Contact line: Design. Segmentation

1 Purpose and scope

The purpose of this document is to ensure that the NNRA's requirements for segmentation of overhead contact line systems are complied with. The document's requirements must be observed in the design of new overhead contact line systems and in the design of expansions and alterations to existing systems.

For segmentation of contact line networks in AT systems with segmented contact lines, the requirements of kapittel 9 (Autotransformatorsystem med seksjonert kontaktledning) must also be observed.

2 Segmentation implementation

Particular emphasis must be placed on the following factors when assessing the use of segmentation:

- Most optimum stability in feed situations and interconnection of grid converters
- Satisfactory fault localisation conditions
- Most optimum flexibility in train operation
- Adequate accessibility for system maintenance and fault repair

Segmentation must be implemented with insulated overlap sections on the main tracks and section insulators or insulated overlap sections on diverging tracks and sidings.

If current collectors are electrically connected, it will not always be possible to adhere to the segmentation regulations as formulated. A system of this nature will require an impact assessment.

Where a signalling installation with axle counters is being used, the design of the segmentation of the overhead contact line system and working areas must be coordinated. This coordination must involve traffic, system owner, signals, tracks and overhead contact line.

2.1 Section insulator

The type of section insulator must be selected according to the running speed of the line. For speeds of > 100 km/h, the contact wire's stagger at the section insulator must be equivalent to 0.

Attempts should be made to avoid placing section insulators on canted track as these will require a higher level of inspection than is normal, and are a typical fault source. If section insulators are placed on canted track they must be adjusted in such a way that the current collector makes contact with both skids simultaneously.

Section insulators must not be located on main tracks.

Messenger wires and contact wires must be connected to the equalising connection on both sides of the section insulator in order to even out potential differences between the live elements in the section of overhead contact line. Power connectors must be routed in such a way as to not feed an unnecessarily high concentration of mass to the overhead contact line. Dynamically, this creates 'hard spots' and is undesirable.

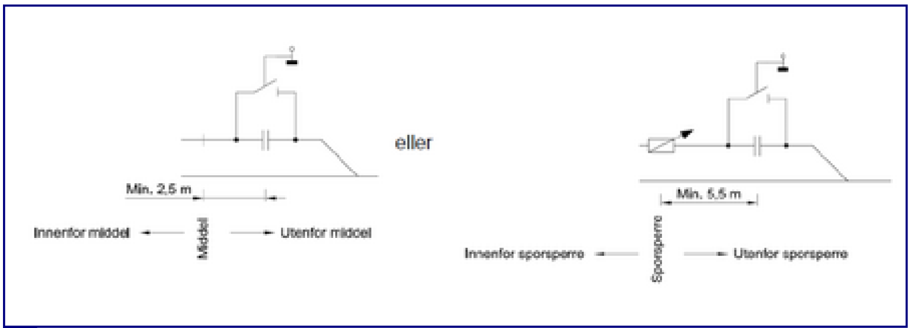
In special instances where it is desirable to insulate one part of the track only, section insulators may be installed within the centre.

An evaluation must be conducted as to whether section insulators should have switchgear layouts.

2.2 Station area segmentation

At stations, the overhead contact line system may be divided into groups depending on the station's size and in accordance with the need to de-energise certain tracks or groups of tracks. The electrical segmentation of a station area must be assessed to ensure it is fit for purpose. It must be possible to disconnect the current and earth the overhead contact line via an earthing switch for loading tracks, sidings and holding sidings. Towards this end, section insulators must be used for insulating. Section insulators must be placed at least 2.5 m outside the centre towards the adjacent track or at a point where there is a derailer at least 5.5 m beyond this.

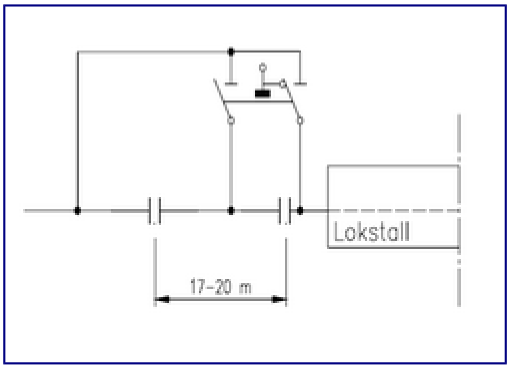
The two versions are shown in Figur 1. The distances shown in Figur 1 are calculated from the middle centre/derailer to the anchor bar between the section insulator and contact wire closest to the centre/derailer.



Figur 1: Loading track, siding and holding siding layout

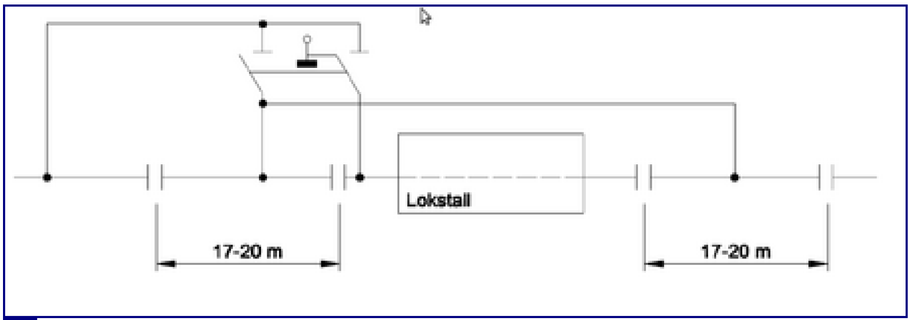
2.3 Engine shed segmentation

An overhead contact line leading into an engine shed must have an insulated section and earthing switch usually set to the earthed position. Unless otherwise specified, this section must be 17–20 m long. For the insulated section, a double-poled switch must be used. The insulated section must be connected to the unearthed switch pole and the contact line leading into the engine shed must be connected to the switch pole to be earthed. Refer to Figur 2.



Figur 2: Engine shed segmentation with entry from one end.

For tracks on which it is possible to enter an engine shed from both ends, there must be an insulated section at each end connected to the same switch. Refer to Figur 3.



Figur 3: Engine shed segmentation with entry from both ends.

2.4 Tunnel segmentation

This requirement applies to railway tunnels over five kilometres long and where the signalling system permits the presence of more than one train on each track in the tunnel at the same time.

Overhead contact line systems in tunnels must be divided into sections, where each individual section must not exceed five kilometres in length.

The location of switches must be arranged in accordance with the requirements of the tunnel's emergency response plan, and in such a way that there are as few switches in the tunnel as possible.

Each section must have remote control and switches.

There must be means of communication and lighting at the switching locations, so as to enable safe manual operation and maintenance of switches and equipment.

2.5 Dead sections

For AT systems, kapittel 9 (Autotransformatorsystem med seksjonert kontaktledning) must also be complied with.

2.5.1 Location of dead sections

A dead section must be established at the following locations:

- By capacitor banks and zone limit switches.
- In joints between sections of overhead contact line where, as trains pass, voltage differences may occur that are greater than:
  - 1,200 V where air insulation or section insulators with arcing horns have been used
  - 800 V where section insulators without arcing horns have been used

  This requirement means that a dead section should usually be established when connecting a feeder or feeder cable longer than approx. 5 km.

Requirements for a dead section:

- The local running speed of trains, through fixed signals or in accordance with special provisions, must not be set lower than 40 km/h.
- Dead sections must not be established outside of distant signals.
- It must be possible to position signs associated with dead sections in reasonable positions.
- The local gradient should not be greater than one half of the gradient that determines the train's weight on the section of line in question.

2.5.2 Design and connection of dead sections

A dead section must be designed as shown in Figur 4. The distance "D" must be at least 400 metres. Insulated overlap sections over three span lengths should be used at each end of a dead section. A current collector located in area "D" must not be able to establish physical or electrical contact between two different sections of overhead line.

If it is not practical to design a dead section in accordance with Figur 4, an alternative solution must be formulated and approved by Jernbaneverket.

Figur 4: Designing a dead section.

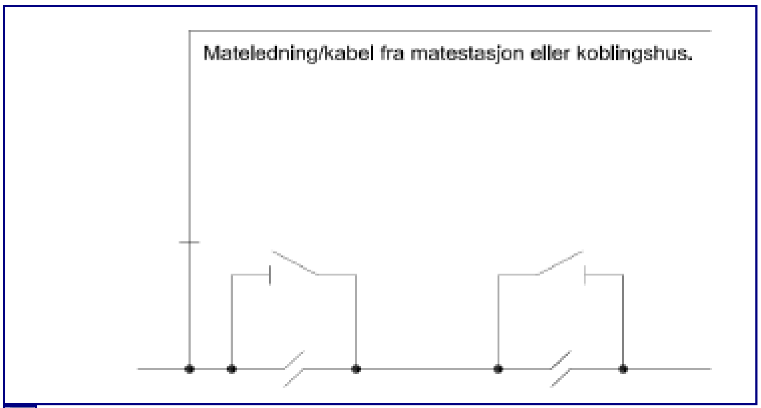
For the implementation of insulated overlap sections, reference is made to Seksjonsfelt, as well as the system description of the relevant overhead contact line system.

The electrical connection of a dead section using feeder/cables longer than 5 km must be conducted in accordance with Figur 5.

For electrical connection of a dead section to zone limit switches and capacitor banks, reference is made to Banestrømforsyning/Prosjektering/Sonegrensebryter and Banestrømforsyning/Prosjektering/Kondensatorbatteri.

In respect of dead sections located where a difference in angle (anti-phase) may occur, the following insulation gaps must be used:

- A minimum static insulation gap of 300 mm between overhead contact line components and live components that may be in anti-phase.
- A minimum vertical distance of 450 mm between sections of overhead contact line that may be in anti-phase.



Figur 5: Electrical connection of a dead section using feeder/cable longer than 5 km

2.6 Insulated overlap sections

Insulated overlap sections must be implemented in accordance with the system description of the relevant overhead contact line system.

Insulated overlap sections should not be designed over four span lengths.

On sections of line fitted with a train detection system requiring insulated joints, insulated overlap sections connected to draining transformers should be positioned in a straight line or at a radius greater than 800 m. This is necessary in order to avoid insulated joints on curves.

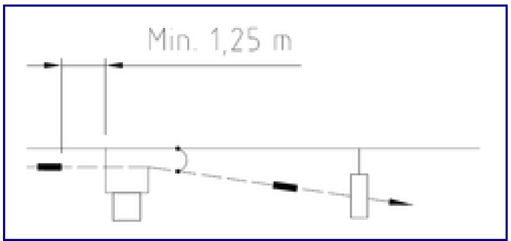
It will normally be advantageous for insulated overlap sections to be positioned in a straight line or at locations where the track radius is as large as possible. This type of positioning will be beneficial in terms of operation and maintenance conditions, as well as necessitating fewer insulated overlap sections over more than three span lengths.

2.6.1 Gaps in insulated overlap sections

The horizontal gap between contact wires and messenger wires in an insulated overlap section must be 450 mm.

If section cantilevers on the same mast can be of different voltages there must at all times be a sufficient insulation gap between these in accordance with Felles elektro/Prosjektering og bygging/Isolasjonskoordinering og overspenningsbeskyttelse Høyspenningsanlegg.

Insulators in the overhead contact line and the messenger wire in an insulated overlap section must be of the rod insulator type. These must be located a minimum of 1.25 m from the cantilever closest to the insulator, refer to Figur 6.



Figur 6: Location of a rod insulator in an insulated overlap section.

2.6.2 Electrical connections in insulated overlap sections

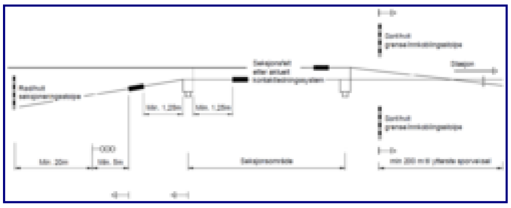
Electrical connections in insulated overlap sections must be designed in such a way that the additional weight of the contact wire and messenger wire is as minimal as possible.

Down leads to the overhead contact line and messenger wire should take the form of drop cables at the end of the insulated overlap section where the raised cable is closest to the mast.

2.6.3 Positioning of insulated overlap sections at main signals

2.6.4 Normal positioning of insulated overlap sections at main signals

Figur 7 shows the minimum distances for the positioning of insulated overlap sections at main signals. Insulated overlap sections may extend over three, four or five span lengths. The distance described in the figure as 'segmentation area' will vary from 50–150 metres depending on the type of overlap section and overhead contact line system.



Figur 7: Schematic drawing of positioning of insulated overlap sections in relation to main signals, single track sections of line, insulated overlap sections over three, four and five span lengths.

In order to limit the shunt length towards the insulated overlap section, two black/white boundary/connection posts must be erected, one on each side of the track, between the outermost set of points and the nearest section cantilever in the insulated overlap section. If the section of line is multi-tracked, the black/white boundary/connection posts must be erected appropriately in relation to the relevant limitations.

There must be a minimum 200 metre shunt distance, or a sufficient shunt distance greater than 200 metres, between the station's outermost set of points and the black/white boundary/connection post.

At a main home signal, block signal or single home signal, a red/white segmentation post must be erected at least 20 metres in front of the signal. For further information regarding black/white boundary/connection posts and red/white segmentation posts, reference is made to Skilt/Plassering av skilt langs sporet, as well as the Railway Signalling Regulations.

On double-track sections of line on which the main departure signal limits the shunt length (no shunt signals cancelling the 'Stop' signal) and where the distance between the main home signal and the main departure signal is greater than the length of the insulated overlap section, the insulated overlap section may be located between the main home signal and the main departure signal.

There must be adequate visibility for all types of signals located along the track, refer also to Signal/Bygging/Lyssignal.

2.6.4.1 For back-to-back main signals

If main signals are positioned back-to-back, the nearest section cantilever must be located a minimum of 300 metres beyond the main home signals.

If this solution is adopted, it is important to note the following:

- The traffic controller must have a de-energised track indication to enable trains to be stopped at the main signal. This is in order to prevent trains from entering a de-energised overhead contact line system.
- The running time from the preceding main signal must be relatively short.

2.6.5 Moving a main signal standing alongside an insulated overlap section

If a main signal standing alongside an insulated overlap section in an existing system is moved, the insulated overlap section must be moved to the new signal location. For the positioning of insulated overlap sections by main signals, refer to Figur 7.

2.7 Signage

During segmentation of the overhead contact line system, signs and orientation posts must be erected in accordance with the provisions of Skilt/Plassering av skilt langs sporet.