Issue 4 / 2009 An ABB Group publication

Corporate technical magazine of the ABB Group in South Africa and the sub-Saharan Africa region

# technologysolutions

## Getting to grips with RAMS

New technology improves reliability, availability, maintainability and safety issues



Showcasing new products introduced at Automation and Power World 2009 in Africa:

## Relion's 670 and 650 series

and the ACS 2000 medium voltage AC drives range





## AC500-eCo, your PLC from ABB Optimal cost, minimum risk. Change for more!



With the new AC500-eCo, ABB now offers a great introduction to the AC500 family which is extremely cost-effective. Just like the AC500 platform as a whole, the AC500-eCo can also be used flexibly thanks to its scalability and modular platform concept. An integrated serial interface parameterised as a Modbus master/slave or CS31 master provides an easy means of exchanging data. A second serial interface and an SD card holder can optionally be attached.

The concept of the AC500 automation platform is a prime example of flexible, future-oriented automation. The clear system structure, standardised interfaces and a standardised programming environment allow quick assembly and configuration.

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## technology solutions

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#### Editorial

# Raising customer relationships to a higher level



Per Wanland.

On 11-12 November ABB South Africa held its greatest marketing event in Africa at the company's new premises in Longmeadow, in the Modderfontein area of Johannesburg. During those two days, some 1 300 people visited Automation and Power World Africa 2009.

Part of the programme was the official inauguration of the new building, performed by ABB's Group CEO Joe Hogan.

Customers at Automation and Power World Africa had the opportunity to listen to about 80 presentations from specialists in the many areas of ABB's competence. Visitors were treated to a "hands-on" experience of an array of ABB products and systems in the purposebuilt 2 500m<sup>2</sup> exhibition area. Several new products were launched, showing ABB's stateof-the-art technology.

Automation and Power World Africa also reinforced and grew the relationship between ABB and its customers and supplier base. Over the two days, thousands of contacts were made between people interested in ABB's advanced technology. A common theme in many of the discussions was that customers had not been fully aware of the width and depth of ABB's value offerings in products, systems and service areas. Many customers saw our advanced technology solutions for the first time.

All business is done between people, and relationships between people, based on skills and mutual trust, are a cornerstone of ABB's marketing strategy. ABB's advanced technology needs skilled sales and marketing people on the company side and informed and trained representatives on the customer side. Based on this principle, actual commercial transactions can be executed in an atmosphere of trust.

Over the last few years, ABB has developed special methodology to create such a positive atmosphere in relationships with valuable customers. Through development of the Channel Partners programme, stronger and more successful relations are created with customers in the products businesses. A common long-term strategy is a cornerstone of the Channel Partners relationships. The programme was launched in South Africa during 2008 and has already connected several customers more closely to ABB's solutions. Improving the knowledge of customer representatives through systematic training is part of the success of Channel Partners.

Through Global and Local Account Management, ABB is broadening and deepening relationships with major global and local customers. Dedicated Global and Local Account managers are developing relationships so that business can be done more easily and value is created on both sides. The Account manager is expected to develop a deep knowledge of the business drivers of a customer's organisation. The manager is also expected to develop personal relationships with customer staff so that, over time, trust is created. The long-term goal of this Account Management strategy is to develop a true partnership to replace the traditional buyer-seller relationship.

We welcomed many of our Channel Partners and dedicated Accounts at Automation and Power World Africa. For them, having ABB as a partner provides access to advanced technology, including Life Cycle support. This will in turn help customers to further increase productivity and improve their level of competitiveness in both local and international markets.

Automation and Power World Africa was not only a remarkable event in itself, but a natural part of ABB's ongoing process of raising customer relationships to a higher level.

**Per Wanland** Group Account Manager, Anglo American, ABB Group

# Showcasing automation and power technologies

ABB South Africa hosted the ABB Group's largest customer event for the African market, Automation and Power World Africa 2009, in November at its new head office, manufacturing and logistics premises in Longmeadow, Johannesburg.

The two-day conference and exhibition, which showcased ABB's latest products, solutions and services, was attended by more than 1 300 customers, channels partners and international delegates. The high turnout reflected the huge interest in power and automation technologies to improve energy efficiency in the face of soaring energy costs.

The event was made carbon-neutral and will be offset with a planned renewable energy project in a rural community, a first for ABB South Africa.

ABB Group Chief Executive Officer Joe Hogan attended Automation and Power World Africa and officially inaugurated ABB's state-of-the-art green building, which incorporates many of ABB's energy efficiency technologies. These technologies include ABB's power factor correction, Building Automation System, highefficiency motors and variable speed drives, in





ABB introduced several new products at the Automation and Power World 2009 event in Johannesburg.

addition to solar harvesting with 140m<sup>2</sup> of roof panels for heating water.

ABB engineers from several continents delivered about 80 presentations at the two-day conference. Knowledge transfer included conference delegates participating in interactive sessions to learn more about the latest technologies in power and automation from experts around the globe. Energy efficiency, productivity, reliability and safety were among the hot topics.

The exhibition, covering an area of more than 2500 m<sup>2</sup>, was a showcase of automation and power products introduced into the African market for the first time. These products were the ACS 2000 medium voltage variable speed drive, Drive Care, Resibloc dry-type transformers, Substation Automation, Fox 505 utility communications, DCB HV circuit breakers and the Relion<sup>®</sup> protection and control family.

Products, systems and services on display included robotics, transformers, drives, motors,

programmable logic controllers, Relion<sup>®</sup> protection and control, Industrial IT System 800xA, low voltage products (including ABB's Building Management System that is being used at Longmeadow) and systems and service.

In this issue of ABB Technology Solutions, we highlight some of the products presented at Automation and Power World Africa 2009 and introduced to the African market for the first time. We trust that this edition will give you insight into ABB's commitment towards efficient, reliable and safe technology for today's and tomorrow's electricity supply.

Enjoy your reading.

Le. Bradshan

**Chesney Bradshaw** Managing Editor ABB Technology Solutions

#### Intelligent Electronic Devices



# For maximum reliability of your power system

The low-down on Relion's 670 and 650 series of line distance protection IEDs.

REL670 and REL650 line distance protection Intelligent Electronic Devices (IEDs) offer extensive application opportunities. They feature full scheme distance protection with independent phase selection, power swing detection and a wide range of scheme communication logics. The IEDs with five-zone distance protection for phase to phase and phase to earth faults enable you to protect different overhead line and cable applications using different system earthing principles. The IEDs are also equipped with residual overcurrent protection functions that enable detection and fault clearance of high resistive earth faults, which are common, especially in sub-transmission networks.

### REL670: optimised for transmission applications

REL670 IEDs provide versatile protection, monitoring and control functionality with maximum flexibility and performance optimised for transmission overhead lines and cables. The powerful IED provides distance protection for double circuit, parallel operating and series compensated lines. This, together with flexible and expandable hardware, allows the IED to meet your specific requirements. As a result, you can benefit from applications with multiple algorithms and comprehensive bay control functionality, including synchronising, synchrocheck, deadline detection and auto-reclosing.

Furthermore, REL670 IEDs are able to protect and control several objects, for instance a combination of a line and a transformer with a single IED. As a result, this IED increases both the reliability and profitability of your entire power system.

REL670 IEDs provide both customised and preconfigured protection solutions. The preconfigured IEDs are equipped with complete functionality adapted for four different configuration alternatives: single pole breaker or multi-breaker arrangements with single or three phase tripping. If needed, they can be adapted to meet your power system's specific requirements. With the customised REL670 IEDs, you have the freedom to completely adapt the functionality according to your needs.

#### REL650: the best choice for sub-transmission applications

REL650 offers optimum "off-the-shelf", readymade application solutions for protection of single breaker connected power lines and cables. The type tested variants are delivered equipped and configured with complete protection functionality, and with default parameters for easy handling of products – from ordering, engineering and commissioning to reliable operation.

The 650 series IEDs introduce a number of innovations, such as significantly reduced parameter setting. In the 650 series IEDs, most basic parameters are set before delivery from the factory. You only need to set the parameters specific to your application. The parameters related to line distance protection are mostly set as primary ohms, which significantly reduces the need to re-calculate the current and voltage values. This allows the IEDs to be quickly taken into operation. The application manual includes setting examples to support the protection engineer.

#### Extensive protection for lines and cables

REL670 and REL650 provide protection of power lines and cables with high sensitivity and low requirements for remote end communication. Measurements and setting of all five zones with several setting groups are realised completely independently to ensure high reliability. The distance protection function is available with both quadrilateral and mho impedance characteristics. This enables co-ordination with existing distance protection schemes in any power network.

#### Intelligent Electronic Devices

The distance protection is further enhanced with load encroachment adaption, which increases the ability to detect high resistive faults on heavily loaded lines. This is especially useful in sub-transmission networks where high line load needs to be allowed while high resistive faults need to be detected and cleared. The unique load current compensation in zone one prevents unwanted trip at resistive faults and high power transfer on the line. Furthermore, an integrated power swing detection function prevents unwanted operation during power system oscillations caused by disconnection of parallel lines, heavy loads or tripping of large generators.

Versatile overcurrent functions provide additional back-up protection. The thermal overload protection will trip the line at overload situations to prevent more severe fault consequences.



REL670/650 IEDs provide distance protection with Mho characteristic.

#### Intelligent Electronic Devices

Breaker failure protection allows high-speed backup tripping of surrounding breakers and re-tripping of the own breaker, for instance, to avoid operational mistakes during testing. This is essential in substations with high short circuit power infeed, which require local back-up protection. The distance and earth-fault protection functions can communicate with the remote end in any communication scheme.

The auto-reclosing functionality increases operation security and is an effective way to restore the network after arcing faults. In REL670 and REL650, auto-reclosing can be made using synchro-check to eliminate the risk of unwanted reclosing during unfavourable circumstances.

#### Integrated protection and control

REL670 and REL650 IEDs are designed for IEC 61850, implementing all the aspects of this standard and thus ensuring open, futureproof and flexible system architectures, with state-of-the art performance. Their performance meets comprehensive communication tasks, for example, GOOSE messaging for horizontal communication. These IEDs provide you with wide application flexibility, which makes them an excellent choice for both new and retrofit installations.

The advanced interlocking functionality of REL670 allows you to avoid dangerous or damaging switchgear operations and to ensure personnel safety. REL670 performs secure bayand station-wide interlocking using an easy-touse reservation functionality. This prevents simultaneous operation of disconnectors and earthing switches and ensures that the interlocking information is correct at the time of operation. The control is based on the select before before-operate principle to assure secure operation and to avoid human mistakes.

The integrated HMI of REL670 and REL650 provide you with a quick overview of the status of the line and service values as well as instant access to important data, such as settings. Using a library of symbols, you can easily configure the graphical display to correspond to your needs and to your substation.

The built-in disturbance and event recorders provide you with valuable data for post-fault



The load encroachment function allows you to efficiently detect high resistive faults without interference with the load impedance.



REL670/650 IEDs provide distance protection with quadrilateral characteristic.

analysis and corrective actions to increase the security of your power system.

Furthermore, the HMI of REL670 allows secure and quick local control for stand-alone applications and provides back-up control for substation automation systems, when control functionality is integrated in the IED. The twoposition versatile switch and the 32-position selector switch functions in REL670/650 enable you to easily manage switching operations via an icon on the IED HMI. The versatile switch function allows you to directly change, for instance, the autorecloser function from on to off, or vice versa, without changing the configuration. The function also presents an indication of the selected position.

The selector switch replaces an external mechanical selector switch and allows you to directly select the position you desire, for instance, to change the autorecloser mode between 1-pole, 3-pole or 1- and 3-pole modes in REL670. In addition to the IED HMI, these switch functions can be operated from a remote system.

#### Fast and efficient system integration

The IEC 61850 compliant REL670/650 IEDs utilise ABB's unique connectivity package concept, which simplifies the system engineering and reduces the risks of errors in system integration. A connectivity package contains a complete description of the specific IED, consisting of data signals, parameters, addresses and IED documentation. The signal data is configured automatically based on the information provided by the connectivity package to efficiently integrate the IEDs in ABB's MicroSCADA Pro automation system.

#### Relion®: complete confidence

Line distance protection REL670/650 IEDs belong to the Relion® protection and control product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems.

To ensure interoperable and future-proof solutions, Relion products have been designed to implement the core values of the IEC 61850 standard. With ABB's leading-edge technology, global application knowledge and experienced support network, you can be completely confident that your system performs reliably in any situation.

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# ACS 2000 – simple and reliable motor control

Meet the newest member of the ABB medium voltage AC drives family.

The ACS 2000 is the latest addition to the ABB medium voltage AC drives range, providing reliable motor control for a wide range of applications.

The ACS 2000 is designed for high reliability, easy installation and fast commissioning – reducing the total cost of ownership. With the integration of an active front end (AFE), line side harmonics are minimised without the use of expensive, specialised transformers and with the added benefit of power factor correction and regeneration.

With its compact footprint, the ACS 2000 can be retrofitted to control standard induction motors via a direct connection to 6.0-6.9 kV line supply (direct-to-line). Alternatively, a simple two-winding input isolation transformer can be applied to allow for flexible line side supply voltages.

The ACS 2000 direct-to-line combines the cost savings of a transformer-less variable speed drive system with the benefits of voltage source inverters (VSIs), including excellent availability and reliability, high and constant power factor and superior dynamic control performance.



#### Medium voltage AC drives

The heritage of ABB's VSI topology, along with a patented IGBT-based multi-level control, provides a proven track record for reliable and motor friendly medium voltage AC drive solutions.

#### Key product features:

- Suitable for use with or without an input isolation transformer
- Direct-to-line connection (transformer-less) provides lowest cost of ownership
- Active front end (AFE) for minimal line side harmonics with power factor correction and regeneration
- Simple drive system integration
- Three-in-three-out cabling technique for quick and easy installation
- Suitable for new or existing induction motors
- High reliability and low maintenance costs

#### Line supply connection flexibility

The ACS 2000 provides different line supply connection options, each offering unique benefits. Depending on the preference or the existing installation, the ACS 2000 is available for connection to an external input isolation transformer or for use without a transformer, the latter allowing a direct connection to the industrial line supply (direct-to-line).

#### Direct-to-line

The ACS 2000 direct-to-line can lower investment costs substantially. Its compact size and lighter weight compared to a drive requiring a transformer means lower transportation costs and less space required in the electrical room.

The ACS 2000 can be easily retrofitted to fixed speed motors, while the direct-to-line technology results in quick and easy installation and commissioning.

#### External transformer

For applications where a voltage-matching input isolation transformer is needed, or galvanic isolation from the line supply is required, the ACS 2000 can be connected to a conventional two-winding oil or dry-type input isolation transformer.

## Active front end for network-friendly and energy-efficient operation

The ACS 2000 is equipped with an AFE, which can be used in conjunction with a simple input isolation transformer or for direct connection to 6.0-6.9 kV line supply. It provides low harmonics and enables four-quadrant operation and reactive power compensation.



Topology of the ACS 2000 for direct-to-line connection.

#### Low harmonic signature

The AFE provides a low harmonic signature, which meets the most stringent requirements for harmonic distortion as defined by relevant standards. This avoids the need for harmonic analysis or the installation of network filters.

#### Reduced energy consumption

For minimal energy consumption, the AFE enables four-quadrant operation, which feeds back braking energy into the line supply.

#### Static VAR compensation

The AFE can also provide reactive power (VAR) compensation. With static VAR compensation, a smooth network voltage profile can be maintained and reactive power penalties can be avoided.

#### Powerful performance with DTC

Precise and reliable process control, together with low energy consumption, results in top performance. The ACS 2000 drive control platform uses ABB's award-winning Direct Torque Control (DTC), resulting in the highest torque and speed performance as well as the lowest losses ever achieved in medium voltage AC drives. Control of the drive is immediate and smooth under all conditions.

## Motor friendly output waveform for use with new or existing motors

The ACS 2000 provides near sinusoidal current and voltage waveforms making it compatible for use with standard motors and cable insulation. This is achieved with ABB's patented multilevel topology, which utilises one DC link enabling a multi-level output waveform with a minimum number of power components.

#### Simple drive system integration

Along with its flexible line supply connection options and advanced software tools, the ACS 2000 allows smooth and simple drive system integration into any industrial environment.

#### Flexible control interface

ABB offers an open communication strategy, enabling connection to higher-level process controllers. The ACS 2000 can be installed with all major fieldbus adapters for smooth integration, monitoring and controlling of different processes, according to customer requirements.



Line and motor current and voltage.

#### DriveOPC

DriveOPC is a software package that allows communication between ABB drives and the customer's Windows®-based applications.

#### Commissioning wizard

The commissioning wizard is an advanced tool that simplifies and speeds up commissioning, reducing plant downtime considerably.

#### Maintenance

The ACS 2000 is designed to maximise uptime and facilitate quick repair. The modular design lends itself to quick and effective replacement of components, resulting in industry-leading mean time to repair (MTTR).

#### **Reliable components**

ABB drive technologies, such as the multilevel VSI topology, provide a low parts count, which increases reliability, extends mean time between failures (MTBF) and improves availability.

#### Easy access

The ACS 2000 has been designed to allow easy front access to all drive components.

#### Redundant cooling

The ACS 2000 is available with redundant fans, which increases availability.

#### Installation and commissioning

Installation and commissioning Proper installation and commissioning of the equipment, done by qualified and certified commissioning engineers, reduces start-up time, increases safety and reliability and decreases life cycle costs. In addition, operators can be given practical training by experienced specialists on site.

With its three-in-three-out principle, flexible line supply connection options and advanced software tools, such as the commissioning wizard, start-up of the ACS 2000 is easy and fast, thereby minimising plant downtime.

#### Life cycle management

ABB's drive life cycle management model maximises the value of the equipment and maintenance investment by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive.

Life cycle management includes:

- Providing spare parts and expertise throughout the life cycle
- Providing efficient product support and maintenance for improved reliability
- Adding functionality to the initial product

#### Training

ABB provides extensive training for its medium voltage AC drives. A range of training programmes is offered, from basic tutorials to programmes tailored to the customer's specific needs.

#### Global network, local presence

After-sales service is an integral part of providing

the customer with a reliable and efficient drive system. The ABB Group of companies operates in more than 100 countries and has a worldwide network of service operations.

#### Services for ABB's medium voltage AC drives

- Supervision of installation and commissioning
- Local support
- Worldwide service network
- Spare parts and logistics network
- Training
- Remote diagnostics
- 24 x 365 support line
- Customised maintenance contracts

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#### Managing RAMS

## Getting to grips with RAMS

RAMS – reliability, availability, maintainability and safety issues with LV switchgear and motor control centres – can be dramatically improved with new technology.

David Stonebridge, ABB Australia

Striking a balance between commercial demands to maximise production in the short term need to be balanced against longer term outcomes that are determined by the management of RAMS (reliability, availability, maintainability and safety).

Typically RAMS-related programmes require regular plant shut downs that diminish the revenue potential of plants. In most mining, power & oil and gas applications, shut downs can cost many millions of dollars or rands a day. In many instances, the entire annual budget for RAMS activities can be lost in revenues in less than a week of plant shut down.

The primary challenge for plant managers today is to fully deliver RAMS programmes with minimal plant down time.

This article focuses on how new technologies and design principles in low voltage switchgear can be employed to improve RAMS programme effectiveness while reducing plant down time

## LV switchgear standards and specifications

The applicable LV switchgear standard is AS/NZS 3439.1:2002 or IEC 61349 & IEC61641. The standard requires that the switchgear purchaser inform the switchgear supplier on a number of issues. There are 38 items listed. <u>The standards cover the complete range of</u> switchgear requirements so it is necessary for the purchaser's engineer to specify:

- The type of switchgear construction required, e.g. withdrawable, demountable, front/back-operated and connected, degree of protection, and segregation etc
- The ratings required, e.g. supply and loads, circuits and cables, and the service conditions.

AS3000:2007 introduces specific requirements for arc fault protection for switchboards >800A. At this time, internal arc fault containment is not mandated. AS/NZS 3439.1:2002 Annex ZD or IEC61641 sets out the test procedures and guidelines for internal arc fault containment. An agreement between the purchaser and the manufacturer is required on where the arc is initiated.

The purpose of all this is to establish the RAMS requirements to suit the application. Generally the purchaser will do this by preparing a site specification. Some site specifications end up as an instruction manual on how to build the switchgear. Site specification can be built up over many years of bad experiences with RAMS. When the purchaser specifies this type of detail design, the question is who is responsible for RAMS? The supplier's type test certificates may no longer be valid if there are significant changes to the type-tested design and additional type testing may need to be specified. A performance-based site specification stating the outputs, functions and requirements may be a better alternative to the traditional detail site specification that tells the supplier how to build the switchgear. This would allow the supplier to offer proven type-tested solutions that would meet the purchaser requirements. This is even more important today with the advancements in intelligent switchgear, where a control or protection function is performed with software and not with wires and relays.

## RAMS issues with traditional LV switchgear

### Bad RAMS experiences with older switchgear include:

Sheet steel that rusts in corrosive atmospheres, insulation that is hygroscopic and breaks down, and insulation that is highly flammable and toxic.

- 1970s insulation materials are dangerous,
   e.g. asbestos is flammable and toxic
- Demountable switchboards are difficult and dangerous to maintain
- Exposed live connections pose a real risk of internal arcing faults

#### Improvements in basic material reliability

Sheet steel corrosive protection has improved with the introduction of materials like aluzinc and zinc-sealed sheet steel with quality backed enamel finishes. Superior insulations that are nonhygroscopic, CFC halogen free, flame retardant

#### Managing RAMS

and self-extinguishing are now available. These days these insulating materials need also be environmental friendly and biodegradable.

## Bad RAMS experiences in operations and maintenance include:

Isolator handles that slip on the drive shaft and isolator main contacts that fail to open, or are welded shut after a fault. Door interlocks have also been known to fail.

Any of these failures can result in a technician opening a compartment door where there are exposed live connections. Even under normal operations there could be live connections, exposed line side terminals, electrical interlocks and lethal control voltage.

The small, cramped LV compartments make it difficult to fault find and conduct maintenance. With live connections, they can be lethal, with the risk of electric shock or initiation of an arc flash.

Arc flash and arc faults are a major safety risk, and five to 10 people a day are involved in arc flash incidents in the US alone. Arcing faults can produce enormous gas pressures and extreme temperatures. Personnel in the path of super-hot gases created by the arc can be killed or will suffer serious burn injuries. Arc flash incidents are most likely to occur as a result of operator error while working on live equipment.

Employers' obligations to provide a safe working environment around low voltage switchgear have been challenged by the general absence of safe equipment. The only recourse has been to insist that operators wear Cat 4 suits or shut down the plant to do the most rudimentary service tasks. Cat 4 PPE is cumbersome and uncomfortable and affords limited mobility and visibility. The limitations of this PPE mean that most service activities cannot be performed and the suits only potentially reduce injury in the event of an arc flash event.

PPE does not provide 100% protection against an arc flash. The suit only protects against heat and can only be regarded as flame resistant. It does not protect against the blinding light, the toxic gases or the pressure waves that may involve several G forces – nor associated shrapnel, which



#### Points of arc fault ignition:

A – Standard tests to AS3439
 The fuse interrupts the fault in 2 ms
 Major concern is line side re-strikes
 B – Line side of protective device
 C – Distribution bus

- D Incomer
- E Main bus

may attain velocities of 300m/s. These matters are recognised in both NFPA70E and IEEE1584, which reinforce the application of PPE as the lowest in the hierarchy of controls.

## Improvements in availability, maintainability and basic safety

A withdrawable design is inherently safe as you cannot open a compartment door where there are live connections and be exposed to the possibility of an arc flash. Operations are always carried out with the doors closed. The functional unit is powered off before it can be withdrawn. The starter or feeder unit is completely withdrawn from the electrical assembly and removed to a safe area for inspection, repair or maintenance.

If the switchgear has been type tested for arcing fault containment, where the arc has been initiated on the line side of the starter protection there is no need for arc safety PPE to carry out normal switchgear operations. In a good withdrawable design, there is no need to do regular maintenance on the fixed portion of the switchgear; the bus bars should be maintenance free. The only components that need maintenance are the hard-working withdrawable modules. Intelligent LV switchgear solutions may even go further by providing advanced condition information on the motor starter.

If there is a need to undertake structural changes to the switchgear precautions must be taken and the best precaution is "work de-energised". The separation of control and communication cables from motor and load cables offers a new way of maintenance in LV switchgears. Power cables are located in their own separate compartment and do not need to be accessed during normal operations. Control cables are located in their own safe compartment away from dangerous voltages.

### Bad RAMS experiences with withdrawable contacts

Early designs of withdrawable modules used the same plug-in contacts as used on the line side contacts of demountable modules. To comply with AS/NZS 3439.1:2002 or IEC 61349, the withdrawable module must satisfactorily pass the mechanical operation type test refer clause 8.2.6. The module is tested for 50 inserts and withdrawals.

This type of contact is not designed to be withdrawn more than this. The intent of the specification with 50 operations is to allow the module to be withdrawn for safe maintenance every four years. In IEC61439, issued in 2009, the mechanical operation type test has been increased to 200 operations. In practice, in many operating plants the withdrawable modules are removed on a regular basis to verify positive motor isolation. Not only are the contacts inadequate for this duty, the withdrawable alignment facility is not either. If the contact plating is worn through over-use, or the contacts are damaged due to misalignment, the contacts will fail. The contacts will overheat and this will lead to further loss of contact pressure, thermal runaway, in-line arcing and possible fire.

## Improvements in reliability, safety and maintainability of withdrawable contacts

There have been significant advancements in withdrawable contact technology. Withdrawable

#### Managing RAMS

modules are now available that are designed to be repeatedly withdrawn in up to 1 000 operations before the contacts need to be replaced. These contacts have been subjected to a range of tests that include short circuit, temperature rise, thermal cycling and heavy duty starting to verify reliability and safety over time and the number of operations

All moving parts need to be maintained; lubricating grease needs applied to the contacts after 100 operations to provide long life. There are withdrawable switchgear systems available that provide maintenance information based on the number of withdrawable operations and the operating load conditions. These modern systems continuously monitor the starter temperature and provide a warning if the temperature is not within the set limits. Early warning systems prevent in-line arcing.

#### Ineffective maintenance results in safety & availability issues

Maintenance managers have to balance between maximising the availability of the plant and minimising the cost of maintenance.

Maintenance managers question their strategies by asking:

- What if we run to failure?
- What if we only do reactive maintenance?
- What is the cost and how long will preventive maintenance take? Shut downs must be kept to a minimum.
- Do we have the trained resources available when we are most stressed during a shut down?
- How do we know what needs to be maintained anyway?

If they make the wrong choice it can easily result in components becoming stressed, overheating and and catching fire. Failures often occur after improper maintenance.

## Improvements in availability, maintainability and basic safety

LV switchgear might be seen as only a small part in the big plant, but it might also become a basis for a revolutionary change in asset management. Keeping the plant assets in their best working condition is essential. Intelligent LV switchgear of today can provide valuable information on the condition of the motor, the switchgear and even the process – which can have major impact on RAMS improvements to the whole plant

An intelligent motor control system can provide a huge amount of information on the motor load condition, continuous monitoring of the thermal load of a motor and provide details on the process condition. Overload warnings, typically ignored by an operator as being spurious, are monitored closely. They are an indication of upcoming problems and may lead to a major trip if continually ignored. Condition monitoring systems count such early warnings and if they reach a certain level the maintenance person is informed. Checks can be made without stopping the process.

Those process related data are:

- Overload (electrically and thermal)
- Blocked rotor or stall (6x FLC w/- motor cooling)
- Underload (monitoring fast changing load condition)
- Underload based on power factor (useful for blocked pump monitoring)
- Earth fault and voltage imbalance monitoring (motor harmonic heating and bearing problems)
- Motor running hours and the number of contactor operations
- The quality of the motor cable termination by temperature monitoring
- The number of insertion cycles of the motor starters

Valuable information from a truly intelligent LV switchgear enables corrective action to be taken to keep the drive running, maintain the plant efficiency and maximise plant availability – taking the "hit & miss" out of maintenance.

#### Conclusion

RAMS in LV switchgear is a very important issue with plant managers, operations, maintenance and safety officers. To make significant improvements to existing switchgear is almost impossible. There is a need to consider the future requirements by influencing and revising the old site specification for new projects or replacement LV switchgear.

There is a greater emphasis on operational health and safety today than there was 10 to 20

years ago. In addition, there have been massive advancements in electronics and intelligent switchgear over the last 20 years. It is time to revise those old specifications to ensure improvements in RAMS in future LV switchgear.

#### Recommendation

Consider the RAMS issues carefully when specifying your requirements to AS/NZS 3439.1: 2002 or IEC 613439 and IEC 61641.

It is not enough to specify "a 50kA, Form4, IP54, type tested MCC" as this may not give you the safety features you need. It will not give you arc fault containment for example. Consider the appropriate external degree of protection to suit the application. IP54 may be appropriate for an outdoor application in a processing plant. For indoor switchgear, AS/NZS 3439.1:2002 clause 7.2.2 states IP3X, IP4X or IP5X is more appropriate.

When the switchgear is located in a modern switch room, a degree of protection of IP4X is better simply because IP54 requires a very high degree of component and busbar de-rating (more than 20%.). For example, if a 3000A ACB is required in an IP54 panel, it would mean installing a 5000A breaker. An IP4X construction allows air to circulate in the switchgear panels and this helps to reduce condensation and prolongs the life of the components as they are operating at a low temperature.

When specifying the RAMS requirements for LV switchgear, the "S" is the most important. Safety needs to be built into the design. With fully withdrawable, all operations are performed with the doors closed and arc fault containment – not only for the starter but the complete LV switchgear, incomers and main bus bars.

Intelligent switchgear with condition monitoring should be considered as this provides the diagnostic tools that are making significant improvements in RAMS. Intelligent technology reduces personnel switchgear interaction.

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