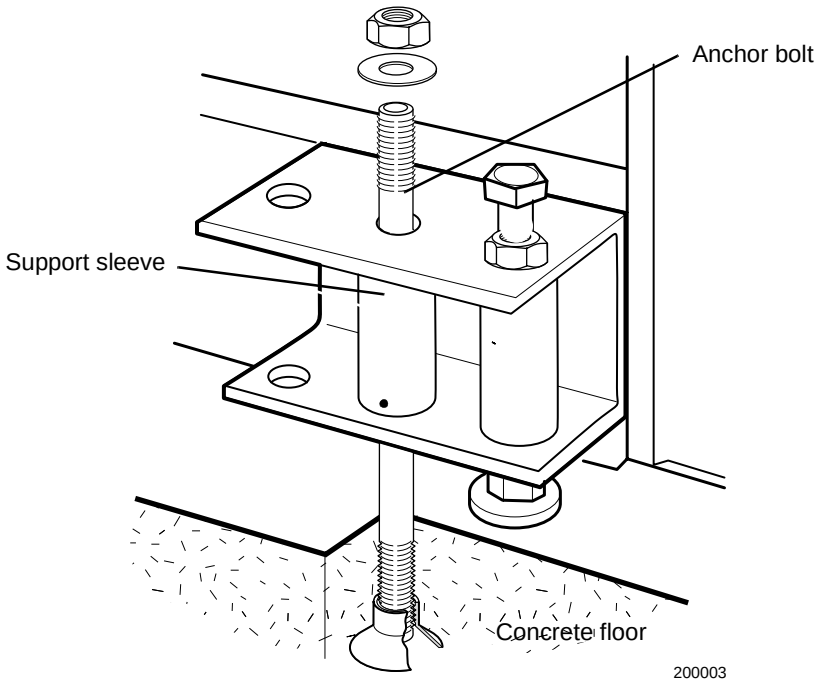


Figure 3-8. Anchoring the lower frame to the concrete floor

Assembling on the switchgear floor

1. Measure and mark out the low frame's (switchgear's) position in the room using chalk on the floor sections.
2. Make any holes required for cable lead-throughs and fit any embedment frames or metal sleeves following the instructions provided by the manufacturer of the sealing system.
3. Fit the anchoring brackets on the lower frame. Do not tighten the bolts.

N.B. The number of anchoring points is dependent on the floor. Usually 4-6 anchoring points are sufficient, even for the largest lower frame.

4. Adjust the frame's support feet so that the lower frame stands horizontal.

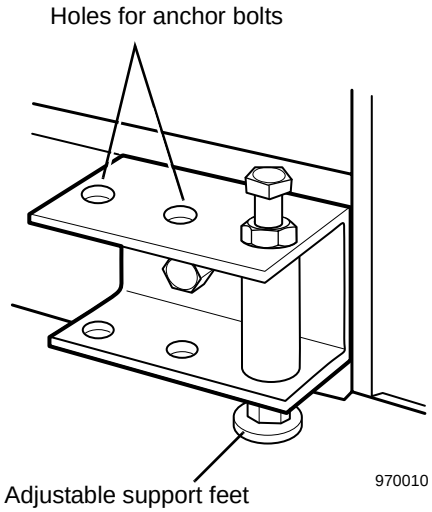


Figure 3-9. Anchoring bracket with adjustable support feet

5. Check using a spirit level that the frame is flat.
6. Mark out the position for the anchoring bracket holes in the floor and drill the holes for the bolts.
7. Bolt the lower frame to the floor sections. Check that the anchoring hooks are turned so that they lock against a floor profile.
8. Tighten the locking nuts on the feet.
9. Tighten the nuts on the anchor bolts.

N.B. The rear adjustable feet should be placed on the outer edge when anchoring the support cubicle. Otherwise the battery carriage cannot be driven fully into the cabinet.

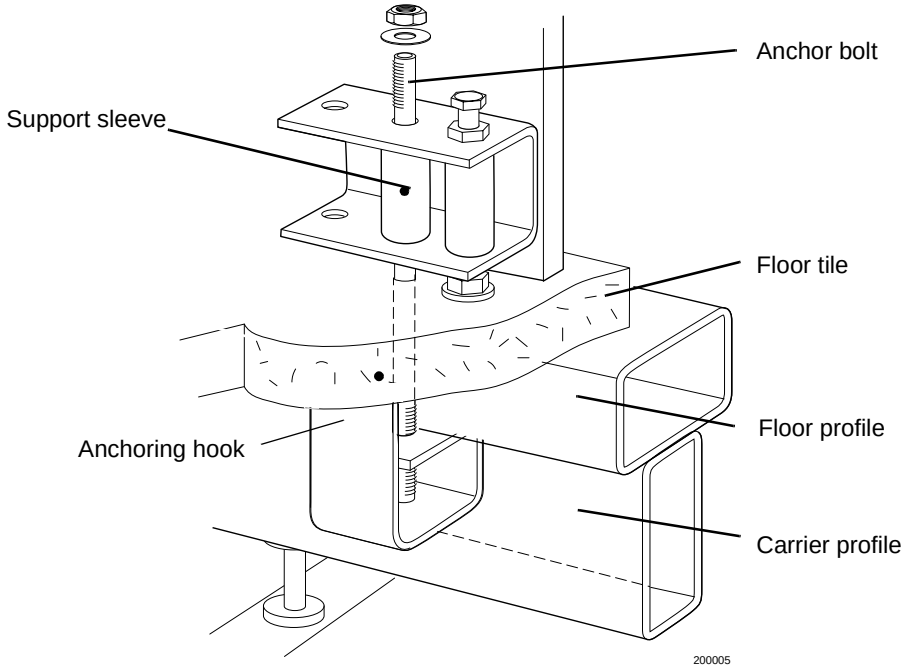


Figure 3-10. Rear anchor point for anchoring the lower frame on the switchgear floor

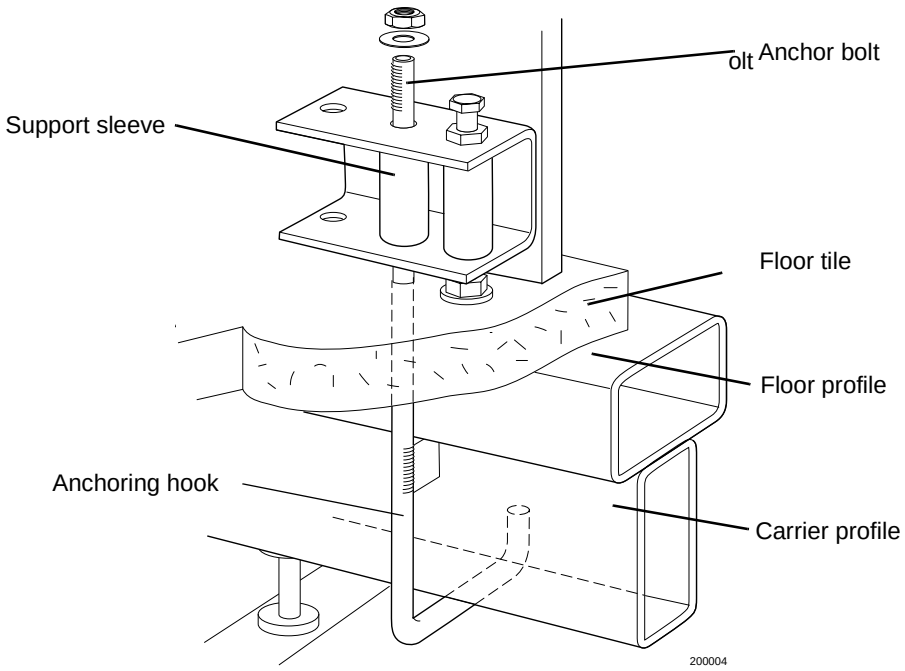


Figure 3-11. Front anchor point for anchoring the lower frame on the switchgear floor

3.6 Installation and assembly of equipment in the lower frame

For comfortable and efficient installation work, it is recommended to always install and assemble all equipment in the lower frame before the switchgear cubicle is put in place. This means savings in time as well as a comfortable working position, but most important of all, the quality of the work will be better.

The following should be carried out before the switchgear cubicle is lifted on the lower frame:

1. Install the power cables including anchoring.
2. Insulate and fit the cable screens with cable lugs for connection to the earth rail.
3. Assemble and install conventional cable current transformers of a ring core type (if these are to be included).
4. Seal the cable holes according to the approved fire seal class.

N.B. A dummy assembly should be used to install the power cables. The dummy assembly has cable glands in exactly the same positions as on a switchgear cubicle and ensures that the cable installation will fit when the switchgear cubicle is lifted in position.

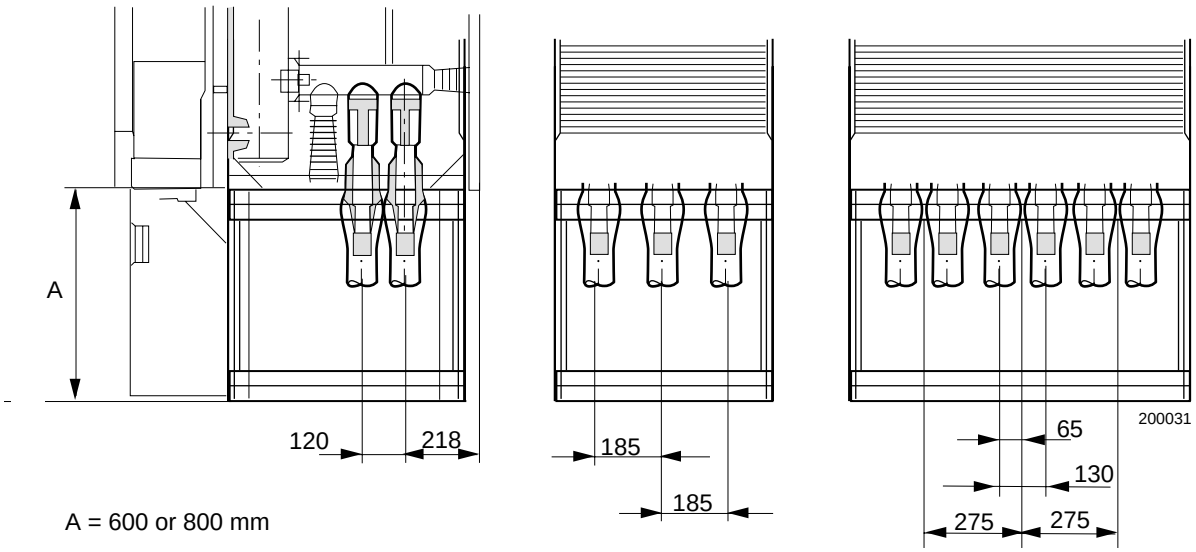


Figure 3-12. Snap-in cable connectors

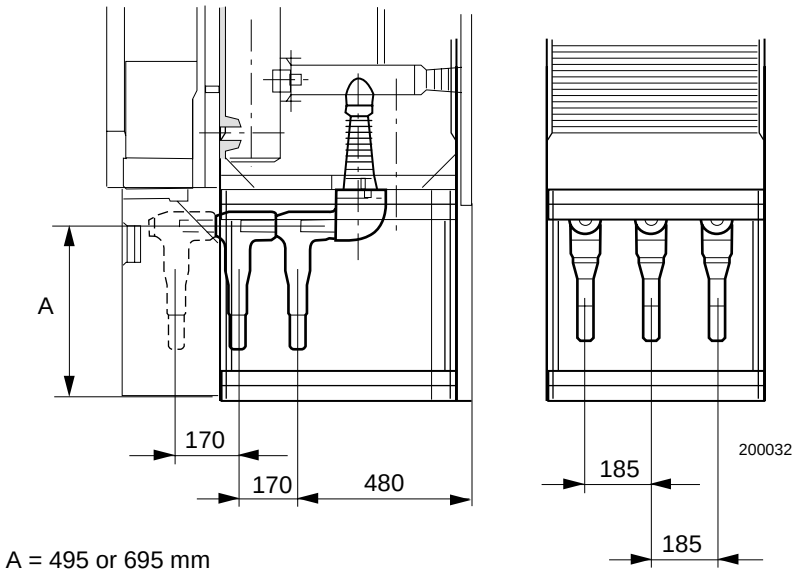


Figure 3-13. Outer cone cable connectors

3.6.1 Installation of power cables

Power cables should be fitted with enclosed and prefabricated terminators, type SOC 630 or SWA or the like, i.e. standard outer or inner cone connectors (snap-in connection). The cable connections shall have a conductive outer layer material, which is earthed. The cable termination shall be single phase encapsulated, which means that an insulation fault only results in an earth fault.

WARNING

An earth screen core kit should be used on three phase cables.

WARNING

If there is a reserve cubicle that will not be connected, the cubicle's main connection should be fitted with a blanking termination in order to provide protection.

On designs with snap-in cables, end terminations should also be fitted in the spare connection tubes that are not used, i.e. that do not have a cable connected. End terminations are of the same type used to terminate busbars.

The current and voltage sensors are integrated in the cable connection device. There is a voltage sensor for measuring and protection and a separate sensor for indicating. In addition to the integrated sensors, a conventional cable current transformer can be installed in the lower frame. The current transformers for charge metering are of a ring core type. These are assembled around the cable connection device.

Cable connections from below

1. Route the cable in the lower frame.
2. Insert the cable through any cable transformers.
3. Terminate the cable according to the manufacturer's instructions.
4. Check that the cable screen is long enough to be routed to the cubicle's earth rail. The cable screen can be jointed if necessary with a conductor that has at least the same cross-section as the screen. The cable screen must be insulated with a plastic sheath, fitted with a cable lug and connected to the cubicle's earth rail.

WARNING

On three phase cables the cable's earthed screen should be moved up using a core screen kit, which prevents flashover between the phases. The screening kit consists of a copper sock per phase. These are fitted to the cable's outer conductive layer. The copper socks are joined to the cable's

copper screen and sealed using insulation tape. Core screen kits from Kabeldon type PSST or the like are recommended.

5. Ensure that the distance between the cables in the same phase is at least 30 mm.
6. Secure the cables in the cable bracket.

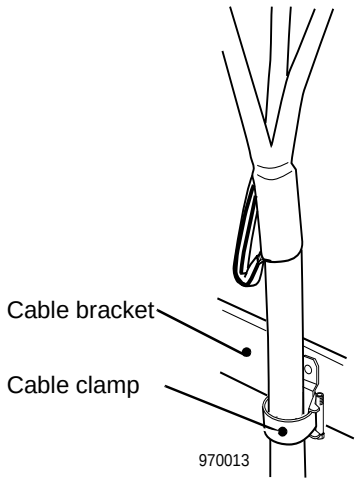


Figure 3-14. Securing the cables in the cable bracket

7. Secure the cable transformers.
8. The cable's earth conductor must be returned insulated through the transformer and connected to the cubicle's earth rail. If the earth conductor is not returned through the transformer, this will result in the protection not working as intended.

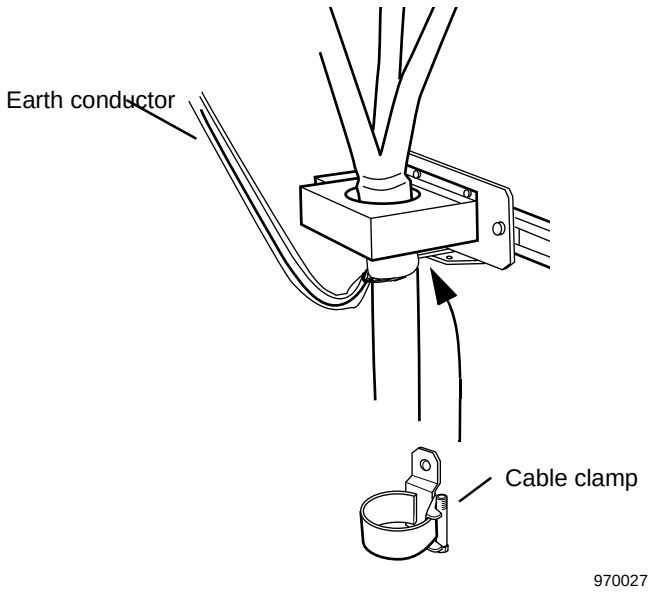


Figure 3-15. Assembly of cable current transformer

N.B. See the Manual about single phase enclosures.

3.7 Assembling the switchgear cubicle on the lower frame

Check the identity of the cubicle carefully before assembly. Start the assembly process with one of the outer cubicles to the left or right of the switchgear line. It does not matter from which end you start.

N.B. Switchgear cubicles that are mechanically identical can differ with regard to the bay computer's software.

The AX1 service trolley is used when assembling the switchgear cubicle on the lower frame. (Can be hired from ABB Distribution AB).

WARNING

Risk for pinch or back injury. Exercise care when lifting and handling the switchgear cubicle. Think about lifting in a manner that is easy on your back and always wear protective gloves. Mind your feet when lifting with the service trolley.

1. Remove the packaging around the cubicle (straps and plastic cover).

N.B. The sensor cables must be removed from the sensors in the cable connectors before the cubicle is lifted on the lower frame. Reconnect the cables as soon as the cubicle is in position.
Check that the right sensor cable has been connected to the right sensor and on the right connection.

2. Place the switchgear cubicle on the service trolley.
3. Drive the service trolley to the lower frame, directly in the centre where the switchgear cubicle is to be fitted.
4. Check that the beam, with the earth rail on the front edge of the lower frame, is removed.
5. Lift so that the lower edge of the switchgear cubicle is a few centimetres above the frame top beam.
6. Drive the service trolley so that it is only a few centimetres from the front edge of the lower frame.

N.B. If the switchgear cubicle stands with one end against the wall the end plate must be fitted before the cubicle is lifted into position.

7. Slide the switchgear cubicle into position on the lower frame. The cubicle weighs 400-550 kilograms and can slid into position by two persons.
8. Bolt the cubicle to the lower frame using the four bolts supplied.

Join the busbar with tubular busbar joint. When assembling one switchgear cubicle the busbar is joined between this and the cubicle assembled immediately before. Joining is described in the following section.

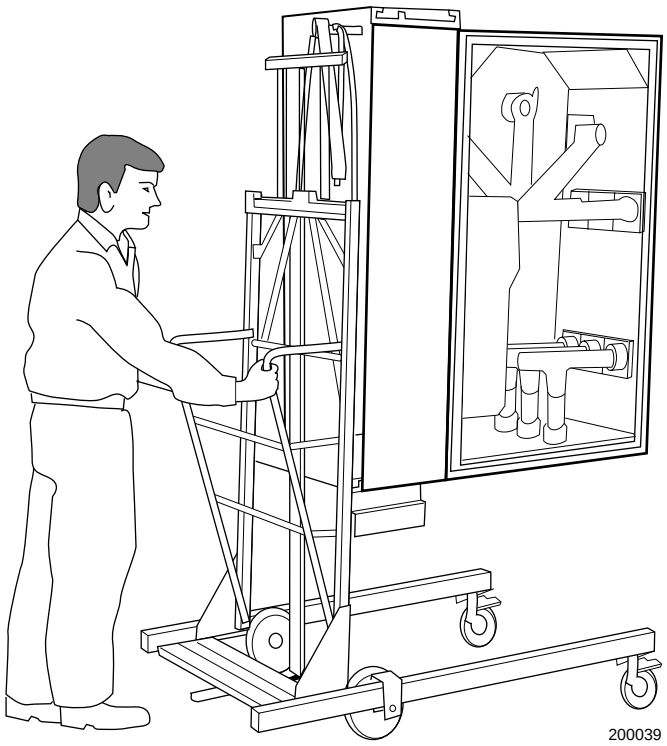


Figure 3-16. Service trolley for the operating mechanism and the switchgear cubicle.

3.8 Joining the busbar

The busbars are joined by inserting the coil spring contacts into the tubular busbar. The coil spring contacts are available in two lengths. The short coil spring contacts are used for joining between switchgear cubicles.

A tubular busbar joint consists of the following parts:

- Aluminium joining piece with silver plated contact surfaces.
- Two or four springs
- O-rings
- Sealing sleeves

N.B. The springs are supplied mounted on the coupling. If a spring is removed or needs to be replaced it can be fitted in any direction. The direction of the spring does not affect the transmission resistance in the coupling. However, we recommend that springs in the adjacent grooves have opposite spring directions.

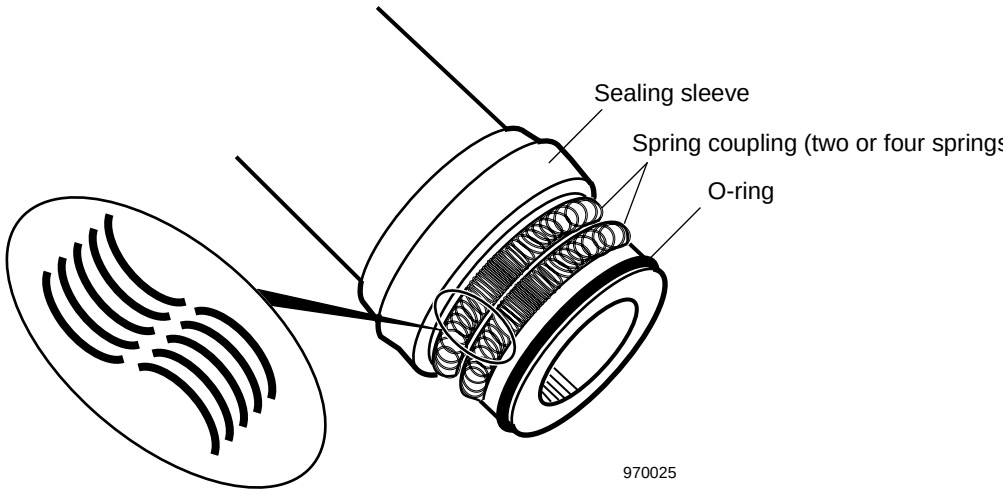


Figure 3-17. Coil spring contact for joining busbars

N.B. Check the coil spring contacts before assembly so that they are not damaged and that all components are assembled correctly.

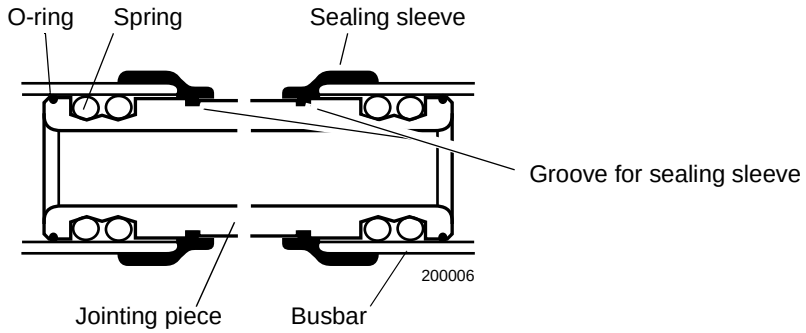


Figure 3-18. Coil spring contact in cross-section

In the following assembly sequence the designation cubicle 1 is used for the right-hand cubicle and cubicle 2 for the left-hand cubicle, for two cubicles to be joined with the busbar (layout from the right outside cubicle towards the left in the switchgear line).

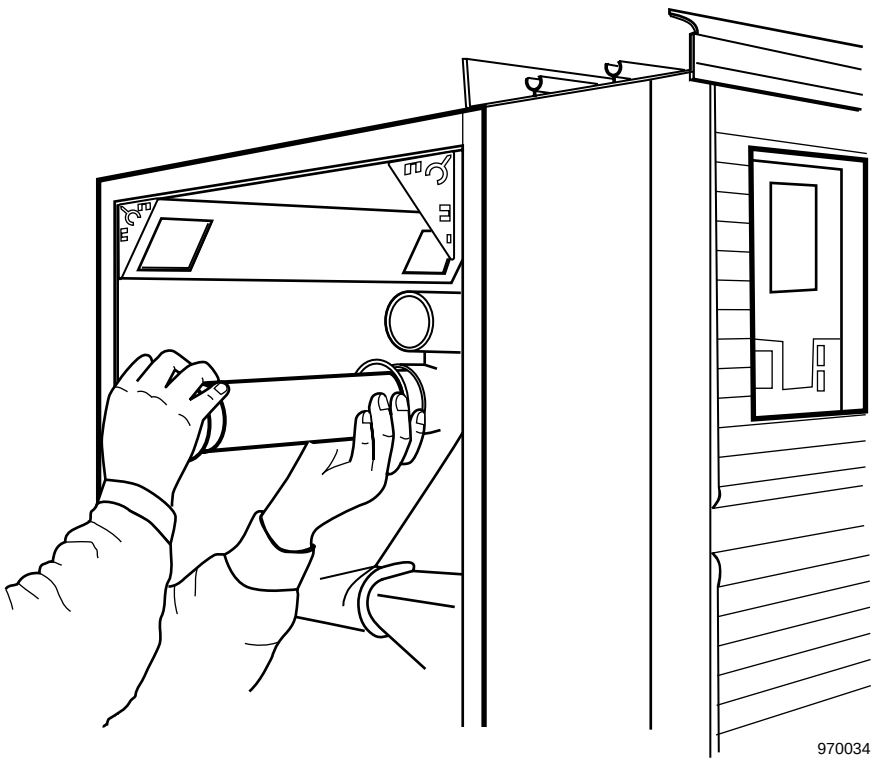


Figure 3-19. Inserting the coil spring contact

Assemble the coil spring contacts for all three phases in the following manner (the description refers to one phase but all three phases should be assembled at the same time):

1. Clean the coil spring contact where the springs will rest using a wiper type Scotch sprite.
2. Apply a thin layer of Fomblin grease type OT-20 on the coil spring contact's springs and contact surfaces.
3. Rock in the cubicles against each other and against the lower frame.
4. Bolt together cubicle 1 and cubicle 2 using the four bolts.

N.B. Aluminium spacers should be placed between the cubicles. (Note the spacers are manufactured of the same type of aluminium section as the cubicle corners.)

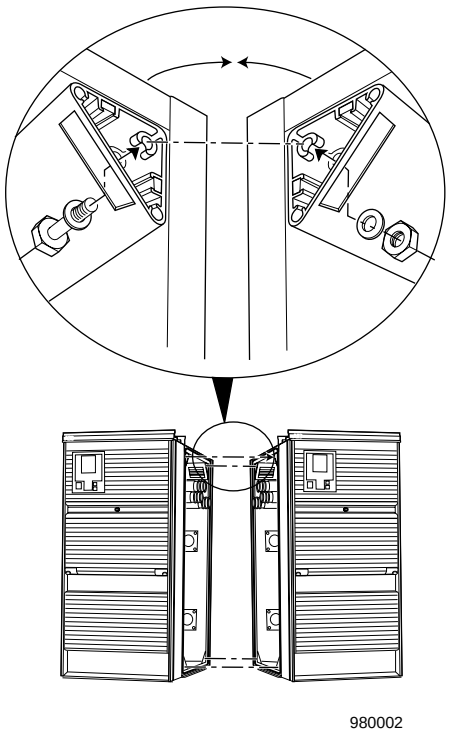


Figure 3-20. Securing two cubicles to each other

5. Remove both sealing sleeves from the coil spring contacts.
6. Bolt cubicle 2 to the lower frame.
7. Slide the bar half-way out through the spring contact. Fit the sealing sleeve on the spring contact.

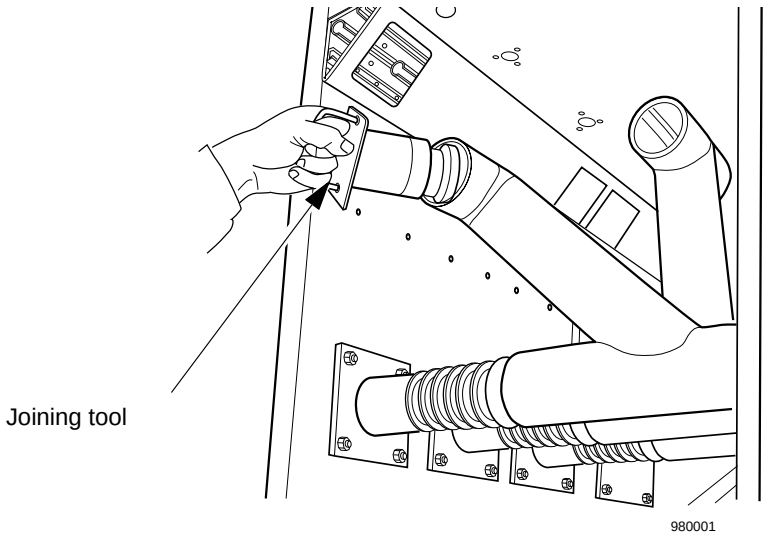


Figure 3-21. Joining using the joining tool

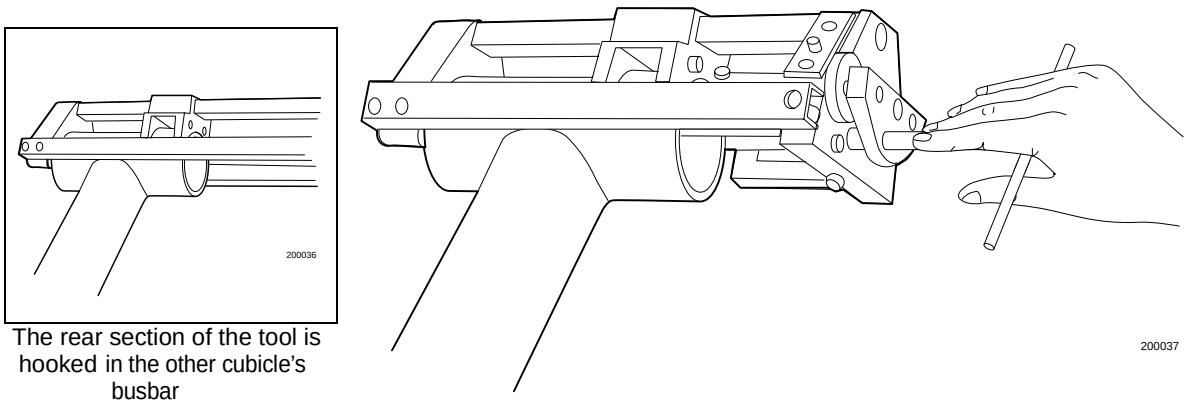


Figure 3-22. Jointing using the screw type jointing tool (used with four springs/joint)

8. Slide the coil spring contact to the correct length by using the joining tool.

9. Slide the left and right sealing sleeves in position, i.e. so that they sit in their grooves on the coil spring contact.

WARNING

The coil spring contacts must be assembled with the great care and highest possible standard of workmanship. It is especially important to apply Fomblin grease to the springs and contact surfaces and that the joint is turned a few times clockwise and anti-clockwise to minimise transmission resistance. It is also very important that the sealing sleeves sit in their grooves.

10. Continue in the same way (steps 1-9) with the other cubicles and busbar joints in the switchgear line.
11. Fit the terminators on the busbar assembly. The terminators are conical and should be pushed in the tubular busbars by hand and then locked using the appropriate locking bolts.

N.B. End terminators must always be fitted in the ends of the busbar section.

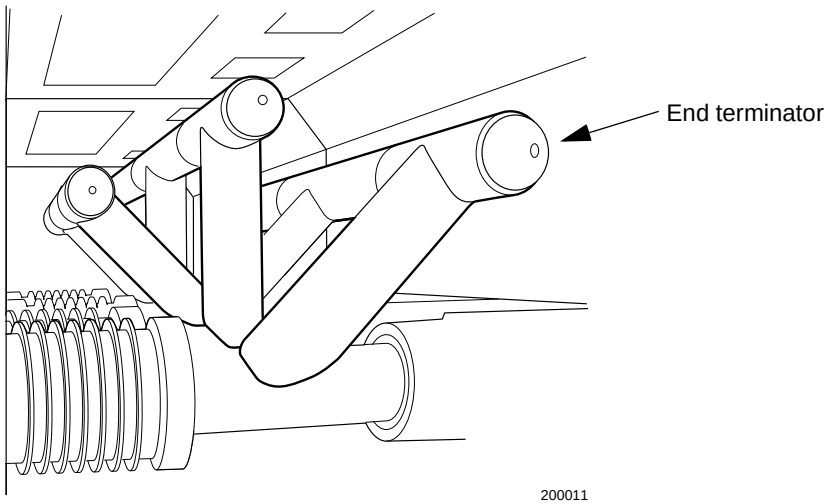


Figure 3-23. End terminators on the busbar section

3.9 Installation of the support cubicle (termination cubicle)

The support cubicle is fitted to the lower frame in the same way as other switchgear cubicles. A floor plate must be fitted for the battery carriage to assist movement of the carriage. The floor plate is supplied with the battery carriage.

1. Fit the floor plate in the lower frame.
2. Fit the rear and side plates on the lower frame.
3. Connect the ribbon cable for the display unit in the connection box to the connector on the battery carriage.
4. Connect 110 V DC cables to the fuse protected terminals.
5. Connect the alternating current for maintenance charging to the appropriate terminals.
6. Slide in the battery carriage in the support cubicle.

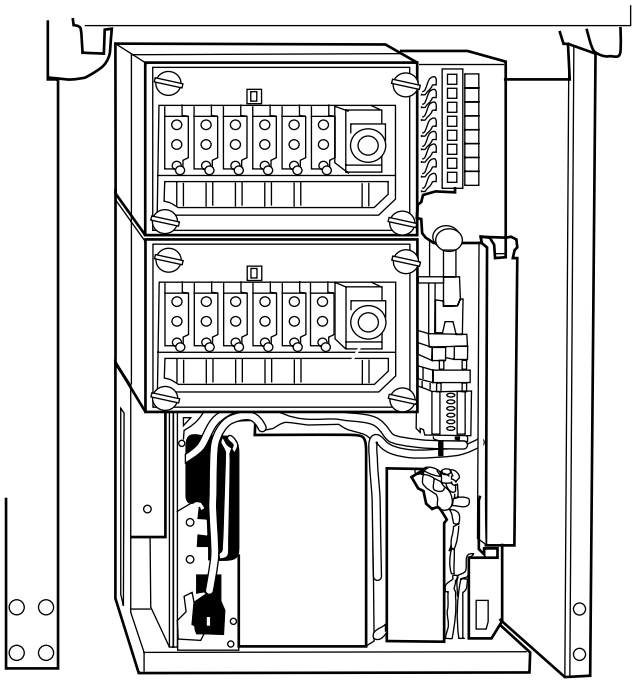


Figure 3-24. Battery carriage in the support cubicle

WARNING

The battery carriage, 110 V DC, may only be used if the maintenance charge is connected. The batteries can be destroyed if loaded without maintenance charging.

3.9.1 Earthing

When all the switchgear cubicles have been assembled, the cubicle's earth rails need to be connected to each other. The vertical cubicle earth rail should be placed between the horizontal earth rails. The earth conductors and screens should be connected to the earth rails. All earth conductors and screens connected to the earth rail shall be fitted with cable lugs for 12 mm connection bolts.

The switchgear's earth rail should be joined with the installation's earth line network (earthing point) via a secure earth connection. The connection to the installation's earth line network should be made from the earth rail in a cubicle located as close to the centre of the switchgear line as possible. Alternatively an earth connection can be placed at each end of the switchgear line.

WARNING

It is extremely important that the earthing of the switchgear and cables is carried out in the correct manner. Incorrect or missed earth connections mean mortal danger to those personnel working on the switchgear. Incorrect earthing also means that equipment can be damaged through a protective relay not functioning as intended.

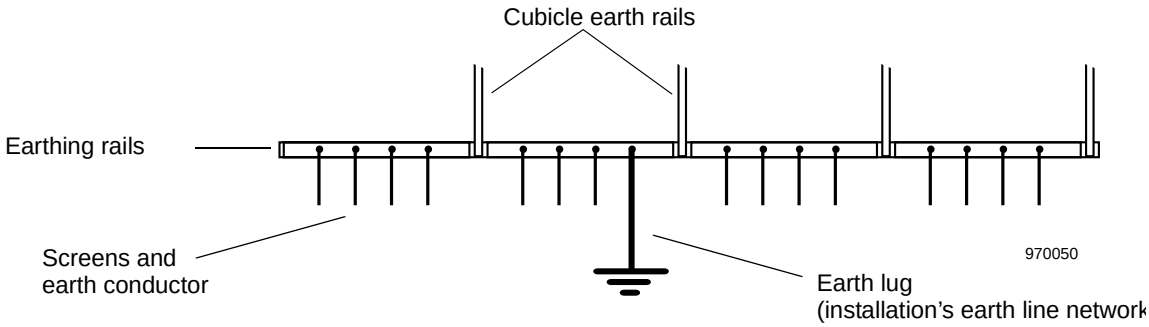


Figure 3-25. Principle view of the earthing system

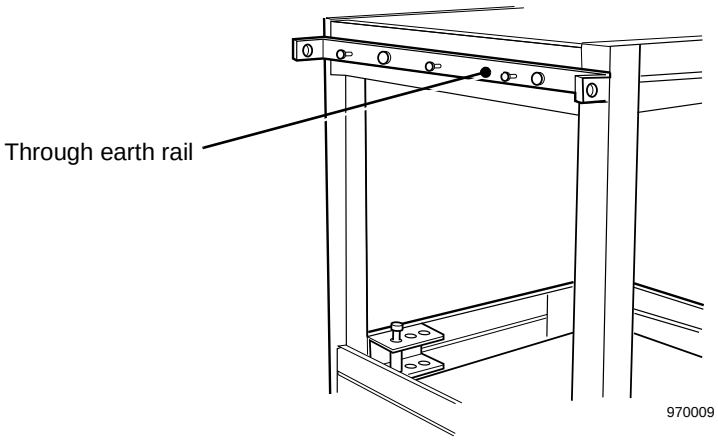


Figure 3-26. Earthing rail on the lower frame

The switchgear cubicle should also be connected with a secondary earth circuit. The connection rail for the secondary earth can be found in the cable compartment on top of switchgear cubicle.

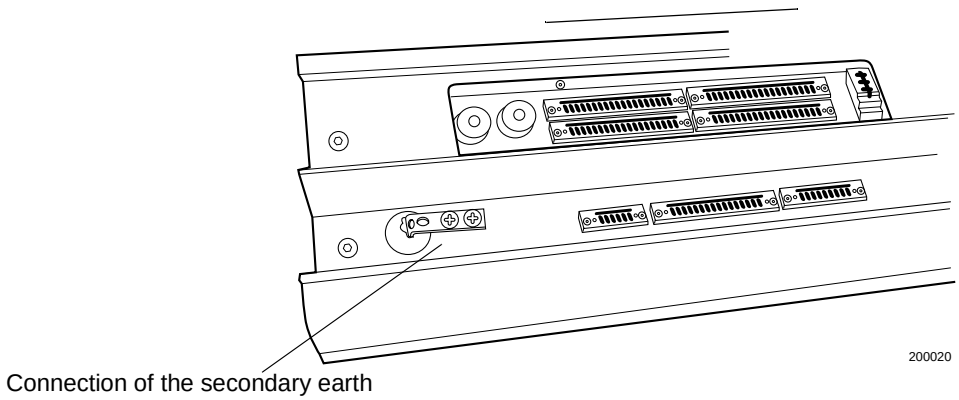


Figure 3-27. Secondary earth connections on top of the switchgear cubicle

3.10 Installation of control cables

The following cables should be routed from the support cubicle to respective switchgear cubicles and between switchgear cubicles (the cable harnesses are prefabricated at the factory):

- Opto-cables for the process bus (connection to the bay computer).
- Signal cables.
- Power supply cables for 110 V direct current/ alarm cables / voltage metering cables.

The cables are routed in the three way cable channel on top of the cubicle. Each way in the cable channel is reserved for a specific type of cable.

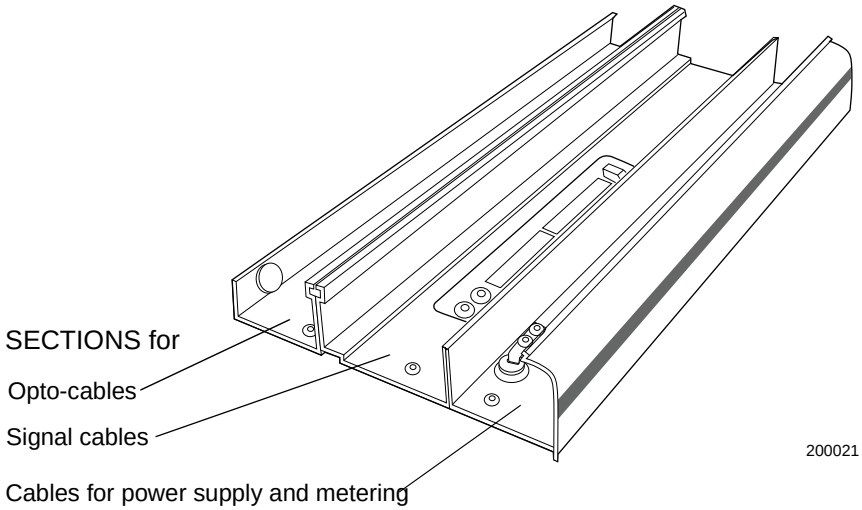


Figure 3-28. Cable compartment on top of the switchgear cubicle

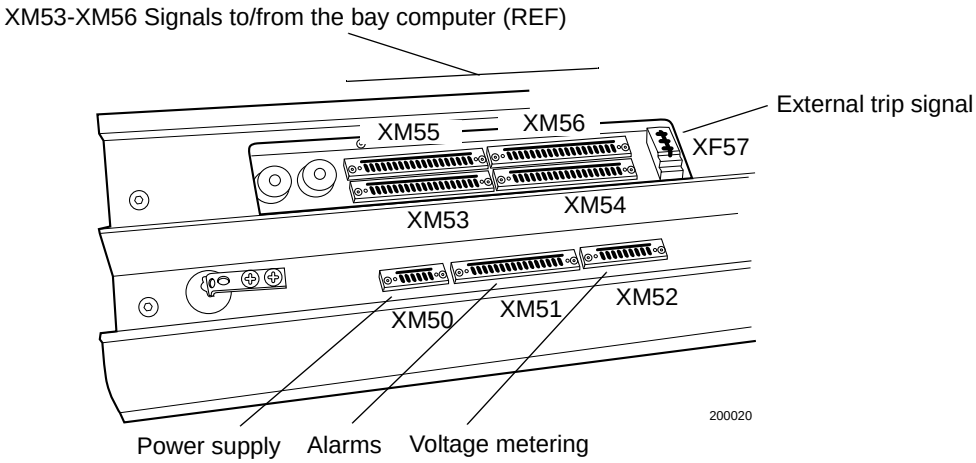


Figure 3-29. Connector top of switchgear cubicle

3.10.1 Cables for 110 V DC power supply

Connect the cable for the 110 V power supply from the support cubicle to each cubicle's power supply connectors. The switchgear cubicle's 110 V connection is made via the connector marked XM50. The power supply cable (cable tail) is equipped with a connector and marker. The connectors are marked H1.XF50, H2.XF50 etcetera. H1.XF50 is intended for the cubicle closest to the support cubicle, H2.XF50 for the next cubicle, etc. Each output from the support cubicle feeds an arbitrary number of switchgear cubicles each with two 110 V voltage lines.

The cables are supplied in standard lengths adapted to the position of each cubicle calculated from the support cubicle. Cable cross section is 2.5 mm^2.

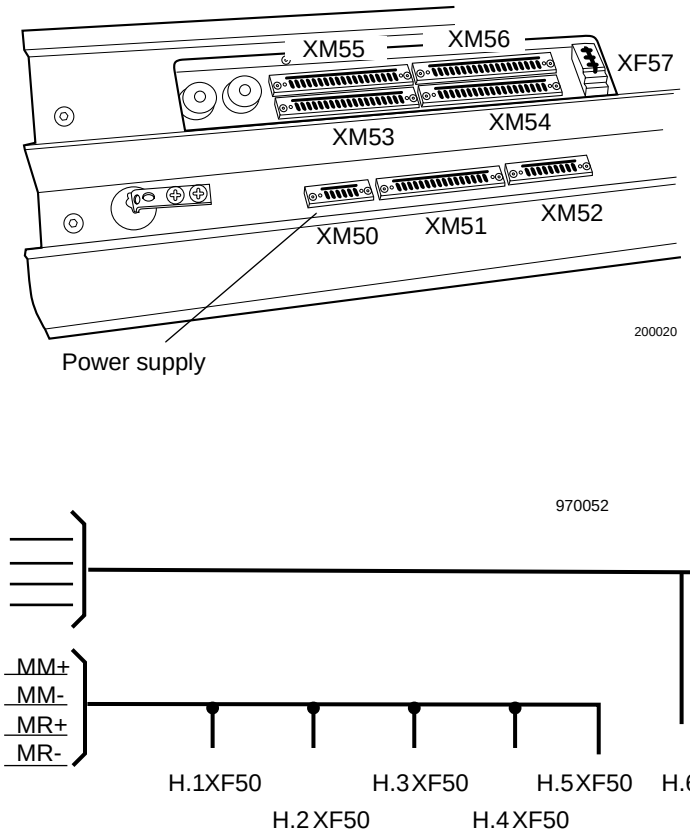


Figure 3-30. Example of the 110 V DC power supply

3.10.2 Opto-cables

Connect the opto-cables between the star coupler RER 111 by the support cubicle and each switchgear cubicle's bus connection module RER 103 on top of the cubicles.

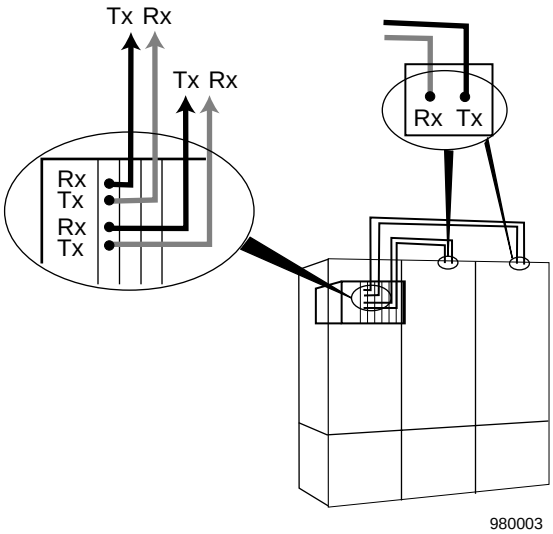


Figure 3-31. Connection of the opto-cables

N.B. Handle the opto-cables carefully. Optical fibres are especially sensitive to mechanical damage such as bending and pressure.

Bear in mind the following when installing the opto-cables:

- The minimum bending radius is 35 mm.
- Do not tighten cable ties too tight so they cut into the opto-cable's insulation.
- Opto-cables should be routed in conduit.

3.10.3 Signal cables

Connect the signal cables from the support cubicle to each cubicle's signal connector on the top of the cubicle. The cables are supplied in standard lengths adapted to the position of each cubicle calculated from the support cubicle.

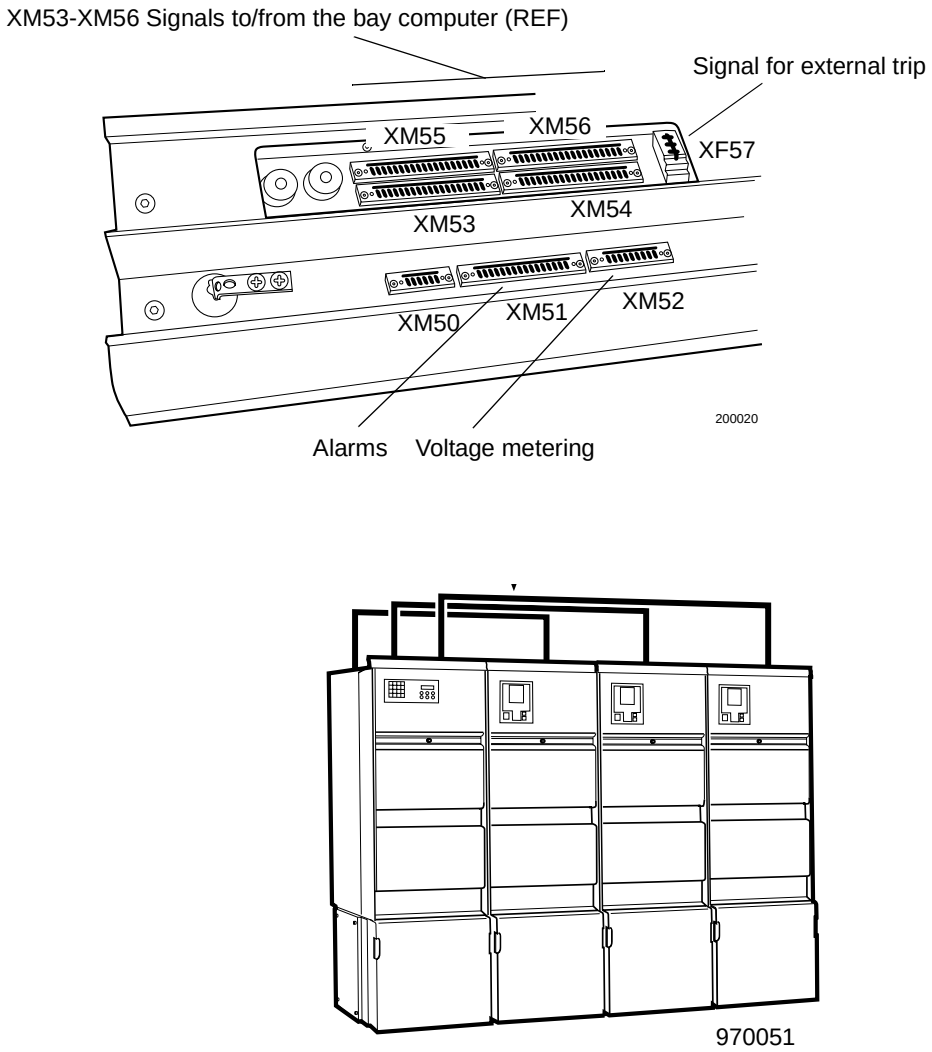


Figure 3-32. Connecting the signal cables

3.11 Installation of separate auxiliary equipment

Any separate auxiliary equipment supplied with the main delivery is installed and operations tested and ready-to-run on delivery from the factory. When supplementing on operational switchgear the voltage supply to the switchgear must be deenergised.

3.11.1 Voltage indication, passive

The voltage status is checked by a fixed voltage sensor. The voltage indication consists of the following:

- Capacitive voltage sensor in the cable glands or post insulators.
- Single phase coaxial cable
- Front panel
- Display unit (option)

The display unit indicates if the voltage within a specific voltage range exists on all phases. The voltage indication system requires no auxiliary voltage supply.

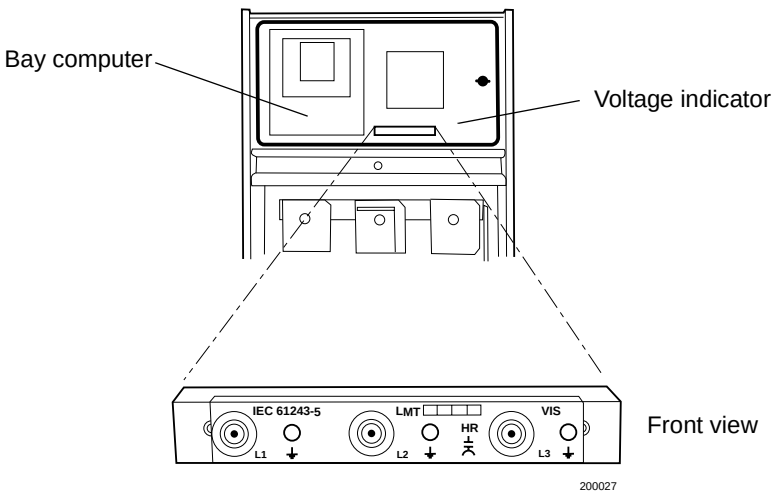


Figure 3-33. Front panel for voltage indication

3.11.2 Emergency stop

The switchgear cubicle has no buttons on the front for the emergency stop.

We recommend that red push buttons for each emergency stop are placed in the switchgear room next to each door representing an appropriate evacuation passage. Connection of the emergency stop is evident from the switchgear drawings.

The emergency stop is connected according to the closed current method, which means the cubicle cannot be made operational if these signals are undetected.

The emergency stop shall be connected in series. All circuit-breakers will be switched off by pressing the emergency stop button.

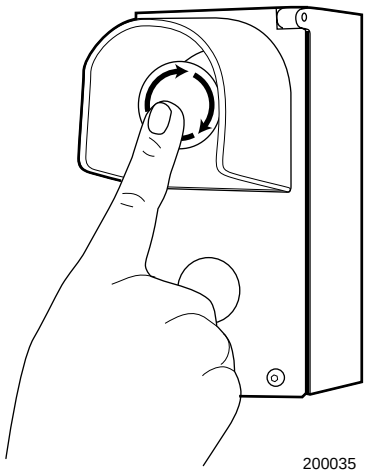


Figure 3-34. Emergency stop box

3.12 Assembling the switchgear's end plates

When the switchgear line is set up and the cable installation completed the switchgear end-plates should be assembled.

Assemble the end-plates on the outer ends of the switchgear as follows:

N.B. Check that the busbar terminators are fitted before the end-plates are assembled.

N.B. Check that no tools or other foreign objects are left in the main enclosure before fitting the end plates.

1. Screw the four spacers on to the cubicle.
2. Lift on and align the end-plates.
3. Fit the washers and dome nuts on the spacer bolts.
4. Tighten the four dome nuts.

N.B. End-plates must even be fitted to an individual switchgear cubicle set-up with one end against the wall. The end-plates must then be fitted before the cubicle is positioned on the lower frame.

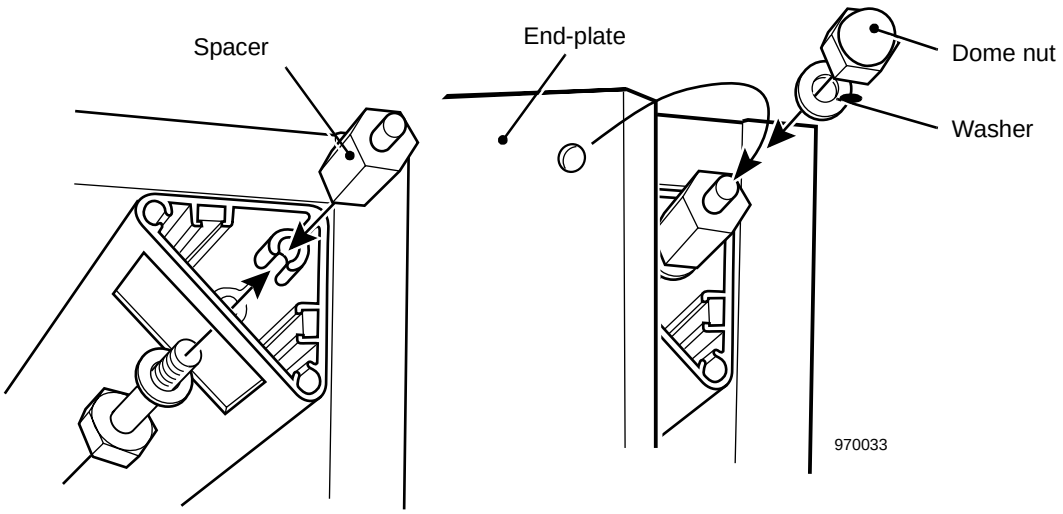


Figure 3-35. Assembly the cubicle end-plate

3.13 Assembling the lower frame's end-plates, intermediate plates and front

The lower frame can be fitted with end-plates and intermediate plates and a front. The end-plates and front have no direction function except providing a degree of dust protection and to form an obstruction against noxious animals. If necessary, the lower frame can also be fitted with intermediate plates and rear plates.

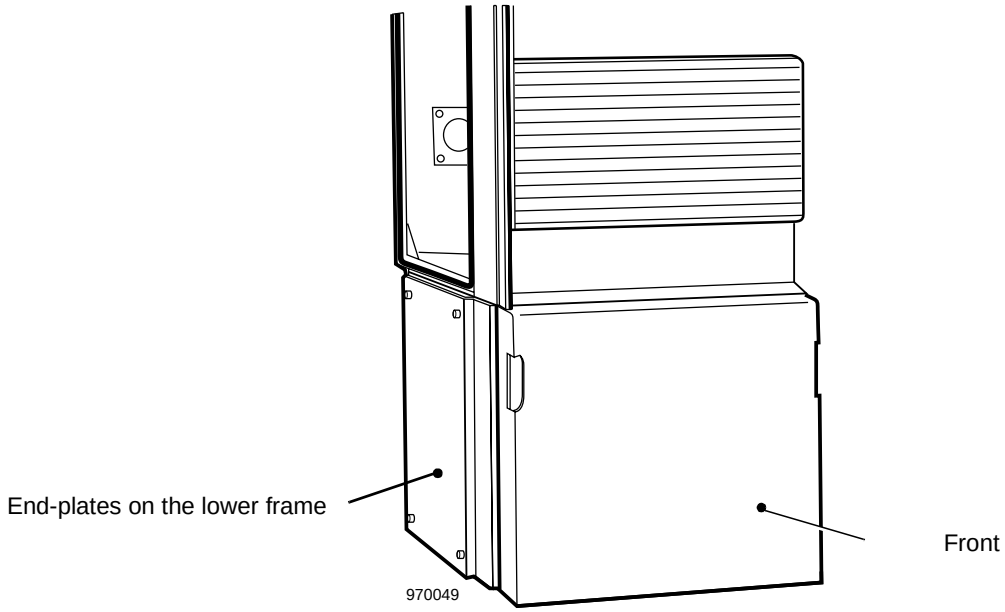


Figure 3-36. End-plates and front on the lower frame

3.14 Supplementary work and installation inspection

Use a check list during the installation inspection. The check list can also be used as verification for the completed installation work.

When the installation is complete the following supplementary work and inspection should be carried out:

1. Check that all assembly work complies with applicable drawings and connection diagrams.
2. Check that the power cables are anchored, i.e. secured in the cable brackets.
3. Check, with parallel power cables with outer cone connectors, that cable number two is strain relieved by the cable strain relief.

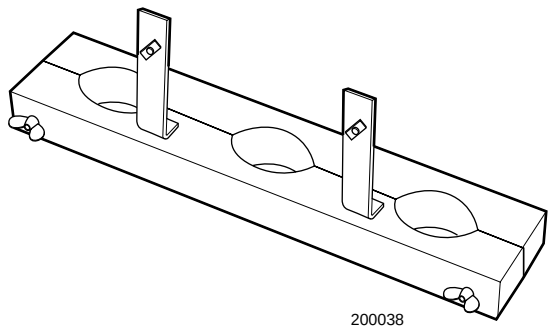


Figure 3-37. Cable strain relief with parallel power cables.

4. Check insulation to earth using an insulation tester (megger).
5. Check the cubicle and unit marking and supplement with signs if necessary.
6. Check that tools, cable residue, insulation material or other foreign objects are not left in the switchgear, operating areas and in the switchgear room.
7. Vacuum clean and dust if necessary.
8. Check that the top plates are fitted on all cubicles.
9. Shut the operating enclosure's doors and covers.
10. Check that the end-plates on the switchgear's outer ends are fitted and that the dome nuts are tightened.
11. Check that the end-plates on the lower frame's outer ends are fitted.
12. Check that the fronts are fitted on the lower frames.

4. COMMISSIONING

4.1 General

Once the installation has been completed the switchgear can be commissioned. Commissioning can be carried out quickly and efficiently as most operations are factory tested. Control, measurement and protection equipment based on digital technology also means that new techniques have been used for current and voltage supplies. Conventional instrument transformers have been replaced by sensors. No reconnection is required for different measurement ranges. On AX1 one size of sensor covers the entire measurement range.

Tools and instruments required for commissioning:

- Hand tools
- Universal instrument
- Test cables
- Insulation tester (megger) 1 kV
- Crank for manual loading of the circuit-breaker springs

WARNING

Exercise great care when commissioning the switchgear. Follow all the safety regulations and directives from the supervisor and electrical safety manager.

4.2 Installation inspection

1. Check that the installation has been carried out correctly and that the assembly site has been cleaned after installation.
2. Check that the switchgear’s end-plates have been fitted.
3. Check that the switchgear’s top plates have been fitted.
4. Check that the power cables are anchored correctly.
5. Check that cable number two on outer cone connectors is secured using a strain relief.
6. Check that the lower frame’s front has been fitted.
7. Check that the cubicles’ earth rails are assembled and joined to each other.
8. Check that the switchgear is earth correctly.
9. Measure the earth point resistance.

4.3 Inspection of control cable connections

1. Check using the connection documentation that all cables are connected and tightened as well as that the connectors are inserted correctly and locked.
2. Check that the cable screens and earth conductors are connected to earth.
3. Check that all cables and connectors are correctly marked.
4. Check that all cables are routed correctly and secured with cable ties.

4.4 Inspection of the support cubicle

4.4.1 Batteries and power distribution

The batteries are valve controlled lead batteries that are fully enclosed and do not require to be filled with water. Pole terminations do not need to be greased as these are silver-plated.

WARNING

All free metal components on the battery are energised. Contact can result in serious injury. Exercise care and only touch plastic areas of the battery.

WARNING

Risk of explosion! Each battery cell is fitted with a valve which can release hydrogen during all operating conditions.

Check and commission the power supply as follows:

1. Check that the mains voltage is connected for maintenance charging the batteries.
2. Check that the battery connections are tightened.
3. Check the connection of the charger and battery fuse with the connection documentation.
4. Make sure all miniature circuit-breakers, MCB (B1.9 and B1.10) for respective cubicles are off.
5. Start the battery charger according to the supplier’s instructions.
6. **Measure the output voltage from the batteries/rectifier on the terminal as set out in the connection documentation for the support cubicle**. The output voltage shall be 110 V DC ±10%. Check the value on the rectifier’s display unit.
7. Set the required alarm groups and levels according to the supplier's directions.

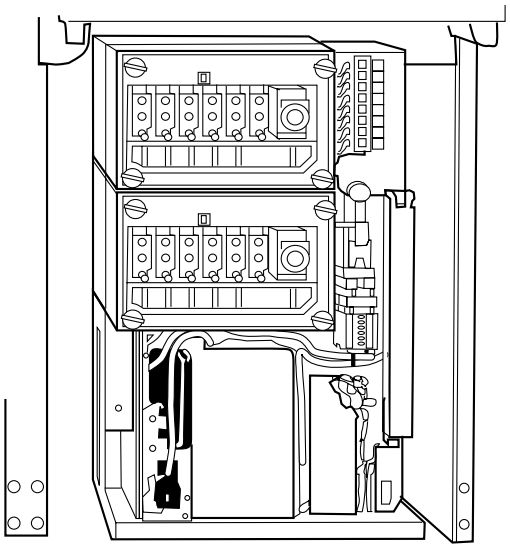


Figure 4-1. Support cubicle with battery carriage

4.4.2 Star coupler for optical fibres

Check that all bay computers and the supervision unit for the battery system are connected correctly via the opto-cables to the star coupler in the support cubicle. See the circuit diagram and the connection documentation.

4.4.3 Cross connections (connection interface)

The support cubicle is the interface between the switchgear and external objects and contains connectors and terminal blocks for signals to and from these objects.

- Check all connection points according to circuit diagram and the connection documentation.
- Check that terminal blocks with a disconnecting function are in the connected position.

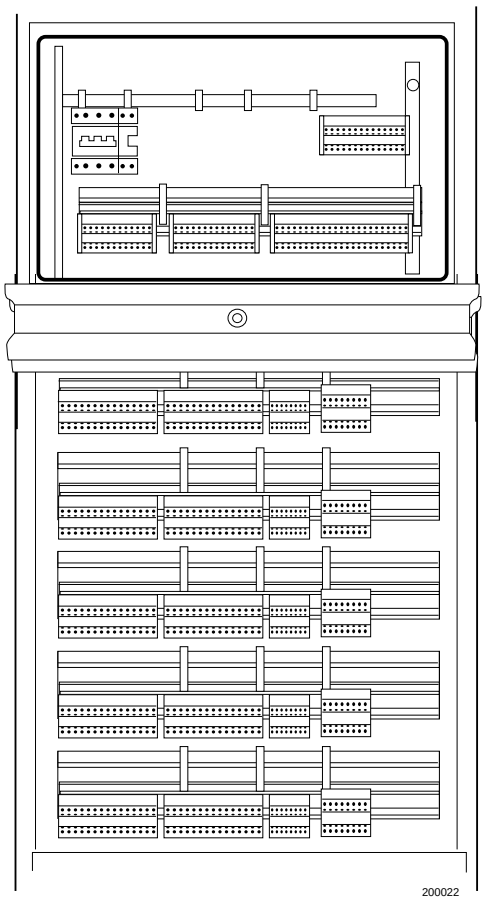


Figure 4-2. Support cubicle's cross-connection section

4.5 Inspection of the switchgear cubicle

1. Identify the phases in all cubicles.
2. Identify the cable's phase at the "other end".
3. Check that cable screens and earth conductors are connected to earth.
4. Check that the core screen kits are fitted if 3 phase power cables are used.
5. Measure the current distribution on the parallel power cable connection.
6. Insulation test using a 1 kV megger.
7. Check that all cables are anchored in the cable bracket.
8. Check that all cables routed through the floor and walls are sealed according to an approved fire class method.

4.6 Voltage feeding protection and control equipment

When the inspection of the installation has been completed the protection and control equipment should be voltage fed.

WARNING

Risk for pinch injury. The circuit-breaker's closing springs are off-loaded on delivery. When the bay computers are voltage fed the springs are automatically loaded when the miniature circuit-breaker (MCB B1.10), which protects the motor, is closed.

1. Connect the voltage supply to the protection and control equipment using miniature circuit-breakers MCB B1.9 and B1.10 in respective switchgear cubicles.
2. The bay computer displays run through a short test when voltage fed:
   a. The nine LEDs come on simultaneously with different colours (red-green-yellow-off).
   b. The three LEDs for protection indication and the LEDs for Local/Remote button come on briefly.
   c. The display is tested at the same time by the display window briefly being inverted.
   d. After the display test the display returns to the normal mode (a standard Mimic display) and the background lighting is dimmed automatically after the specified time.
3. Check the power supply's connection points if the test is not carried out.
4. Make sure the operating voltage is connected in the support cubicle and in respective switchgear cubicles and switch on the miniature circuit-breakers (MCB) B1,9 and B1,10.
5. Check that no alarms except "Cable not earthed" are indicated.
6. The bay computers have undergone extensive testing before delivery. If, despite this, any abnormalities are suspected a functionality test should be implemented. The functionality test consists of three parts: operations test, Mimic-test and I/O-test. The operating test is described in the document RE_54_ Operator's Manual
   1 MRS750500-MUM EN.

N.B. The bay computer opens the circuit-breaker in the cubicle during start up.

4.7 Checking parameters

Parameters such as alarm levels, times, etc. are set for controllable objects in the switchgear cubicle (circuit-breaker, disconnector, arc eliminator). Parameter values should be set for the protection and measuring operations in the bay computer for the switchgear cubicle in question before voltage feeding the main circuits.

N.B. By resetting the parameters in REF the operation of the emergency stop can, for example, be changed.

4.8 Setting a password

Three passwords with different authorisation levels can be set to prevent unauthorised persons from operating objects or modifying set parameters. It is appropriate to select passwords for the different levels in association with commissioning.

See the description for the bay computer or the section for operation and maintenance of AX1.

4.9 Arc eliminator system

At least one cubicle in a switchgear delivery contains one arc eliminator system. The system consists of three arc eliminators, three trigger units and a controller. The system also includes the cables between the component system parts.

When the auxiliary voltage is connected to the system the controller performs an internal check of the system and starts to charge the capacitors. The charging time is around 15 minutes. **Ext pwr** and **Pos open** come on when system is ready for use. Other alarm LEDs should be dark, i.e. turned off after the system check.

4.9.1 Activating the arc eliminator system

The energy to each eliminator is stored in a capacitor. The coil's switching current is controlled by a thyristor which is "triggered" from the arc supervision function in the arc eliminator's controller. The activation signal comes from the detectors located throughout the switchgear.

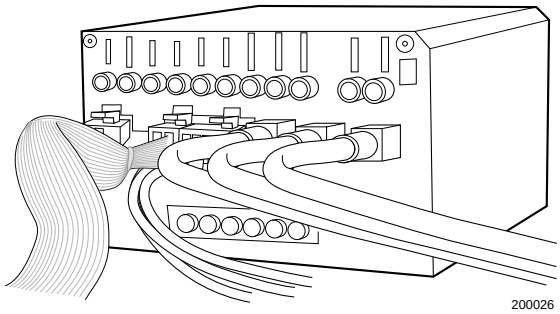


Figure 4-3. Arc eliminator system's controller

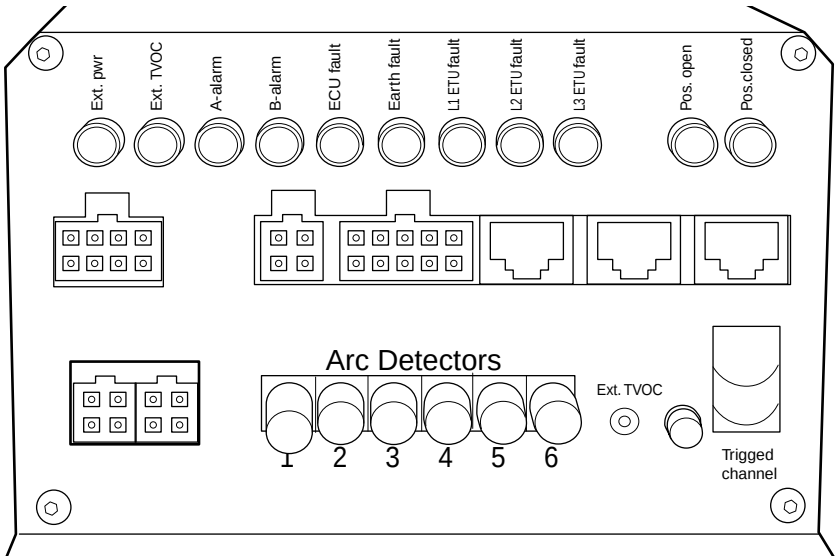


Figure 4-4. Front of the controller

The controller gives the following indications:

Table 4-1. Indications on the controller

Text	Colour	Note/significance
Ext pwr	Green	Comes on if there is high voltage
A-alarm	Red	Comes on if triggering is not possible
B-alarm	Red	Comes on if triggering is possible, but all system parts are not OK. A B-alarm is given during capacitor charging. The eliminators can not be triggered.
ECU Fault	Red	Comes on with a controller fault
Earth fault	Yellow	Comes on with an earth fault on the ETU, ECU or control cables.
L1 ETU Fault	Yellow	Comes on with a fault in the trigger unit/operating mechanism on phase L1. Flashes when the capacitor is charging
L2 ETU Fault	Yellow	As for phase L2
L3 ETU Fault	Yellow	As for phase L3
Pos open	Green	The arc eliminator is open and ready for closing
Pos closed	Red	The arc eliminator is closed, i.e. has closed
Ext TVOC	Red	Comes with a fault in the tripping circuit for the externally connected TVOC

4.9.2 Resetting the arc eliminator system

The arc eliminator system is rest after closing by using the resetting button on the controller. The system then senses the functionality of the electronic circuits and whether the capacitors are charged. If this is so, earth faults are reset automatically. Resetting takes approx. 1 hour and when the system is reset **Pos open** and **Ext pwr** are lit. Other alarm LEDs should be dark, i.e. turned off after resetting.

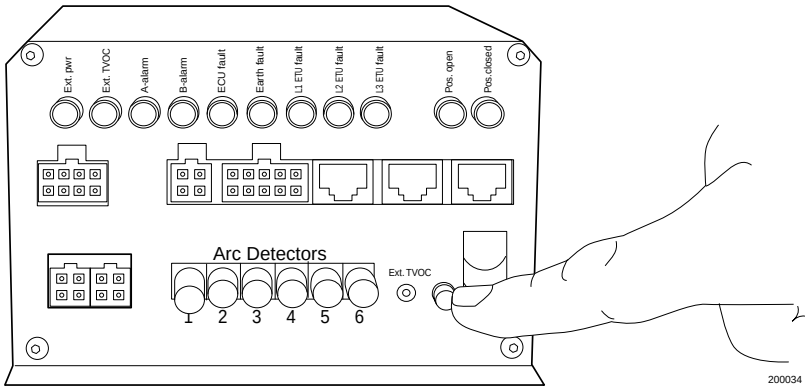


Figure 4-5. Resetting button on the controller

WARNING

Fatal voltage. The capacitors in the arc eliminator system are highly dangerous to touch when charged. Exercise immense care with all work on the system.

WARNING

Fatal voltage. Contact outlets on the controller (**XM93, 94, 95**) are highly dangerous to touch. Exercise immense care with all work on the controller and in its vicinity.

WARNING

The switchgear ought to be taken out of service immediately if an A-alarm is indicated on the controller.

WARNING

If a B-alarm is indicated on the controller the cause should be investigated and rectified immediately.

4.9.3 Connection of one or more extra sensors

The switch **Ext. TVOC supervision** on the controller should be set in the **ON** position if one or more extra sensors (TVOC-units) are connected to the arc eliminator system.
In the **ON** position even these extra sensors are supervised by the system.

The arc eliminator's controller requires an input voltage of between 20 - 60 V on the input EXT.TVOC in order not to indicate faults in the external trigger equipment. The controller will give an alarm for a fault on the external trigger equipment with deviating voltage.
If the voltage on EXT.TVOC input is higher than 80 V the controller can still trigger. Voltage above 80 V occurs if any Triac on the arc guard starts to conduct (arc has occurred).

4.9.4 Testing the arc eliminator system

When connecting the mains voltage to the cubicle it takes approximately 20 minutes before the arc eliminator system is operational. During this period the system is checked internally and the capacitors are charged. When the system is ready the two lights on the controller, **Ext pwr** (green LED) and **Pos open** (green LED) come on.

WARNING

The arc eliminator system should be tested in its entirety before the installation is commissioned.

Test the system as follows:

1. Measure using a multimeter across the eliminator to establish that it is in the open position.
2. Simulate an arc by applying a photo flash in the high voltage enclosure. The eliminator should now go to the closed position.
3. Measure using a multimeter across the eliminator (verify) to establish that it is in the closed position.

On the controller **Ext pwr**, **B-alarm**, **L1-L3 fault** and **Pos closed** should now be lit. L1-L3 flash to indicate that the capacitors are charging. A display also shows which detector has seen the photo flash.

4. Press the Reset button to reset the eliminators.

The eliminators automatically return when the capacitors are charged. When resetting is ready the controller indicates with **Ext pwr** (green LED) and **Pos open** (green LED).

5. Verify that the eliminator returns to the open position by measuring with a multimeter across the eliminator.

N.B. The arc eliminator does not normally need to be tested after the installation is operational.

4.10 Energising the high voltage circuits

NOTE All applicable safety regulations should be reviewed before energising the main circuits. Check with the electrical safety and operations managers.

WARNING

Fatal voltage. Exercise immense care when energising the high voltage circuits.

1. Energising the switchgear's busbar by connecting the incoming line's circuit-breaker.
2. Read off the voltage values on the bay computer to check that the busbar has been energised.

4.11 Functionality test

The functionality of all switchgear operations should be tested before commercial operation.

4.11.1 Locally in the switchgear

- Operations test the equipment.
- Check the measurement values.
- Check the alarms.
- Check the parameter settings.
- Setting parameters for the configured protection and measurement operations.
- Inspection of protection and measurement operations.

WARNING

High noise level. Wear ear protection during operations testing of a circuit-breaker. The tripping of the closing springs produces a loud noise that can impair hearing.

WARNING

Pinch risk. A loaded closing spring in a circuit-breaker has a large amount of stored energy. Mind your fingers and hands when operating the circuit-breaker.

4.11.2 From the master control room or operating centre

- Operations test the equipment.
- Check the measurement values.
- Check the alarms.
- Check the statistic signals.

WARNING

Always inform persons in the switchgear room or in its immediate vicinity before operations testing is carried out.

4.12 Acceptance inspection before commercial operation

Once commissioning has been completed an acceptance inspection should be carried out before the commercial operation of the switchgear.

The acceptance inspection should be carried out according to the customer's specifications and the demands set out in the contract.

5. OPERATIONS AND MAINTENANCE

5.1 General

The medium voltage switchgear AX1 is designed for use under operating conditions described in the IEC standards set out in chapter 1. The switchgear requires a minimum of maintenance due to the well-thought out design and choice of materials.

Local operations from the switchgear only require the switchgear's upper cover to be opened so that the bay computer is accessible.

5.1.1 Cover over the bay computer enclosure

To open the cover

- Press in the cover catch button in the centre of the switchgear.
- Raise the cover.
- Push in the cover.
- The cover stays in the raised position.

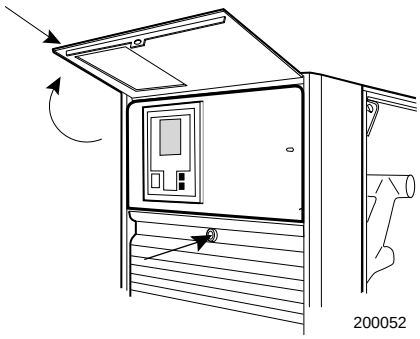


Figure 5-1. Opening the bay computer enclosure cover.

Shutting the cover

- Pull the opened cover out a few millimetres releasing the catch holding the cover.
- Lower the cover and press it in to engage the lock.

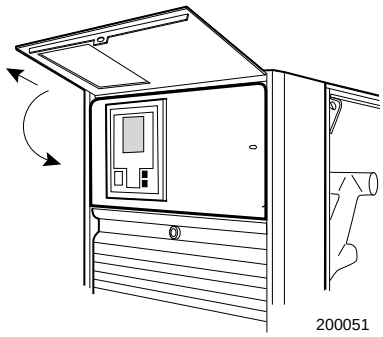


Figure 5-2. Shutting the bay computer enclosure cover

5.1.2 Operating mechanism's sliding cover

Open the operating mechanism's sliding cover by pushing in the catch buttons at the same time as the cover is slid downwards while the catch is held in.

With 600 mm high lower frames the sliding cover must be removed to open the entire operating enclosure. If you do not need to open the operating enclosure completely slide the cover down as far as possible.

The sliding cover is removed by unscrewing the catch unit that locks the door in the runners on the right-hand side of the door.

N.B. With a 800 mm lower frame. The cover can be removed if it is pulled down completely.

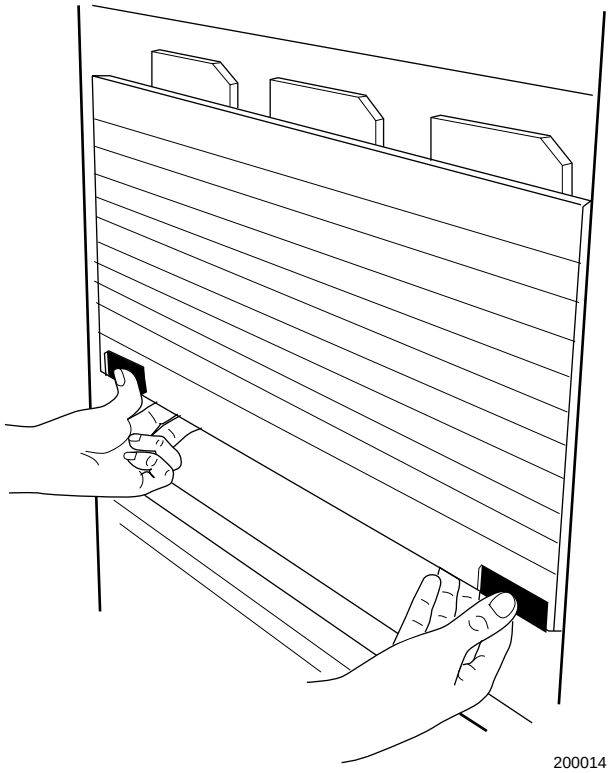


Figure 5-3. Opening the operating mechanism enclosure door.

5.2 Front of the bay computer (buttons, LEDs, display)

The bay computer REF is intended for protection, control, measurement and monitoring. The front accommodates in addition to the function keys a display that displays text messages and schematics. The messages are given as status, alarms and instructions to the operator. The front panel of the bay computer is used for local control and monitoring of the switchgear. Remote mode is indicated with master control from a stationary computer. Local operations are only possible if local mode is selected. The choice of Local/Remote operations is password protected on delivery, see section 5.3.1.

The bay computer is described in full in the following documents:

- RE_54_ Operator's Manual, 1 MRS 750500-MUM EN
- RE_54_ Technical Reference Manual, 1 MRS 7500527-MUM EN

This section deals with the functions necessary to know for normal operations and maintenance of the switchgear. For more detailed information please refer to the above mentioned documents.

The bay computer's front panel is identical in all switchgear cubicles.

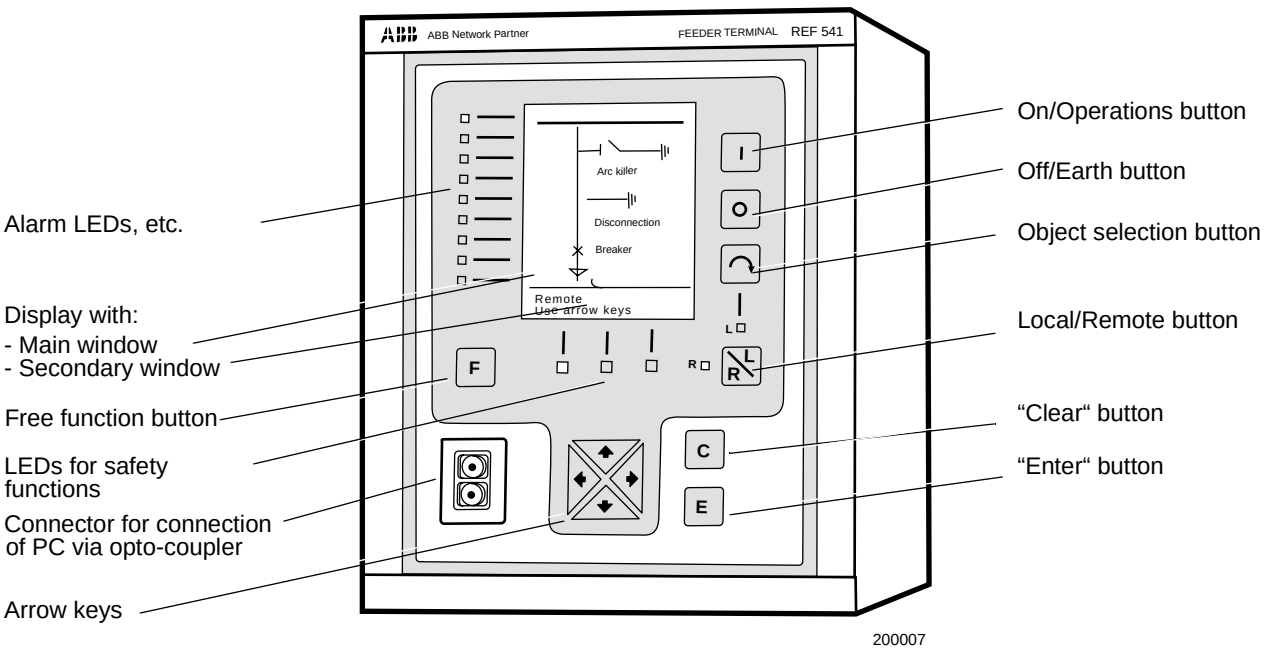


Figure 5-4. Bay computer REF

The front panel has the following buttons and display:

- A display divided into a main window and a secondary window.
  - The main window displays detailed information such as schematics, object, incident, measurement values, operations, alarm and protection parameters.
  - The secondary window shows indications/alarm and help text for protection functions and text providing the operator with information about operating possibilities.
- A Local/Remote button.
- Three buttons for object control, **I** (On/Operations), **O** (Off/Earth), **curved arrow** (Object selection).
- Eight LEDs for alarms.
- One LED to indicate interlocking.
- Three LEDs to indicate the following:
  - Green (correctly connected auxiliary current, flashing indicates internal relay fault)
  - Yellow (protection function start).
  - Red (protection function tripped).
- One section with four arrows and two buttons for (C) “clear/cancel“ and (E) “enter“.
- Connector for connection of an optical PC-connection.
- Free programmable button (F). Not normally used. See configuration drawing for the specific function.

5.2.1 Background lighting and contrast

Background lighting

The background lighting is normally dimmed. The display comes on when any button on the panel is pressed.

Contrast

Press the E button and any of the arrow keys

- Arrow up to increase the contrast.
- Arrow down to reduce the contrast.

5.2.2 Arrow keys

The arrow keys are used to control parameters and the display's cursor between rows and characters in the menus and lists. Briefly pressing the up or down arrow keys (less than a second) is a step up or down in a menu or lowest possible increment up or down when setting parameters.

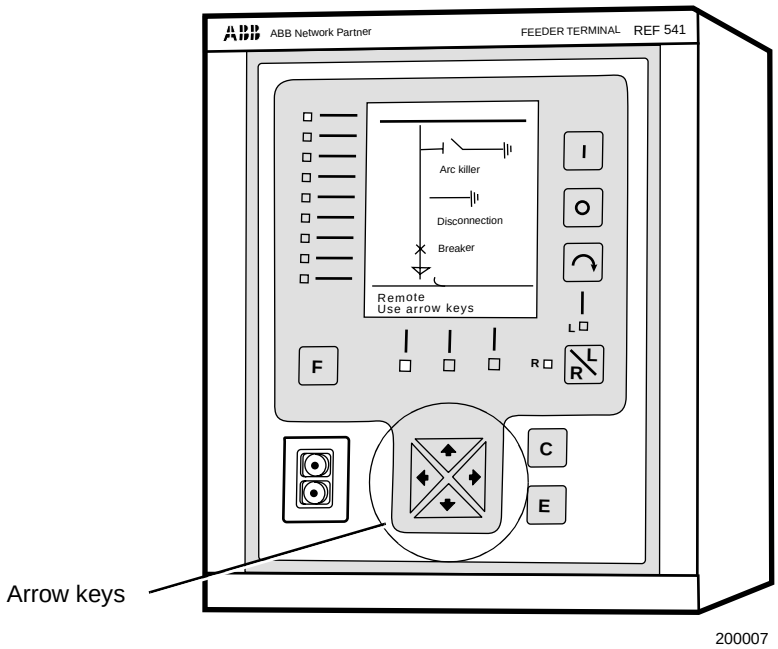


Figure 5-5. Arrow keys for moving the cursor

Up/Down arrows

Move the cursor up or down for selection of a row in a menu or to change the set values/parameters.

Left/Right arrow

Move between "rows" (left/right) and to select from the hierarchical levels.

5.2.3 C- and E button

Pushbutton C (Clear/cancel) and E (Enter) are used as follows:

C

On user level:

- Undo changed parameter setting (before E button is pressed).
- Clear existing buzzer alarm (A, B, C alarms).
- Clear incident from list of incidents.
- Clear alarm for alarms no longer active on the alarm list.

On technical level:

- See manual 1MRS750500-MUM.

N.B. If C is held in for at least 5 seconds all indication messages are erased from the secondary window.

E

On user level:

- Allows transfer to technical level, see section 5.3.5.

On technical level:

- See manual 1MRS750500-MUM.

N.B. If E is held in for at least 5 seconds all indication messages are erased from the secondary window.

5.2.4 Local/Remote button

The Local/Remote button is used to select the operating mode.

Pressing the button steps forwards to the next operating mode. The LEDs indicate the selected operating mode.

The Local/Remote button is password protected on delivery, see section 5.3.1.

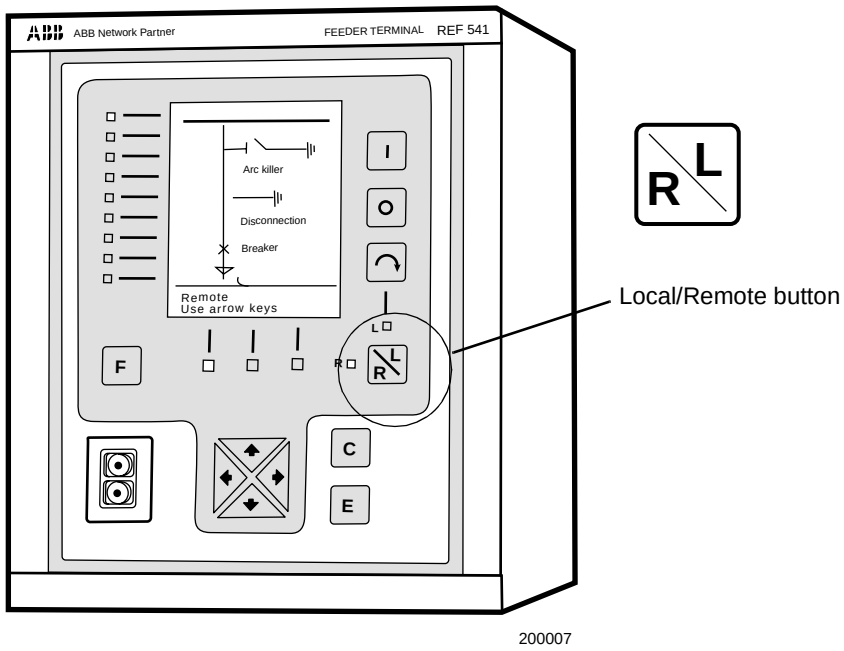


Figure 5-6. Local/Remote button for selecting the operating mode

Local
Remote operations via stationary computer are blocked. Yellow LED, L on.

Remote (**Remote**)
Local operations blocked. Yellow LED, R on.

Disconnected
See manual 1MRS750500-MUM.

Logic
See manual 1MRS750500-MUM.

Local and logic
Remote operations blocked. LEDs L and unmarked on.

Remote and logic
Local operations blocked. LEDs R and unmarked on.

5.3 Bay computer's functions

5.3.1 Choice of operating mode (levels)

When controlling and monitoring from the bay computer REF there are two levels:

- User level
- Technical level

The user level is the level used for normal operations and maintenance. The technical level contains information for programming of protection functions.

User level

Data is presented in four different displays on the user level:

1. Schematics (line drawings)
2. Measurement display
3. Incident display
4. Alarm display

Passwords

The bay computer offers three password levels to prevent operation of an object either unintentionally or by unauthorised personnel, or the modification of set parameters.

The following three passwords can be used:

Password 1 (schematics) gives the possibility to select the operating mode using the logic button.
Default value is **1*****.

Password 2 (parameters) gives the possibility to set and change parameters.
Default value is **2*****.

Password 3 gives the possibility to select the technical level.
Default value is **3*****.

Password 1 can be set in two positions: activated/deactivated.

Password 2 is always selected.

Password 3 can be set in two positions: activated/deactivated.

On delivery all password are set to the default values. During commissioning it is possible to select the safety level, i.e. determine which passwords shall be active and which passwords should be chosen instead of the default values.

5.3.2 Changing passwords

Passwords can be changed as set out in the documentation for the bay computer REF. See manual 1MRS750500-MUM.

5.3.3 Object selection in the main window

Press the object selector button to step through the available objects until the required object is highlighted (inverted text). The object is selected until the operate command is given or until time-out. The time-out period can be set. Selection using the object selector button is only possible when the operating method Local is selected using the Local/Remote button.

5.3.4 Indication of protection functions

There are two kinds of indicating messages in the message window:

- Information on protection functions and conditions together with LED indication.
- A text message without LED indication. This message is related to remote monitoring (external).

The message in the secondary window has a special priority. If several different indications are initiated simultaneously the message with the highest priority is shown first.

The following priorities apply:

1. Internal fault IRF.

2. Relay protection tripped, CBFP (Circuit Breaker Failure Protection).

3. Start, blocking, monitoring.

4. Help messages.

The last captured and active message is shown in the help window according to the predetermined priority.

Indication messages (priority 1-3) automatically give an overview of the protection and condition circuits and internal faults in the protection functions. Indications are shown in priority order in an incident list and remain until acknowledged.

Acknowledgement

Press button C for five seconds.

The help message (priority 4) assist the operator by displaying what should be done next.

5.3.5 Technical level

The technical level is accessed from the schematics in the user level.

- Press E for five seconds to access the technical level.
- State the password if necessary.
- Return to the user level by pressing E for two seconds in the technical level's main menu. The technical level is described in detail in the documentation for the bay computer REF.

5.4 Supervision

5.4.1 Supervision of the switchgear and switching devices

The following functions are supervised in an AX1-cubicle with switching devices and bay computer:

Circuit-breaker

Standard supervision

- Closing coil (Trip Circuit Supervision)
- Spring loading time for the motor
- Gas density
- Closing time
- Opening time
- Status indication
- Loaded/offloaded springs

Optional supervision

- Opening coil (Trip Circuit Supervision)
- Closing speed
- Opening speed
- Circuit-breaker wear
- Planned maintenance
- Inactivity alarm

Disconnector

- Running time
- Gas density
- Electrical locking of operations in earthed mode
- Status indication.
  Status indication is conencted in series, which means all disconnectors must be in the same position in order to give status indication on the bay computer. If the signal is not available within 12 seconds after the start of operations the voltage to the motors is cut and an alarm generated.

Arc eliminator

- Breakage in the trigger cable harness or an error in the thyristors' Gate-circuit
- Poor capacitor capacitance (<50%)
- Short circuit in the charging circuit
- Fault in the charging circuit
- Fault in the trigger circuit from the external arc guard
- IRF on the controller
- Capacitors not charged
- Earth fault
- Acceptable capacitance on the capacitors (>60%)
- High leakage current from the capacitors

Bay computer

- Supply voltage
- Temperature metering
- CPU watchdog
- Supervision I/O card
- Supervision of internal bus

Measurement

- Current metering circuit (option)
- Voltage metering circuit (option)
- Voltage sensing on the cable side

5.4.2 Supervision in the support cubicle

Battery supervision system BRC 2000 has an alarm panel for 16 channels on the front display. LEDs indicate the status of the battery system as follows:

Standard supervision

- Continuous charge high/low
- Over- and undervoltage
- Earth fault +/-
- Battery circuit fault
- Temperature fault
- Lost mains voltage
- Rectifier fault
- Blown fuse
- Capacity test

Non standard

- Low battery capacity
- Cell fault
- Remote communication

5.4.3 What is not supervised in the AX1?

- The arc detectors are not supervised.
  The continuous operation of these is ensured by the following:
  a. The arc detectors are fitted in the top, which means that they are not covered by dust.
  b. An extra amount of arc detectors are fitted, which means redundancy is obtained.
  c. The detectors only receive direct light and not reflected light.
- The extra release coil is not supervised.
  This is due to the following:
  The user has direct access to the release coil, which means it cannot be monitored in the normal way. If the extra release coil needs to be supervised a supervision relay type SPER can be fitted in the support cubicle.

5.5 Alarm signals from the switchgear

In each bay computer as standard there are a number of relay outputs for alarms. These are used to impart the switchgear cubicle's status to the support cubicle. Alarms (relay outputs) are commonly connected in the support cubicle where they can be accessed on terminals.

N.B. These relay outputs are potential free.

All alarm contacts are of the type NO, Normally Open and have the same contact data.

Signal contact data:	Nominal voltage	250 V ac/dc
	Continuous	5 A
	Limiting making capacity and conductivity under 0.5 sec	30 A
	Limiting making capacity and conductivity under 3 sec	8 A
	Breaking capacity dc, when the load's time constant L/R <40 ms at 48/110/230 V dc	1A / 0.25 A / 0.15 A

5.5.1 Internal relay fault (IRF)

Bay computer

- Supply voltage
- Temperature metering
- CPU watchdog
- Start-up check
- Supervision of I/O card
- Supervision of internal bus

When this contact makes (in any bay computer in the switchgear) the signal will appear on the terminal in the support cubicle. Accordingly, it is a bay computer in the switchgear that indicates the internal relay fault.

5.5.2 A-alarm

Circuit-breaker/disconnector

- Density monitor alarm
- Supervision of one (1) release coil indicates the circuit fault (option)

Arc eliminator

- Breakage in the trigger cable harness or an error in the thyristors' Gate-circuit
- Poor capacitance on the capacitors (<50%)
- Short circuit in the charging circuit
- Fault in the charging circuit
- Fault in the controller
- Fault in the trigger circuit from the external arc guard
- IRF in the controller

When this contact makes (in any bay computer in the AX1 switchgear) the signal will appear on the terminal in the support cubicle. Accordingly, it is any bay computer in the switchgear that indicates the A-alarm.

5.5.3 B-alarm

Circuit-breaker/disconnector

- The circuit-breaker's opening speed exceeded (option)
- The circuit-breaker's closing speed exceeded (option)
- The circuit-breaker's closing time exceeded
- The circuit-breaker's opening time exceeded
- The circuit-breaker's spring loading time exceeded
- Supervising one closing coil activated (option)
- Density monitor supervision for one (1) pole activated
- The disconnector's running time towards operating mode exceeded
- The disconnector's running time towards earth mode exceeded
- The disconnector's mode position is undefined
- Electrical locking of operations in earthed mode
- Auxiliary voltage supervision for motor spring voltage (MM)
- Inactivity (option).

- Pole wear (option).

Arc eliminator

- Capacitors not charged
- Earth fault
- Sufficient capacitance on the capacitors (<60%)
- Leakage current on the capacitors too high

When this contact makes (in any bay computer in the AX1 switchgear) the signal will appear on the terminal in the support cubicle. Accordingly, it is any bay computer in the switchgear that indicates the B-alarm.

5.5.4 C-alarm

This alarm acts as a customer specific alarm. Only used when the customer requires an extra alarm level. (option)

When this contact makes (in any bay computer in the AX1 switchgear) the signal will appear on the terminal in the support cubicle. Accordingly, it is any bay computer in the switchgear that indicates the C-alarm.

5.5.5 MR-alarm (auxiliary voltage supervision)

- Auxiliary voltage supervision of the relay voltage (MR)

When this contact makes (in any bay computer in the AX1 switchgear) the signal will appear on the terminal in the support cubicle.

This signal is connected in parallel in the support cubicle to give a common alarm.

5.6 Alarm handling

The following measures are recommended with an alarm:

IRF-alarm

One of the bay computers in the switchgear is down and the cubicle in question will be taken out of service as soon as possible for maintenance, e.g. to change the bay computer.

A-alarm

An A-alarm means it is impossible to release one (or more) circuit-breakers or that arc eliminator operation is unavailable. The switchgear should be taken out of service immediately and the cause of the fault repaired.

B-alarm

The cause for the B-alarm should be repaired as soon as possible.

C-alarm

A C-alarm is defined by the user (customer) and therefore it is the user who determines the degree of importance and appropriate actions for the alarm.

MR-alarm

The MR-alarm indicates that the bay computer has no supply voltage. This should be rectified as soon as possible.

5.7 Gas supervision

For full isolation against earth potential the poles of the circuit-breaker should be filled with SF_6 gas to the right pressure (2.8 bar overpressure). The switchgear is equipped with analogue pressure switches and the pressure can be read off on the controller or by using a portable instrument directly on the sensor. The sensor and gas filling valves are accessible from the operating section. The amount of gas (a few litres) that the circuit-breaker holds is relatively small compared to gas insulated high voltage switchgear. SF_6 gas is stabile and odourless.

SF_6 gas must not be released to the atmosphere. The gas is handled by ABB, in the workshop and during service work, using special extraction equipment. The gas is heavier than air and can be poured/sucked into another container under controlled conditions. SF_6 gas that is exposed to arcs contains poisonous and corrosive substances in both gas and powder forms. Circuit-breaker poles must not be opened under site conditions or by inexperienced personnel. Contact ABB who has knowledge and the resources to recycle the gas.

5.7.1 Density monitor

The density monitor is fitted on a plate between the operating mechanisms for the disconnector and the circuit-breaker.

A low gas pressure is indicated on the density monitor's alarm unit by LEDs and on the bay computer.

- If the gas pressure falls below 1.8 bars overpressure this is indicated by a yellow LED.
- If the gas pressure falls below 1.5 bars overpressure the colour of the LED changes to red.

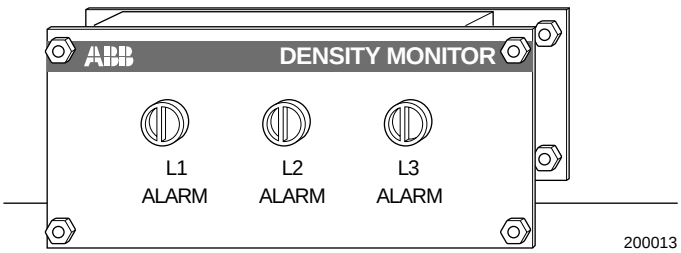


Figure 5-7. Density monitor unit (alarm unit)

In connection with this, the corresponding alarm contacts in the density monitor's alarm unit also make.

- If the gas pressure falls below 1.8 bar in one or more of the poles a B-alarm is indicated on the bay computer.
- If the gas pressure falls below 1.5 bar in one of the poles a B-alarm is indicated on the bay computer.

- If the gas pressure falls below 1.5 bar in two or three of the poles an A-alarm is indicated on the bay computer.

5.8 Switchgear operations

5.8.1 Operating the switching devices

Local operation of switching devices such as circuit-breakers or disconnectors is performed as follows:

1. Select local operation using the Local/Remote button. The yellow LED L comes on. If the Local mode is already selected, go to point 3.
2. Enter the password 1 (if active).
3. Select operating mode Local.
4. Press the object selector button to select the object. The objects in the schematics are highlighted one at a time (stepping) each time the object selector is pressed.
5. Press the button **I** (On/Operations) or button **0** (Off/Earth). On-Off refers to circuit-breakers while Operation/Earth refers to disconnectors.

Single-line schematics on the display indicate new status of the object.

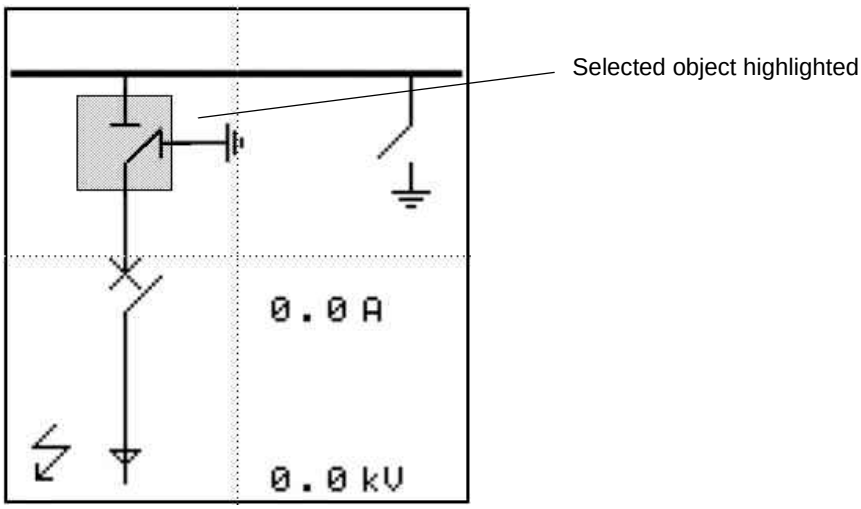


Figure 5-8. Selecting an object

5.8.2 Activating the arc eliminator

The arc eliminator in the incoming enclosure is activated during commissioning. After any function the eliminator must be activated again as soon as it has been established that no remaining faults exist.

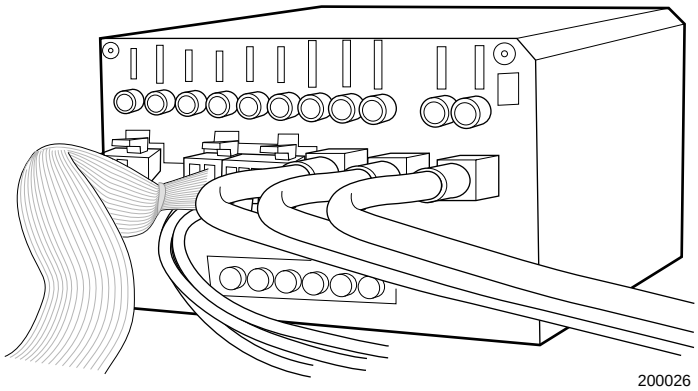


Figure 5-9. Arc eliminator system's controller

5.8.3 Resetting the arc eliminator system

The arc eliminator system is rest after closing by using the resetting button on the controller. The system then senses the functionality of the electronic circuits and whether the capacitors are charged. If this is so, earth faults are reset automatically. Resetting takes approx. 30 minutes and when the system is reset **Pos open** and **Ext pwr** are lit. Other alarm LEDs should be dark, i.e. turned off after resetting.

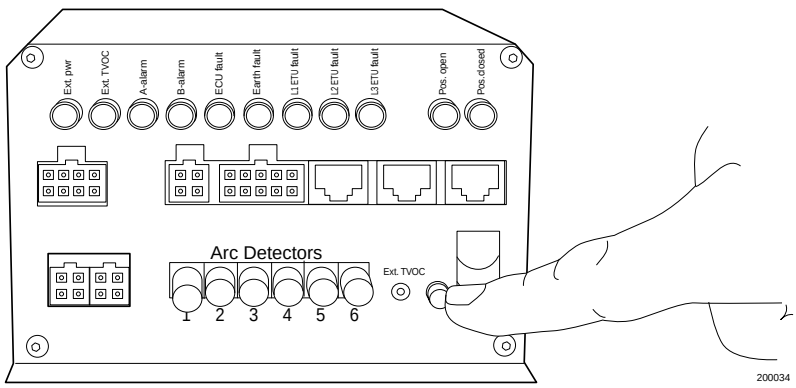


Figure 5-10. Resetting button on the controller

WARNING

Fatal voltage. The capacitors in the arc eliminator system are highly dangerous to touch when charged. Exercise immense care with all work on the system.

WARNING

Fatal voltage. Contact outlets on the controller (**XM93, 94, 95**) are highly dangerous to touch. Exercise immense care with all work on the controller and in its vicinity.

WARNING

The switchgear should be taken out of service immediately if an A-alarm is indicated on the controller.

WARNING

If a B-alarm is indicated on the controller the cause should be investigated and rectified immediately.

5.8.4 Earthing

The integrated SF_6 encapsulated switching device contains a disconnector/earthing switch and circuit-breaker in the same enclosure. The incoming enclosure also houses an arc eliminator.

When the circuit-breaker breaks the operating current the connections to the busbars are opened. Thereafter the disconnector/earthing switch operates to the earth position. The circuit-breaker closes again and the cable becomes earthed. The earthing switch function complies with the demands of five closing operations against the short circuit current as the circuit-breaker is used for the connection to earth.

The safety regulations state the an invisible break point is permitted under the condition that a safe, mechanical indicator is provided.

WARNING

Open the cubicle's sliding door and check on the mechanical indicator that the disconnector is open and the earthing switch made before any work is carried out on the cubicle.

WARNING

As the circuit-breaker is interlocked against making the cable live when the disconnector is in the earthed position, the circuit-breaker will not close to earth the cable if the cable is live.

With all work on the high voltage side of the switchgear cubicle, the operating mechanism for the disconnector/earthing switch as well as the circuit-breaker's operating mechanism should be locked in the disconnected/earthed position respective closed position. As an extra safety precaution all cubicles can be equipped with an extra capacitive voltage indication that indicates whether the cable side is deenergised.

Earthing of the busbar can only be carried out via the sectioning cubicle or by using a portable earthing device, which is connected on the cable side in combination with a closed circuit-breaker and disconnector.

WARNING

Lock the operating mechanism for the disconnector/earthing switch using a padlock in the disconnected/earthed position before carrying out any work on the switchgear.

Lock the circuit-breaker's operating mechanism in the closed position before carrying out any work on the switchgear.

N.B. The Local/Remote switch should be in the Local position when earthing.

Earthing the power cable

Conditions:

- Local/Remote button in Local position
- Circuit-breaker Closed
- Disconnector in Operation position

Temporary earth the power cable as follows:

1. Highlight the circuit-breaker (curved arrow).
2. Press **O** (Off/Earth). The circuit-breaker opens.
3. Highlight the disconnector.
4. Press **O** (Off/Earth). The disconnector switches to the earth position.
5. Highlight the circuit-breaker (curved arrow).
6. Press **I** (On/Operation). The circuit-breaker closes.
7. The cable is now earthed.

5.8.5 Indication messages

The indication messages (priority 1-3) provide an automatic overview of the following:

- Indication of the protection functions.
- Condition control.
- Internal relay protection faults.

The indications are shown in order of priority in a list in the incident window. These are active until acknowledged. Acknowledge by holding the C button in for five seconds.

5.8.6 Indication of protection functions

When a protection function is activated, the name of the function and the text START are displayed in the help window. The protection also shows which phase or phases the fault has occurred on.

```
NOC3Low:START
L1, L2, L3
```

When the activated protection function is blocked the text BLOCK is displayed in the window.

```
NOC3Low:BLOCK
```

When the activated protection function trips an object the text TRIP is displayed in the window.

```
NOC3Low:TRIP
L1, L2, L3
```

When the protection function gives a delayed tripping signal for the circuit-breaker's failure protection the text CBFP (Circuit Breaker Failure Protection) is displayed in the window.

```
NOC3Low:CBFP
L1, L2, L3
```

5.9 Compiling statistics for operations and maintenance support

Operations and maintenance support can be obtained from the statistics that can be compiled with information from the bay-computer.

Information can be:

- Number of operations per circuit-breaker (wear value, option).
- Current, voltage (option), output (option).
- Protection functions (option).
- Operating times (option).

The statistics can be shown on a PC locally in an office or workshop, in the station's control room or transmitted to an operations centre.

The following values can be obtained for storage of statistics by the bay computer:

- Number of cycles.
- Busbar current (via the incoming cubicle).
- Outgoing current.
- Outgoing output (option).

5.10 Maintenance of the switchgear

The integrated supervision system in the AX1 allows interval controlled maintenance to be replaced by measures triggered by fault indication. An ocular inspection of the switchgear at appropriate times, depending on the operating conditions, is recommended as a supplement to supervision as set out in the maintenance plan, table 5-1.

The fault correction maintenance is related to faults discovered in the switchgear and is primarily based on making a diagnosis, from an alarm, that results in rectification. The fault correction maintenance described in this manual involves the replacement of faulty units. However, if you wish to attempt to repair faulty units, this usually demands special knowledge which is not provided in this manual.

The overhaul of equipment should be carried out according to defined criteria, for example a specific number of operations. The overhaul should be carried out by authorised AX1-specialists.

WARNING

Fatal voltage. Exercise great care during work on the switchgear. Follow all safety regulations carefully. Maintenance plan

Table 5-1. Maintenance intervals for the switchgear AX1

Equipment/Action	10 years	1000 operations	2000 operations	10000 operations	Note
General/Visual inspection	O				With normal environment according to SSG
Circuit-breaker/operation				O	
Check/clean the ventilation terminals on the main-circuit enclosure	O				
Operating mechanism for the circuit-breaker/ocular inspection			O		
Operation of the disconnector/earthing switch		O			

5.10.1 measures with an alarm

Authorised service personnel should be contacted if there uncertainty regarding the measures to be taken in the event of fault indication.

Operations supervised in AX1 are evident from section 5.4, Supervision.

It is recommended that the general condition of the switchgear be checked in connection with fault indication and subsequent fault clearance, see section 5.10.2, General/Ocular inspection.

5.10.2 General/Ocular inspection

Check the general condition of the switchgear, for example:

- Surface finish (are there scratches?, visible corrosion?)
- Cable insulation (burnt?)
- Is there anything that looks, smells or sounds abnormal?
- Connectors and terminals (are they correctly made and tightened?)
- Pole bolts and connections in the battery system
- The cleanliness of the operating enclosure, bay computer enclosure and the lower frame (clean with a damp cloth and vacuum cleaner if necessary)

5.10.3 Check the ventilation terminals on the main-circuit enclosure

There are ventilation terminals in the base and on top of the main-circuit enclosure to ventilate the enclosure. These terminals should be inspected when work is to be carried out on the main-circuit enclosure or every ten years according to the maintenance plan.

1. Deenergise the switchgear
2. Remove the top plate from the switchgear cubicle.
3. Check that no foreign objects are covering the ventilation terminals' grilles.
4. Blow out each ventilation terminal using a hair dryer and check that the air flows through.

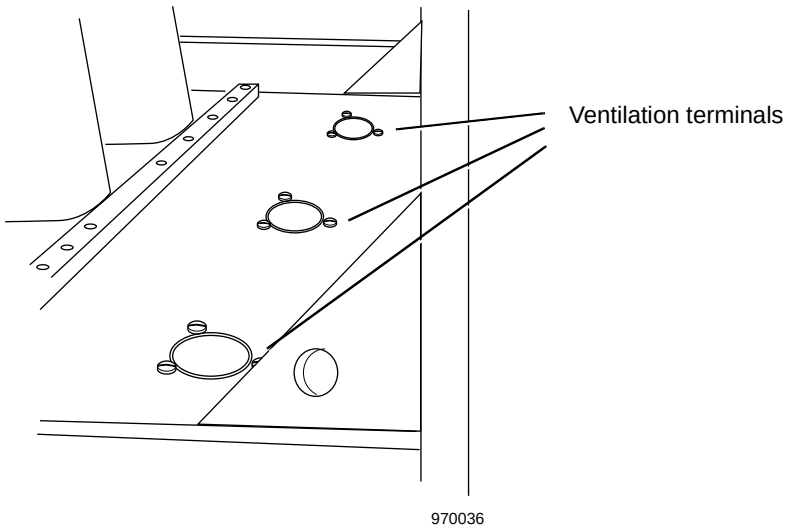


Figure 5-11. Ventilation terminals in the bottom of the main-circuit enclosure

5.10.4 Operation of the circuit-breaker

Authorised service personnel should be contacted if there uncertainty regarding the measures to be taken in the event of fault indication.

Operations supervised on circuit-breakers are evident from section 5.4, Supervision.

5.10.5 Checking the operation of the disconnector

Authorised service personnel should be contacted if there uncertainty regarding the measures to be taken in the event of fault indication.

Operations supervised on disconnector/earthing switch are evident from section 5.4, Supervision.

5.11 Trouble shooting

Trouble shooting on a medium voltage switchgear AX1 is based on a fault initiating an alarm. Acknowledged faults that still remain indicate that the faults still exist on the switchgear. This means that trouble shooting and diagnostics followed by fault correction measures need to be carried out. The fact that not all types of fault can be anticipated must always be taken into consideration when performing trouble shooting. Faults can occur that do not give an alarm, but result in other fault states or malfunction. Trouble shooting is primarily based on knowledge of the switchgear's operation and knowledge of trouble shooting logic as well as experience of trouble shooting. The trouble shooting chart below can therefore be seen as a guide rather than a list of possible faults and causes.

WARNING

Follow applicable safety instructions when trouble shooting. Always contact the responsible supervisor before trouble shooting is started.

N.B. condition or by inexperienced personnel. Contact ABB who has knowledge and the resources to recycle the gas.

Table 5-2. Trouble shooting chart

Equipment/Fault	Cause	Action	Note
Circuit-breaker operating mechanism Springs not loaded.	Motor has no or too low control voltage	Check connectors and cables	Loading of the springs shall auto-start after closing
	Faulty motor	Check the supply voltage to the motor. Contact the service workshop if the motor is faulty	
The control system does not give a signal that the circuit-breaker is in position.	Angle fault in the loading device	Contact the supplier/service workshop	The springs in the operating mechanism are not sufficiently loaded. The circuit-breaker is not fully engaged.
	Angle fault in the loading device	Contact the service workshop	The control system does not give a signal that the circuit-breaker is in position.
	The angle sensor is damaged or loose	Contact the supplier/service workshop	The angle sensor consists of reading forks on a circuit board. The circuit board is mounted close to the pole shaft on the device's lower left-hand section.
Circuit-breaker operating mechanism The circuit breaker does not close/open despite the indication showing the springs are loaded.	Operating coil does not switch	Measuring the control voltage with closing/opening. Check the operating circuit, operating coil, closing/opening springs.	
Operating mechanism for the disconnector/earthing switch does not function	The motors lack voltage	Measure that there is operating voltage Check the connectors	
Bay computer "Is black"	No supply voltage	Check the supply voltage and connectors	

Table 5-2. Trouble shooting chart

Equipment/Fault	Cause	Action	Note
Bay computer Object cannot be selected	Incorrect operating mode	Check that the Local mode is selected	
Bay computer Green lamp on display flashes		Contact the service workshop	

6. ENVIRONMENT AND RECYCLING

6.1 General

Environmental aspects have stood to the fore during the development of the switchgear AX1. The environmental impact during the product's service life from material production to recycling have been assessed and evaluated using a LCA-analysis (Life Cycle Assessment).

The life cycle assessment involves identifying the product's environmental impact during its entire service life. This includes: raw material, manufacturing, use, recycling and depositing.

The factors that form the primary environmental impact are the material in the switchgear, operating losses and the possibility of recycling. Factors such as manufacture and transport are also worth evaluating, but only have a minor significance.

6.2 Material

Raw materials with a low environmental impact have been chosen for the X1 switchgear. The compact design uses less material, which in itself results in less impact on the environment. Aluminium has been used as far as possible in the actual cubicles. The secondary enclosures and the lower frame are entirely made of aluminium. Aluminium requires little energy to recycle. The main-circuit enclosure is manufactured of stainless steel and alu-zinc (zinc coated sheet steel). The tubular busbar system is manufactured of uninsulated copper that is easy to recycle.

Table 6-1. Main materials in AX1

Switchgear component	Material	Note
Tubular busbar system	Copper/aluminium	
Cubicle frame (operating enclosure)	Aluminium	
Cubicle frame (main-circuit enclosure)	Alu-zinc and stainless steel	
Lower frame	Aluminium	
Doors and covers	Aluminium	
Ends	Enamelled sheet	
Lower frame's cover plates	Pre-enamelled sheet	Enamelled scratch-proof sheet
Bay computer	Electronic components Gold plated contacts Plastics	
Batteries		
Switching devices	Copper Aluminium Steel Silver Epoxy plastic SF_6-gas	
Operating mechanism	Steel Spring steel Brass Diverse composite materials	
Cables	Copper Plastics Gold plated contacts	

6.3 A few facts about SF_6-gas

An AX1 switchgear contains no components hazardous to man or the environment, if the materials are taken care of and recycled correctly. The only element that can have a long-term effect on the environment, however very small, is the SF_6 gas used as an insulation gas in the switching devices. The gas must be taken care of and recycled.

N.B. SF_6-gas that escapes to the atmosphere makes a certain contribution towards the greenhouse effect. Therefore handle the gas sensibly. Do not release the gas into the atmosphere. Reuse the gas or destroy it when necessary.

The amount of SF_6-gas in a switching device in AX1 is very little.

Properties

- The gas is not toxic. It is not hazardous to inhale as long as the oxygen content in the surrounding air is sufficiently high.
- The gas is heavier than air. This means that leaking gas can collect, for example, in cable trenches.

6.4 Life cycle

6.4.1 Installation

Packaging (pallets, plastic wrapping, ties)

Wooden pallets with battens for the AX1-cubicle can be returned to the supplier. ABB Distribution has a deposit system for pallets (more information can be provided on request).

Other packaging, for example the plastic wrapping and ties, etc. can be sorted and taken to an approved environment station.

Damaged pallets

Pallets from ABB Distribution contain no toxic wood impregnation agent and can therefore be burnt.

Cable waste

Excess cable and cable waste should be taken to an approve environment station for recycling.

Other materials

Any other remaining material from the installation should be sorted and taken to an approved environment station.

6.4.2 Operations and Maintenance

Operations

Operation of the switchgear is dependent on the objects and processes to be supplied by the switchgear and it is therefore important to bear in mind factors that involve lower operation losses as early as the planning stage. One such factor could be that a cubicle for incoming supply is placed in the vicinity of the switchgear cubicle that supplies large loads. In this way heat loss in the busbars can be reduced. A marginal reduction in heat loss has immense significance over a period of 10-20 years.

Maintenance

- Handling SF_6 gas
  - All regulations concerning the handling of SF_6 gas must be followed when refilling the SF_6 gas and during the inspection of sealing system.

- Replacing the units
  - When replacing faulty units, the faulty unit should be sent to a service station to undergo a possible service and repair. If it is not environmentally or economically motivated to repair the unit it should be taken to an approved environment station for destruction or disposal.

6.4.3 Scraping and recycling

Gas filled switching devices

Handle SF_6 gas with care to avoid gas leakage.

Contaminated SF_6 gas can be handled in several ways:

- ABB offers to take care of the circuit-breaker when the gas filled equipment is to be scraped.
- Used gas can be filtered and reused.
- Gas suppliers can regenerate the gas.
- The gas can be destroyed.
  - SF_6 gas is heated up together with lime. The natural products plaster and felspar are then formed.

Metals

Metal components can be sorted and left to an approved environment station for recycling.

Electronics

Bay computers should be left with an approved electronic recovery company.

Batteries

Batteries should be left at an approved environment station or returned to the supplier.

Non recyclable material

Material that cannot be recycled should be left at an environment station for destruction or disposal.

ABBPower Tecnology Products
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