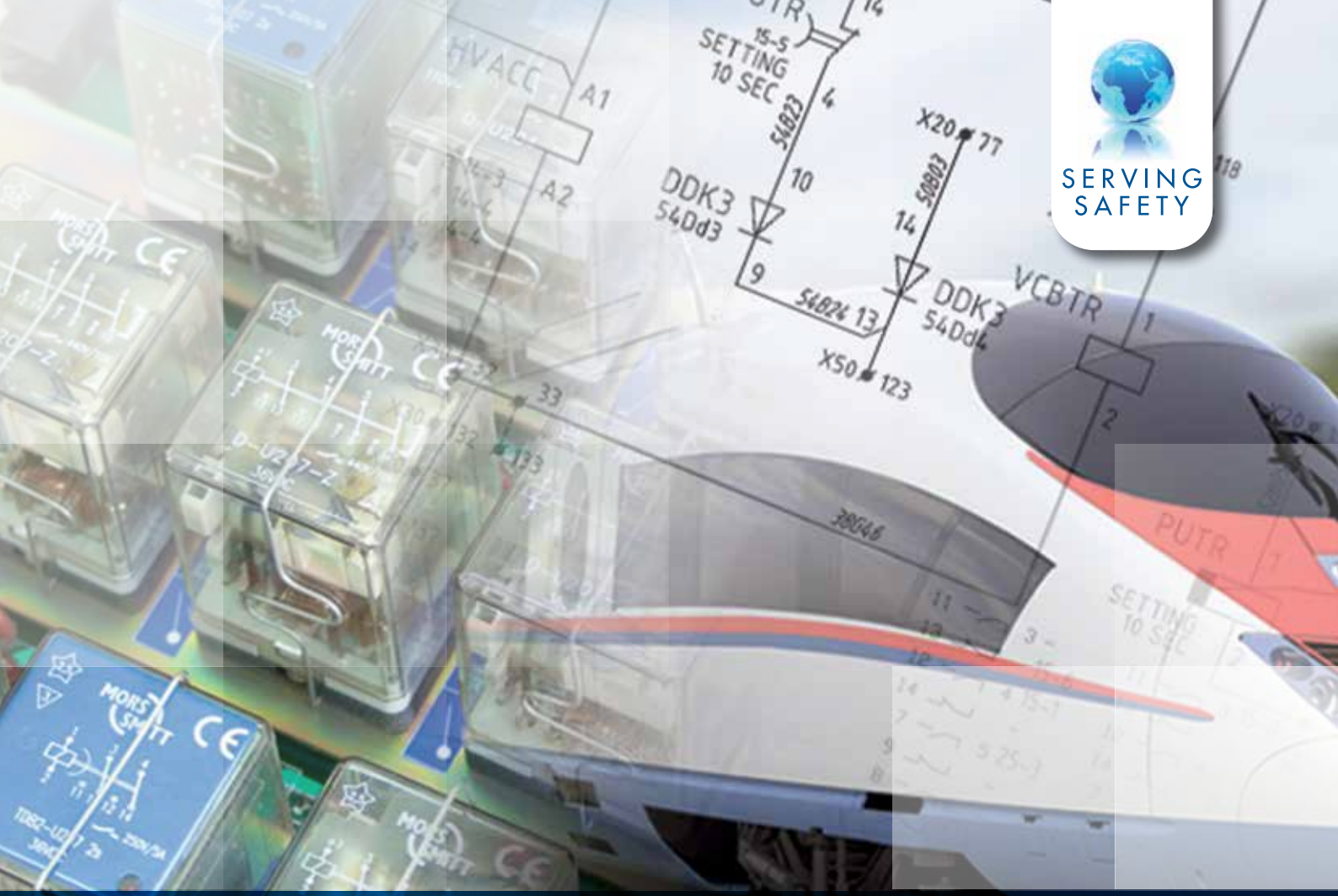


Mors Smitt Railway technology

Engineered solutions

Optimizing rolling stock LCC & RAMS

Mors Smitt
A Wabtec Company

SERVING SAFETY

Mors Smitt Railway Technology

Engineered solutions

From design to solution

Engineered solutions

SERVING SAFETY

Optimizing rolling stock LCC & RAMS

Designing, updating and improving electrical control systems to the latest standards and state-of-the-art technologies improve the life cycle costs (LCC) of rolling stock. Reliability will improve and long term availability of technology is guaranteed by Mors Smitt. We design easy maintainable products and solutions that comply to the latest health and safety standards
using the latest eco-friendly materials. Optimized energy consumption contributes to a
cleaner environment.

Mors Smitt solutions contribute to an optimized environmental performance of rolling stock offering rail operators real competitive advantages.

Perfect solutions

New built or retro-fit, Mors Smitt will deliver a perfect and competitive on time solution for any onboard challenge of space limitations and technical requirements. No matter the size or quantities.

We understand the need for integrated specialised and optimised electrical solutions when (spare) parts are no longer available or improvement in e.g. energy efficiency or reduction of weight and space is required.

Always listening carefully

In close cohesion with you, the best configuration of power distribution, protection components, relays and contactors will be selected to get the optimum result.

Our experience

Our experienced engineers have thorough knowledge of train components & technologies, and we can design, develop, test and deliver your solutions to the latest railway standards and directives. All research & development, engineering, manufacturing, assembly and testing will be done inhouse in one of our own factories in France and The Netherlands.

Winning strategy

The company strategy for the future is based upon further responsible development and
expansion of our high quality components and solutions, responding to tomorrow's needs in the many current sectors we serve. It is based upon putting the skills and talents of its staff to work for company, clients and mankind. Keeping that part of the world's operation for which it plays
a role, working successfully, without question and without failure.

IRIS Certification

Would this benefit you ?

- Lower maintenance costs
- Less downtime
- Quick installation and replacement times
- Easy maintainability
- Long term availability
- Improved reliablility
- Improvement in energy efficiency
- Easy upgradeable systems
- Reduction of weight and space
- Environmental compliant & sustainable product design
- Compliance to the latest safety regulations
- Extension of life expectancy
- Replacement obsolete components
- Up to date installation drawings / documentation
- A solid quality assurance plan
- On time delivery, within budget
- Improvement of passenger comfort & satisfaction

Mors Smitt is the answer to your request

You send us

- Circuit diagrams
- Space enveloppe
- Preferred electrical interfacing

or

- Send us your old panel / component for rehabilitation

We offer you

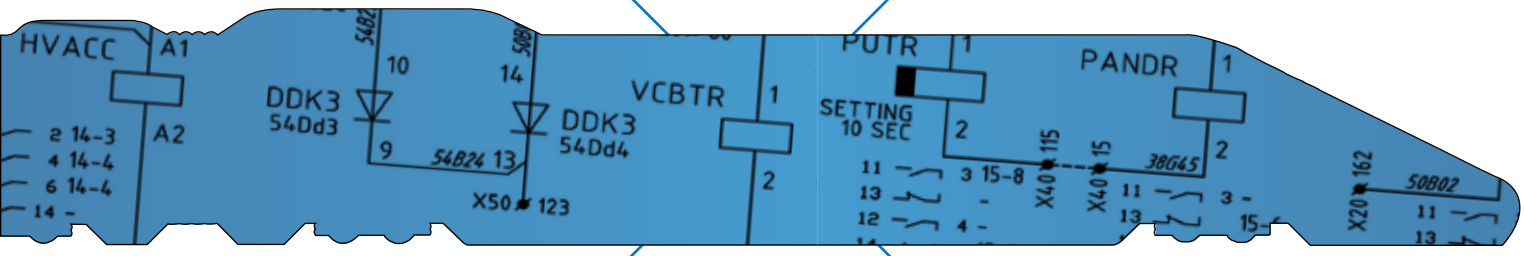
- Quotation within 1 week
- Tested prototype ≤ 16 weeks

SERVING SAFETY

We offer state-of-the-art engineered solutions for

Upgrading of existing trains

New built trains

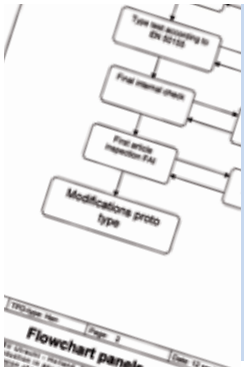


Midlife refurbishment

Replacement of obsolete parts

Products

- Relay / contactor panels
- Electrical distribution boards
- Power distribution systems
- PCB modules
- Form Fit Function solutions
- Build to print solutions
- Customized solutions



Services

- Turn key project management
- Quality assurance planning
- Engineering
- CAD & 3D inventor design
- On site commissioning
- After sales service
- Manuals & training

Your DNA

Always listen carefully

Market know-how

- Experience on the railway market:
  - *50 years components*
  - *25 years in supply complete electrical distribution panels*
- Comprehensive, practical know-how and design to railway standards and directives
- Co-design with major rolling stock builders
- Experienced ,creative and motivated engineers in all disciplines, e.g. electrical, electronic, mechanical, software etc
- Expertise in safety-critical circuit design up to SIL4
- In depth knowledge of train components & technologies

Commitment

- IRIS certified
- ISO 9001:2008 certified
- Quality, no concessions
- On time, within budget delivery
- Customer focussed
- Flexible approach
- LCC, RAMS design

Global supplier

- World wide support
- Multiple factory sites & support centres

Mors Smitt
A Wabtec Company

Innovative

Use of state-of-the-art design, testing & manufacturing technologies

Solutions for

- New built
- Upgrading existing trains
- Midlife refurbishment
- Retrofit of old parts
- Replacement of obsolete parts

Responsibility

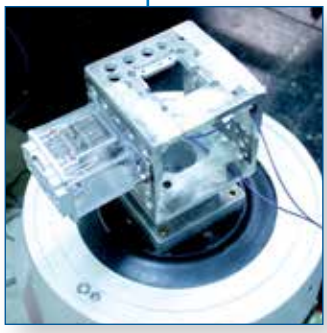
- ISO 14001 certified
- Focus on environmental performance
- Minimizing carbon footprints
- Recyclable packing
- Waste reduction

In house research & development, engineering, manufacturing, assembly and testing.

Environmental test facilities

Assembly

100% functional test



Shock & vibration test facilities

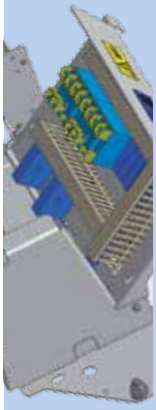
Component testing

Pre-testing

Our capabilities

Enquiry

- Estimated component quantity
- Available space enveloppe
- Prefered interfacing
- Schematic & circuit diagrams
- Location in train
- Mechanical construction



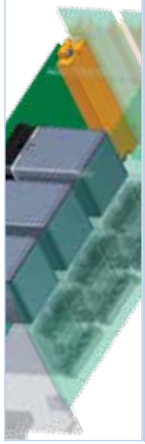
Engineering

- Kick off meeting
- Electrical & electronic design
- Mechanical design
- CAD & 3D inventor design software platforms
- Design review / customer meeting
- Product specification

Commercial and technical proposal

Order receipt

Prototype



Project design

- Pre engineering
- Preliminary planning
- 3D mechanical design drawing
- Interface proposal
- Product specification
- Quotation

Quality assurance plan

- Scope of supply
- Detailed engineering and design
- Planning
- Schematics
- Components specifications
- Project team
- Supervision and testing
- Manufacturing and assembly plan

SERVING SAFETY

Testing and inspection

- Quality control
- Type & functional testing
- FAI - first article inspection
- FAT - factory acceptance test
- Modifications

On site support

- Commissioning & engineering support
- Training
- Implementation support
- Modification on site

Design freeze

Delivery first panel(s)

Delivery serial product

Manufacturing and assembly

- Components manufacturing
- Puchasing parts
- Final approval customer
- Start production
- Quality and testing control

After sales support

- Warranty service
- Spare parts
- Maintenance support
- Product repair
- Training

Your benefits

Reliability

- >50 years of railway experience
- Huge installed base
- Proven reliable, less downtime
- Preferred supplier major trainbuilders / operators

Availability

- Long term availability of components and solutions
- Global presence
- World wide professional support
- Inhouse R&D, engineering, manufacturing and testing

Optimizing RAMS ↓ LCC

Maintainability

- 'No maintenance' design
- Plug & play solutions
- Modular & flexible design
- Quick installation and replacement

Safety

- Railway type tested
- 100% functional testing
- Quality assurance to IRIS
- Railway directive compliancy

Railway compliancies

EN 50155
Electronic equipment used on rolling stock
EN 50264-1
Rolling stock power & control cables
IEC 60571
Electronic equipment use on railway vehicles
IEC 60077
Electronic equipment for rolling stock
IEC 60947
Low voltage switch gear and control gear
IEC 61373
Rolling stock equipment - Shock & Vibration
EN 50121
Electromagnetic compatibility for railway applications
NF F16-101/102, TS 45545-2
Fire behaviour - railway rolling stock
IEC 60529
European protection class standard (IP.. class)
IEC 60068-2
Salt/Mist, Damp/Heat

Quality Assurance

IRIS
ISO 9001:2008
ISO 14001

Project references

HVAC panels	*LIRR - USA*
Trainline panels	*NJT - USA*
Relay moduls (PCB)	*MarschBahn - Germany*
Light control (PCB)	*Traxx locomotives - Germany*
Power distribution panel	*Dutch Railways - Netherlands*
Relay door control panel	*CL455 - UK*
Power distribution panel	*BB47500 SNCF - France*
Platform edge detection	*Marta - USA*
Brake fault PCB	*Marta - USA*
Power (MCB) distribution panels	*SSL LULtd. - UK*
Brake fault relay panel	*WAMATA - USA*
Relay cradle	*SLRT - Singapore*
Deadman relay control panel	*Dutch Railways - Netherlands*
Relay panels	*SMRT - Singapore*

SSL - Sub Surface Line

MCB panels

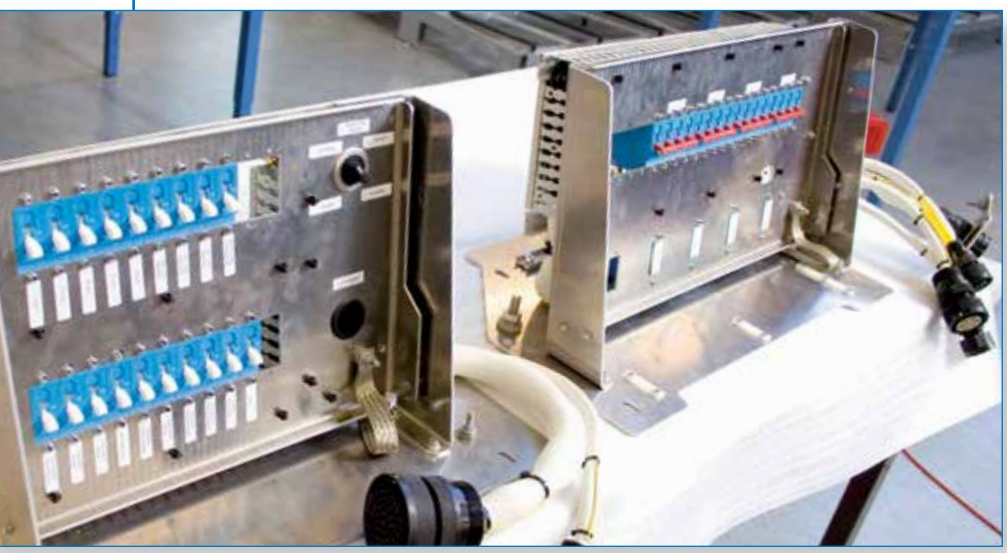
The electronic distribution panels (AC & DC panel) for the SSL project of Bombardier for transport for London have been developed in close cooperation with Bombardier. Bombardier Transportation provided the schematics and space limitations. Mors Smitt provided a creative solution.

Especially for this project a smart mechanical construction was developed resulting in easy assembly in the trains. In addition Mors Smitt was very closely involved with the integration of the solution to optimise the performance of the panel. A tilting panel was designed to place beneath a seat on the train. This way the available space as well as the operating possibilities are combined without making concessions to the maintainability of the panel.

Installation

Bombardier selected a construction where the earth leakage module is combined with a circuit breaker to guarantee the optimum user safety.

The MCB panels are connected to the train wiring with connectors. The installation of the panels was simple and fast, plug & play. The MCB panels were 100% tested before delivery. Delivery per trainset was 'just in time' according to Bombardier planning.



Train builder

BOMBARDIER

Operator

LULtd. - London

SERVING SAFETY

Design

3D design of panel

Unique features

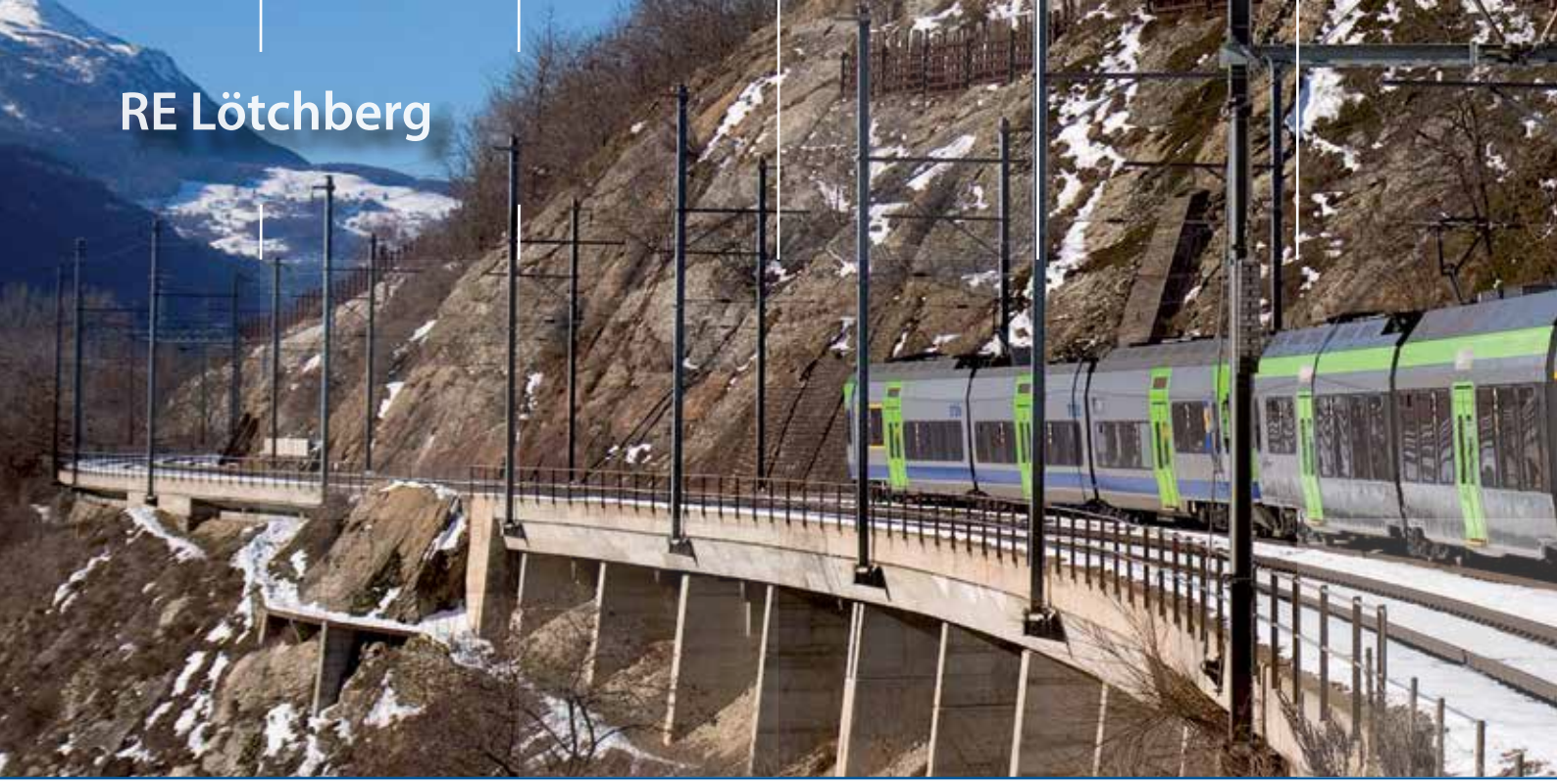
The ultra reliable hydraulic magnetic miniature circuit breakers from Mors Smitt are used.

Smart hinge construction for easy access during maintenance.

Special connectors are used for quick installation of the panel.

Scope of project SSL

Project duration	2009 - 2015
No. of panels	2.792 pieces
Circuit breakers	32.000 pieces
Earth leakage	5.000 pieces
Connectors	7.500 pieces
Length of the wiring	70 km
No. of crimp connections	225.000 pieces
No. assembly hours	Ca. 21.000 h



RE Lötchberg

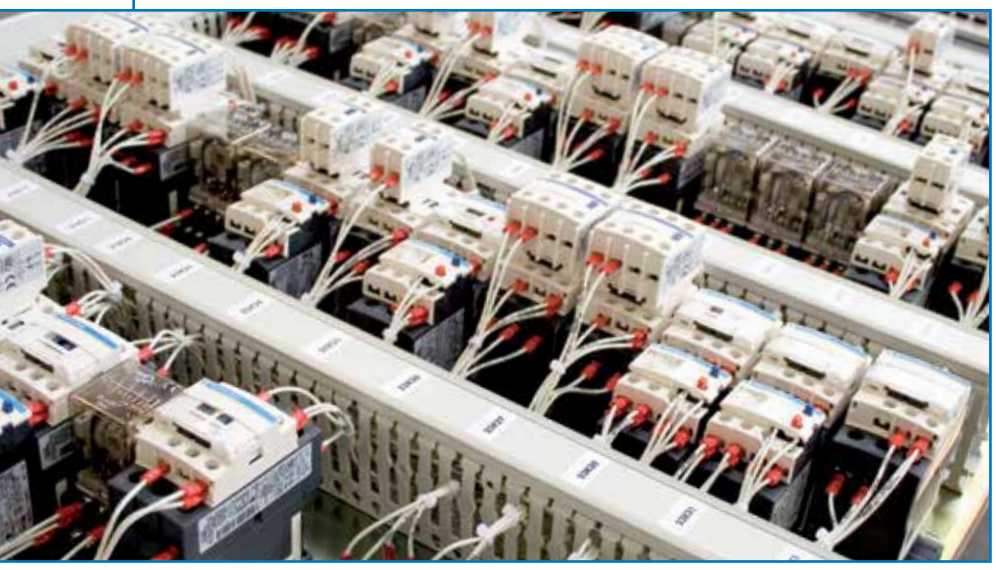
Built-to-print electrical distribution panels

Mors Smitt was selected by Alstom as the turn key supplier of the electrical distribution panels for the RE Lötschberg project.

Mors Smitt offered the following services: parts procurement, detail engineering, implementation modifications, manufacturing of the panels, 100% testing of the panels (in house test computer) and supply of the panels to the trainbuilder.

Our inhouse testcomputercheck offers the following functionalities:

- All connections (min, nom, max. voltage)
- Isolation resistance test
- High voltage withstand test



Contractor

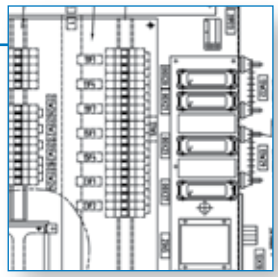
ALSTOM

Operator

bls

SERVING SAFETY

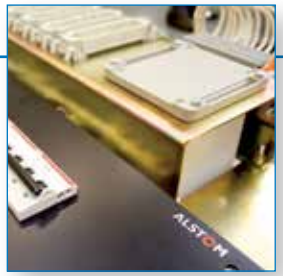
Design



Panel design

Unique features

Printed wiring (wire number and wire location) and cable ducts are applied .



Turnkey solutions offered, also foreign parts purchasing.

Mors Smitt D-U200 high reliability relays are used.

Scope of project RE Lötschberg:

Project duration	2007 - 2009
No. of panels	• 13 trains x 5 types panels • 8 trains x 5 types panels
MCB	2.100 pieces
Relay	2.100 pieces
Contactors	1.650 pieces
Length of the wire	50 km
No. of crimp connections	47.000 pieces
No. assembly hours	Ca. 3.150 h

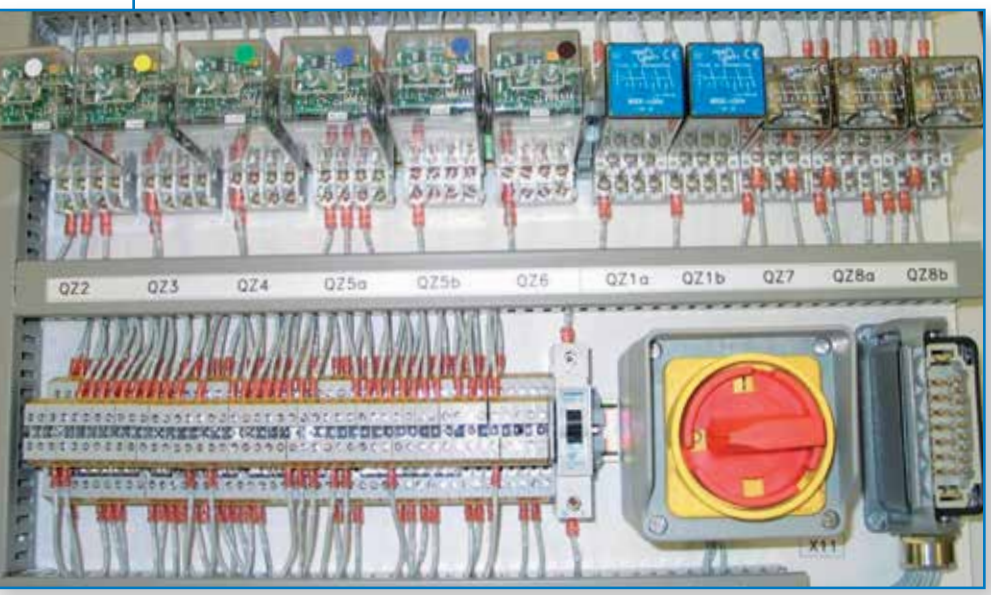
Deadmen control

Deadman control panel

A deadman system (vigilance, alertness, drivers safety device, SIFA, VACMA) monitors the drivers alertness and applies the emergency brakes when the driver is not responding to indications given by the system. Deadman systems are defined by UIC standard UIC-641.

The deadman uses a timed cycle to repeatedly test the driver for allertness. Under normal circumstances the driver has to push a pedal at all times, to show its presence to the system. At given intervals the system lights up an indicator light to instruct the driver to release the pedal for a brief moment. If the driver responds by doing so, the time cycle is reset and the cycle repeats itself. However, if the driver does not respond to the light, after some time an audible signal is given. Again, if the driver responds to this by briefly releasing the pedal, the cycle is reset and starts all over again. If the driver does not respond to the audible alarm, the emergency brakes are applied to stop the train.

- Monitoring of drivers alertness
- Indications given by system when driver have to respond
- Applies emergency brakes if driver is not responding



Contractor

NedTrain

Operator

NS - Dutch Railways

SERVING SAFETY

Unique features

Cable duct, wire numbering printed on the wire and Harting connectors are used.

High quality Mors Smitt instantaneous, flashing & time delay relays are applied.

Mors Smitt time delay relays with safety contacts (WNT, weld no transfer) have been selected.

Scope of project deadman control:

Project duration	2002 - 2003
No. of panels	555
Trains	275 (Mat '64)
Relays	6.105 pieces
Panel assembly time	4.440 h
Installation time	2.200 h

Since date of use no failures are recorded

SEPTA - Electrical distribution board

Electrical distribution boards

For the Hyundai Rotem SEPTA project Mors Smitt designed the complete electrical distribution board fitted in a small space envelope. Especially for this train situation, with key points like low maintenance, plug and play connection and two sides reachable, a special design was made. Hyundai Rotem provided the train schematics and Mors Smitt designed the complete system and the mechanical design for the electrical distribution board.

Mors Smitt designed 4 separate panels which were mounted together in a square box. All connections are separate on a terminal panel on the square box and easy to reach. Two of the panels act as doors to give access to the other (inner) panels. The board is made according to the SEPTA required standards. Every wire has a ferrule and sleeve with a destination code and wire number.

Installation

Hyundai Rotem and Mors Smitt selected a configuration with MCB's, D-U relays and contactors in one square electrical distribution board. Where possible Mors Smitt used cage clamp connections for fast mounting and low maintenance. For connection of the train wiring to the electrical distribution board X-com connections were used. (fast, easy mounting and low cost).

Mors Smitt assisted Hyundai Rotem with commissioning on site. All electrical distribution boards were fully tested (100%) before shipping to SEPTA. The delivery was according a pre delivery schedule from Hyundai Rotem USA.

Contractor

Hyundai - ROTEM

Operator

SEPTA Philadelphia

SERVING SAFETY

Design

3D design of panel

Unique features

Sturdy wiring and cable layout

Cable ducts offer flexibility, easy maintenance

Panel mount, rear wiring, spring terminal relay sockets

Scope of project SEPTA:

Project duration	2008 - 2011
No. of panels	120 pieces
Circuit breakers	7.600 pieces
DU relays	7.000 pieces
Timer relays	500 pieces
Length of the wiring:	90 km
Terminals	Ca. 52.500 pieces
No. of crimp connections:	Ca. 160.000 pieces
No. assembly hours:	Ca. 11.500 h

RATP metroline 1

19" relay rack panels

19" relay rack panels were developed for RATP Paris Metroline 1 to provide an interface between train and new platform screen doors. These panels asure safe stopping of trains in subway stations alligned with the screen doors.

The relay rackpanels control train stopping when access doors are enabled to open, transmit information about the side to operate towards fixed installation, ensure test and trouble shooting functions for maintenance purposes.

Installation

Mors Smitt provided an onboard compact and safe package. We kept strict manufacturing and testing deadlines, such as ten racks every two weeks to be installed by RATP technicians, in order to keep the Paris metro line 1 in normal operation.

Train builder

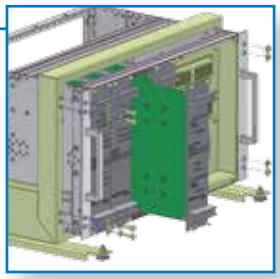
ALSTOM

Operator

RATP

SERVING SAFETY

Design



3D design of the relay racks

Unique features

19" rack panels

Removable circuit boards

Scope of RATP Metroline 1:

Projects duration	2006 - 2007
No. of racks	360 racks
Schedule	10 racks/2 weeks
R&D & assembly time	5.000 h

SMRT Refurbishment

Electrical relay boards

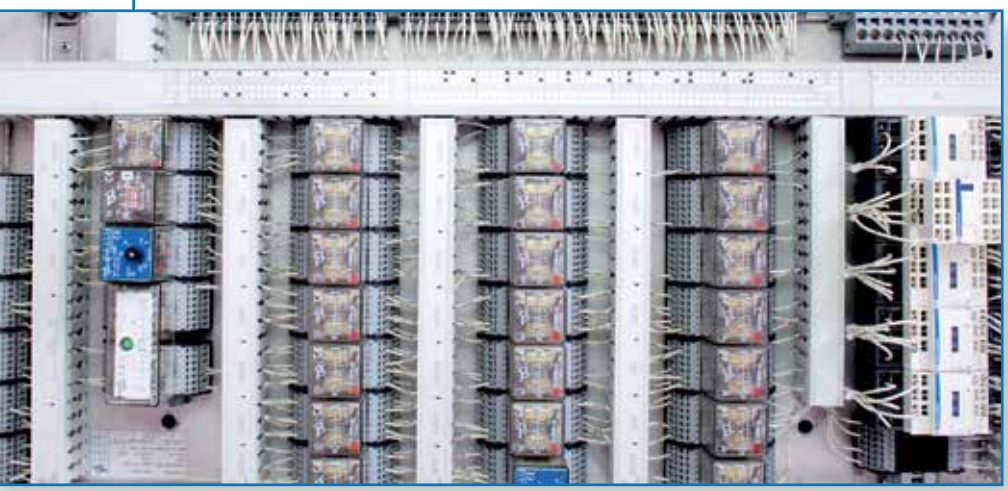
In Singapore Mors Smitt refurbished ordered by Hyundai Rotem type C151 metro cars. The 20 years old trains were refurbished; all the panels were replace by new panels with new type relays. Through the lack off basic train information it was a challenge to design the circuit diagrams of the panels. Mors Smitt has been several times on site to check and compare the existing diagrams with the new design. To relieve the customer, a turnkey construction for delivery of the relay panels was choosen in 5 different configurations. This was succesfull due to good teamwork between Hyundai Rotem, SMRT and Mors Smitt.

Installation

Mors Smitt selected the correct relays to replace the existing relays after analysing the contact load and contact quantity. There are 5 different configuration panels, each of them designed for its own application in the train. The implementation and commissioning was part of the contract. For easy mounting and connection to the train we used cage clamp and X-com technology for terminals and relay sockets. Black printed identification on the white wiring was provided. Before delivery of the panels each panel was 100% functionality tested on our automatic test system.

Modification

During the production phase several modification requests were succesfully executed. By using swing batches of complete trainset panels and the X-com quick connectors the job was done 'quick and easy'.



Contractor

Hyundai - ROTEM

Operator

SMRT - Singapore

SERVING SAFETY

Design

Panel design

Unique features

Wire identification by unique, individual printed wires

Spring terminal connection

Optimal flexibility by coded connectors. Integrated jumper feature.

Scope of project SMRT:

Project duration	2005 - 2008
No. of panels	660 pieces
DU relays	20.000 pieces
Special relays	3.000 pieces
Diode modules	1.200 pieces
Contactors	1.800 pieces
Length of the wiring	95 km

Hong Kong Airport express

SERVING SAFETY

Form-fit-function replacement

MTR corporation experienced in the airport express many intermittend failures with 'industrial' type miniature contactors / block relays.

Due to the open construction of these relays dust collected inside the relay causing intermittend contact failure. Mors Smitt developed, based on its high quality 8 pole railway relay, a form, fit and function replacement.

The Mors Smitt solution fitted exactly in the space envelope of the old relays and the existing wiring could be identically connected to the Mors Smitt solution.

Operator

MTRC - Hong Kong

Unique features

Wiring identical to replaced unit

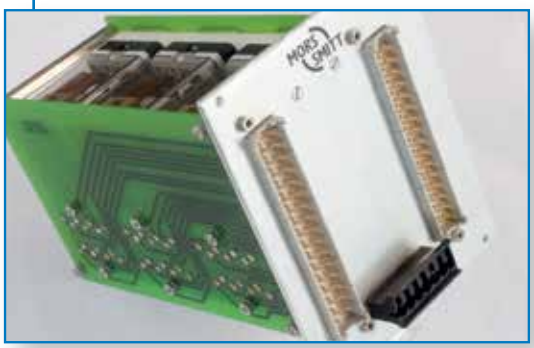
Identical mounting as replaced unit

SERVING SAFETY

Free configurable relay module

The Mors Smitt challenge for the Nord-Ostsee-Bahn was to develop a compact module that had 24 contacts, max. 3U high (available slot), with standard available connectors on the front and all functionalities free configurable.

The module comprises of 6 pieces high quality 4 contact D-U200 / DGG-U200 relays. Also time delay relays as well as special function relays can be placed in these modules.



Operator

NOB

Contractor

BOMBARDIER

Unique features

Mors Smitt D-U200 instantaneous relays plugged into PCB sockets.

Standard din connector for quick and easy connection.

RATP metroline7, 8 and 13

Retro-fit, function addition & wiring

For RATP Paris metrolines 7, 8 and 13, relay blocks for door opening and closing as well as general speed control and braking were developed for new trains as well as existing trains with additional functionalities. The solution contributed to time reduction of trains between stations and met increasing passenger traffic demand.

The project consisted of ready-to-install relay blocks inside the trains, integrating two blocks:

One for timing and one for control into one timing relay block to reduce space and adding extra functionalities on existing trains.

Installation

Mors Smitt provided a cost effective package of new and retrofit solutions including blocks assembly, wiring and functionality tests ready to install by RATP technicians.

Contractor

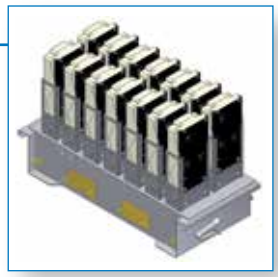
ALSTOM

Operator

RATP

SERVING SAFETY

Design



3D design of panel

Unique features

R&D for integration of timing board and relay function into one relay block unit for new and retrofit applications.

Use of ultra reliable safety critical relays B and C type for door, speed, and breaking control.

Relay blocks validated and ready to install for fast installation and easy maintenance.

Scope of RATP Metroline 7, 8 and 13 project:

Project duration	2008 - 2011
No. of panels	435 blocks
B400 and C relays	3.960 relays
Length wiring	15 km
R&D & assembly time	1.800 h

SERVING SAFETY

Mors Smitt Railway Technology

Engineered solutions

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Your local contact:

BRO-Eng. Solutions V1.6 Sep 2015

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