The incredible shrinking switching station

The new gas insulated installation at Port Hamm takes up a fraction of the space needed by its predecessor.
Rising electricity costs fuel reliability issues

Trevor Gregory ABB UK Managing Director

With commercial and domestic users facing double-digit increases in their electricity bills, security of supply is a high profile issue. There are demands for tougher targets for minimising customer interruptions and customer minutes lost.

National Grid’s figures show that the grid is 99.9997 – 99.9999 per cent reliable and that distribution networks have seen improvements in service, with power cuts down by 11 per cent since privatisation in 1995. However, customers expect more improvements in performance.

Following the much publicised power failures in London and Birmingham in 2003, a new incentive scheme will penalise National Grid automatically in the event of similar failures. This brings the grid into line with low-voltage distribution networks, which are already subject to incentive schemes that penalise poor reliability.

This emphasis on reliability, coupled with the Government’s drive to achieve a lower carbon economy, poses a significant challenge.

Distribution Network Operators (DNOs) will be able to spend £5.7 billion over the next five years in strengthening and replacing their networks, which are already subject to incentive schemes that penalise poor reliability.

This network feeds over 1.2 million homes from the local environment.

The Port Ham interconnector switching station on the banks of the River Severn just outside Gloucester is a grid supply point (GSP). It takes electricity at 132kV from the National Grid substation, a few miles away at Walham, and feeds it into the Central Networks distribution network. Through a network of primary and secondary substations, this network feeds over 240,000 customers in Gloucestershire, Herefordshire and much of south and east Worcestershire.

The original outdoors station, built in the early 1950s, had experienced above-average load growth, to a current peak load of 672MW. The AIS (air insulated switchgear) had reached the end of its useful life. So in 2002 we decided to completely rebuild the facility to ensure continued reliability of supply, as well as to provide scope for further load growth.

INDOOR GIS

Initially, the project was tendered in the expectation that the AIS would be replaced by gas insulated switchgear (GIS) under a like-for-like basis. However, in consultation with the ABB and Balfour Beatty consortium, we decided that building a new indoor GIS (gas insulated switchgear) station would offer a number of important advantages, such as minimising customer interruptions and delivering a cost-effective return on investment. Wide area monitoring systems provide tools to mitigate or prevent widespread power outages, while compact gas insulated switchgear and undergrounding of cables reduce environmental impact.

The strategic importance of Port Ham has made it a flagship project for Central Networks. And we have been particularly keen to use it both to gain experience of applying GIS technology in challenging applications, and to develop a model approach to the delivery of large capital projects.

We have been very pleased with progress to date. During the summer, a key milestone was passed with the successful energisation of the interconnected circuit. Eight out of the 16 circuits were transferred by the end of October – putting us bang on target to have Port Ham fully commissioned for the end of 2006.
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National Grid’s figures show that the grid is 99.9997% – 99.9999% per cent reliable and that distribution networks have seen improvements in service, with power cuts down by 11 per cent since privatisation in 1995. However in today’s ‘wired’ society, consumers expect demand and more improvements in performance.

Following the much publicised power failures in London and Birmingham in 2003, a new incentive scheme will penalise National Grid automatically in the event of similar failures. This brings the grid into line with low-voltage distribution networks, which are already subject to incentive schemes that penalise poor reliability.

This emphasis on reliability, coupled with the Government’s drive to achieve a lower carbon economy, poses a significant challenge.

Distribution Network Operators (DNOs) will be able to spend £3.7 billion over the next five years in strengthening and developing their networks. The challenge is to strike a balance between the capital expenditure needed to maintain the levels of reliability required by customers and to accommodate growth in distributed generation, and the need to protect customers from unnecessary or inefficient investment and operating costs.

Speaking at the launch of a consultation on regulating the connection of offshore wind farms, energy minister Malcolm Wicks said: “The development of Round 2 offshore wind power has a vital part to play in reaching our renewable energy targets and aspirations. Connecting wind farms to the onshore grid is an important aspect of delivery and this consultation sets out clear options for the offshore regulatory framework. It is critical to introduce a regime that allows offshore wind farms to connect at a cost that is acceptable both to developers and electricity customers.”

ABB offers transformer of sampling as an easy way to test, improving any transformer fault problems. And a new HV test can provide a mobile facility for locating and repairing faults in underground cables rated up to 11kV.

10 Health and safety checks for sophisticated power equipment
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11 New 670 Series substation conforms to IEC 61850
ABB has responded to the introduction of the IEC 61850 protocol with a new range of automation products.

12 Offshore wind farm bane on ABB submarine cable
All the submarine cables for the 9MW Burbo Bank offshore wind farm, located in Liverpool Bay will be supplied by ABB. The XLPE cable will connect 25 3 MW wind turbines and transport the power to shore.

The Troll A offshore platform, 70km off the Norwegian coast, is the first to obtain land-based power via ABB’s HVDC Light technology. This solution saves money, occupies less platform space and has low environmental impact.

13 Port Ham shrinks from view
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LIMITED DOWNTIME
In addition to saving space, GIS also offered two further advantages. First, we have been able to reduce circuit downtime, as the new GIS circuits could be constructed with the existing units still in service. Downtime was limited to the rerouting of the network connections. This was a crucial factor, because of the critical position of Port Ham in the supply network. Second, the GIS was constructed outside the existing live compound, considerably reducing health and safety risks to personnel working on site.

ABB is working with transmission and distribution network operators and regulatory bodies to ensure that this investment is efficient and effective. Innovative proven transmission and distribution connection technologies such as FACTS (Flexible AC Transmission Systems) and HVDC Light enhance system stability and reliability and deliver a cost-effective return on investment. Wide area monitoring systems provide tools to mitigate or prevent widespread power outages, while compact gas insulated substations and undergrounding of cables reduce environmental impact.

Geraint Hancock, contract delivery manager with Central Networks Infrastructure Services, updates on progress at the new Port Ham switching station.

PILING
One of the major project challenges was the soft ground – on the flood plains of the River Severn – which required major foundation work before construction could begin. It was certainly impressive to see the project team driving some 120 cast concrete piles down 15 metres to the bedrock in just over 10 days. The building itself has been raised on stilts to ensure that the switchgear is at least one metre above the predicted level of the once in 100 years flood level.

FLAGSHIP PROJECT
The new indoor switching station comprises 20 bays of GIS switchgear: 12 feeder circuits – four National Grid incomers; two bus couplers; and two bus sections. The size of the investment and the strategic importance of Port Ham has made it a flagship project for Central Networks. And we have been particularly keen to use it both to gain experience of applying GIS technology in challenging applications, and to develop a model approach to the delivery of large capital projects.

We have been very pleased with progress to date. During the summer, a key milestone was passed with the successful energisation of the interconnector circuit. Eight out of the 16 circuits were transferred by the end of October – putting us bang on target to have Port Ham fully commissioned for the end of 2006.
Bringing wind power to the grid

The UK’s largest onshore wind farm is being equipped with ABB power transformers together with associated high voltage switchgear and control equipment. Scottish and Southern Energy’s new £85 million Haydard Hill WindFarm Development will be connected to Scotland’s main power transmission grid.

The wind farm, with its 52 wind turbines is capable of generating 120MW. The development project includes a substation and control building, to convert the power generated to the 132kV required for grid transmission, together with a 10km overhead power line to connect the site to the grid supply point (GSP) at Maybole.

ABB is supplying two 90MVA 132/33kV power transformers directly to Scottish and Southern Energy. It is also supplying an 11-panel 33kV switchboard, two 5Mvar capacitors, a 145kV dead tank circuit breaker, six CVTs, six panel 33kV switchboard, two 5Mvar capacitors, surge arrestors and line traps, to Cruickshanks, the Balfour Beatty Group company specialising in high voltage substation design and construction.

Gas insulated installation nears completion

The new 132kV Norton substation, near Stockton on Tees, is not only one of the first to be constructed by a DNO (Distribution Network Operator) under new regulations, but also one of the most important projects ever undertaken by NEDL.

ABB has successfully energised and transferred to National Grid the sixteenth and final outgoing circuit of the 132kV substation. This means that all the major works have been completed in just over two years since ground was broken on the £9 million project in April 2003. ABB is now completing the work by removing the old AIS (air insulated switchgear) substation to make room for the next phase, the construction of a new 11kV substation.

Gas insulated installation nears completion

ABB has embarked on a £137 million (US$240 million) investment programme to streamline its global transformer business. The aim is to consolidate its position in the marketplace against a background of worldwide manufacturing over-capacity, rising raw material costs, and a regional shift in demand.

The company will be focusing on increasing productivity and improving efficiencies, and will close a small number of its higher-cost plants.

The new programme will be completed by the end of 2008. In 2004 the transformer business had global sales of around $2.5 billion and employed 15,000 people in 57 plants located in 28 countries.

High living in Manchester

ABB is to provide a complete high- and low-voltage power connection package for the new Beetham Tower in Manchester. The 171-metre high, 48-storey, building is set to become the UK’s highest living space.

Beetham Tower has been designed by Ian Simpson Architects. The striking, slender glass tower at the heart of the development will be the tallest structure in Manchester city centre.

Some 4MVA is needed to support the Tower’s 219 apartments, penthouses and 295-bed five-star Hilton hotel. ABB is supplying a complete turnkey connection package on a tight project schedule, ensuring that the building can be occupied at the earliest possible opportunity.

ABB is installing the building’s complete 66kV HV and 230/400V LV electrical distribution network, including a 1MVA distribution transformer. The company is also liaising directly with United Utilities to manage the smooth transfer of the completed connection to the local power network.

Under a separate contract, ABB is providing a ChP (combined heat and power) scheme for the building.

Transformer business adapts to new conditions

ABB has a long tradition in transformer manufacturing. From its early days of supplying lighting columns to the Department of Public Works, to the insurance company situated at the heart of the City of London, it has maintained a strong trading relationship with the City of London for over 100 years.

A transformer is a device that transfers electrical energy from one circuit to another. It can increase or decrease the voltage, and may change the current as well. Transformers are used for both high-voltage and low-voltage applications.

The risk to life or property are also well down – from an initial level of 200 per month to around 100 per month.

Transformers are essential to the operation of power systems. They are used in power generation, transmission, distribution, and utilization.

ABB is a global technology leader in power and automation. The company is well ahead of the target with over 96 per cent of the equipment in full working order. The emphasis on inspection, combined with the renewal programme, has seen a considerable drop in the level of routine fault repairs, from a typical 2,500 to 3,000 per month at the start of the project to just over 2,000 per month. At the same time, emergency call-outs, where there is a perceived

UNITED STATES

Series of transformer bank

In a $31 million project, the largest bank of power transformers ever installed in India will strengthen the country’s power network and help meet the ever-growing demand for electricity.

ABB is supplying ten 500MVA transformers and ten 60MVA 765 shunt reactors to Power Grid Corporation of India Limited.

DRIEDAL

$30 million order for industrial substations

ABB is to supply Brazil’s leading aluminium producer, Companhia Brasileira de Aluminio, with three new industrial substations as part of a programme to sharply increase output. The new installation will include the largest turnkey substation yet supplied to an industrial customer in the country. The 75MVA substation will provide power to a new aluminium room.

BELGIUM

Transformer bank to control cross-border power flow

The Belgian grid operator, Elia, has placed an order for three phase-shifting transformers, which will control the power flow between Belgium and The Netherlands. The throughput rating makes this transformers, with a rating of 1200 MVA, the largest in the world. Phase-shifting transformers like these control the quantity and direction of electricity between power networks.
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ABB's approach to project management has changed profoundly over the past five years. Stephen Trotter, General Manager of ABB UK's power systems projects division, outlines some of the initiatives that are helping the company to deliver first-class projects.

Delivering operational excellence

ABB has just one aim in any power systems project: to deliver operational excellence at every stage – from initial sales enquiry through delivery and commissioning, to long-term service and warranty. That’s why, over the past five years or so, we have made some profound changes to the way we approach project management. We have effectively doubled the size of our delivery resources, improved existing processes, added new capabilities and created new functions. The key focus is now on achieving the closest possible match between our services and customer needs, and on changing our emphasis from selling systems to becoming a trusted partner capable of delivering project right from the start, enabling the customer during the early contract negotiations to establish a common baseline for the management of the project. This includes all aspects of the project scope, contractual commitments, budgets, targets and margins. The focus is on ensuring this flows down into ABB’s supply chain. So, the project manager and supporting cast now play an active role in the negotiation process, to help develop the budget and to establish the schedule that they will be called on to deliver. The result is complete ‘clarity of expectation’ from the customer, ABB and our supply chain.

The key driver behind these changes was the recognition that, while ABB has a long-established track record in the successful delivery of a wide variety of projects, there were times when we fell short of customer expectations. This was especially true when project quality and delivery schedules were eroded by inefficiencies on both sides, most often caused by difficulties in communication, definition of scope and a lack of consistency. So we have worked hard to put in place the right processes, resources and people to ensure that all our efforts are focused on understanding what customers need, meeting their expectations and knowing how they define success.

The RIGHT PROCESSES

Possibly the greatest process change so far has been greater emphasis on on-time delivery performance. We recognise the cost of poor delivery, and measures have been put in place to record and identify problems and implement improvements. We have also introduced improved document control procedures.

The RIGHT RESOURCES

In addition to the traditional elements of power systems project management – such as design, installation and commissioning, as well as site health and safety and quality management – ABB has added three new resources:

Control and protection

There was a tendency for this to be regarded as a separate, add-on element provided by another division, with an emphasis on individual projects. Now, the requirements for control and protection systems are integrated into the project right from the start, enabling the optimum, most cost-effective scheme to be developed and implemented in the fastest possible time.

Commercial management

For a smooth transition from contract agreement to site work, the project team works closely with both ABB’s tendering team and the customer. The key to this is the development of the optimum approach to site clearance, foundation and piling work, access road construction, building works and so on – effectively eliminating the cost uncertainty that can often cloud this part of the project.

Civil engineering and construction

Civil engineering and construction is an often neglected component of the project. Yet it can be absolutely vital in ensuring its success. A major difference between ABB and its competitors is that through our own in-house civil engineers we are now able to introduce preferred civil engineering and construction contractors at the pre-contract stage. This enables us to call on their experience to develop the optimum approach to site clearance, foundation and piling work, access road construction, building works and so on – effectively eliminating the cost uncertainty that can often cloud this part of the project.

The RIGHT PEOPLE

Since 2000 we have ramped up our recruitment and training programme to ensure we have the right people in place, now and well into the future. Our roster of project managers has grown rapidly – it now stands at 27. And this growth has been reflected across the board in the various vital skills such as application engineers, planners, commissioning management and so on, resulting in an increase of over 50 per cent in our total delivery resources.

Because ABB is a global organisation, we have been able to bring in skilled and experienced people from around the world, with 15 nationalities represented in the various UK teams. We are also recruiting bright young engineers and giving them the chance to become the project engineers of tomorrow. As an integral part of our training and accreditation schemes, all ABB project managers have either achieved, or are working towards, PMI (Project Manager Professional) certification from the Project Management Institute (PMI).

The RIGHT OUTCOME

In essence, our new approach to project management is aimed at increasing customer satisfaction by providing a framework for constant two-way communication, making the whole project process transparent so that ABB and its customers understand and respect each other's expectations. Our new approach has been so successful that it has earned ABB recognition from the Project Management Institute (PMI).

ABB recognizes the key role that it plays in ensuring its customers' success and satisfaction. The company is committed to providing the highest levels of service and satisfaction, and has established a strong track record in the successful delivery of various projects. The focus is now on achieving the closest possible match between services and customer needs, and on changing the emphasis from selling systems to becoming a trusted partner capable of delivering project right from the start. ABB is committed to developing the optimum approach to site clearance, foundation and piling work, access road construction, building works, and other aspects of the project, to effectively eliminate cost uncertainty. The company has also added three new resources to its project management team: control and protection, commercial management, and civil engineering and construction. ABB’s recruitment and training initiatives have resulted in a growth of over 50% in its total delivery resources, with 15 nationalities represented in its UK teams. The company is recruiting bright young engineers and giving them the chance to become the project engineers of tomorrow, while also improving its processes and procedures to ensure on-time delivery performance and to meet customer expectations accurately.
ABB’s approach to project management has changed profoundly over the past five years. Stephen Trotter, General Manager of ABB’s power systems projects division, outlines some of the initiatives that are helping the company to deliver first-class projects.

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The key driver behind these changes was the recognition that, while ABB has a long-established track record in the successful delivery of a wide variety of projects, there were times when we fell short of customer expectations. This was especially true when project quality and delivery schedules were eroded by inefficiencies on both sides, most often caused by difficulties in communication, definition of scope and a lack of consistency. So we have worked hard to put in place the right processes, resources and people to ensure that all our efforts are focused on understanding what customers need, meeting their expectations and knowing how they define success.

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Possibly the greatest process change so far has been greater emphasis on our on-time delivery performance. We recognise the cost of poor delivery, and measures have been put in place to record and identify problems and implement improvements. We have also introduced improved document control procedures.

The project managers provide a direct link between ABB and its customers. The customer is encouraged to develop a good understanding with their counterparts on the customer side – planner talking to planner, engineer talking to engineer, and so on. This deep relationship enables us to understand problems and to find the best answers. Indeed, an increasing number of customers now actively come to us asking for solutions, so that we can help them well before an issue escalates into a problem.

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In essence, our new approach to project management is aimed at increasing customer satisfaction by providing a framework for constant two-way communication, making the whole project process transparent so that ABB and its customers understand and respect each other’s expectations. Or in other words, it helps ABB to deliver operational excellence.
Andy Osiecki outlines how ABB’s unique automated factory acceptance test system is taking quality assurance procedures for NICAP bay solutions to a new level.

NICAP put to the ultimate test

For many of our latest high-voltage substation projects – including new-build, modifications, extensions and refurbishment – we are adopting a bay solution for the substation protection and automation systems based on National Grid’s standardised NICAP (National scheme for Integrated Control And Protection) philosophy. This approach, based on pre-engineered, pre-tested and pre-approved equipment offers a number of important customer advantages. For example, we can condense the same functionality into a much smaller footprint, reduce the amount of expensive on-site work and achieve major reductions in the delivery time for this element of the project.

However, the high level of factory testing inherent in the NICAP approach does call for an even greater emphasis on quality assurance procedures. In particular, we need to provide a full audit trail that demonstrates that the factory-assembled equipment will function exactly as it has been designed to.

FAT

The traditional method of conducting a FAT (Factor Acceptance Test) on bay control and protection equipment would be to hook up the IEDs (Intelligent Electronic Devices) and relays to a network of switches, relays and lamps selected to simulate the substation plant. We felt that this approach, which relies heavily on manual switching and recording of results, no longer offers the level of rigour and repeatability appropriate for NICAP. So we developed our own dedicated, fully automated, computer-controlled test installation, or System Verification Simulator (SVS).

The SVS at our Stone engineering facilities is based on a high-spec PC running a Citect SCADA software package with USB serial controlled I/O devices linked to ABB’s own engineered modules that simulate the behaviour of substation plant such as circuit breakers, disconnectors and earthing switches. In effect, we are now able to duplicate the whole substation within the laboratory, and can run automated, self-monitoring test sequences to establish that the substation interacts correctly with the NICAP panels. Over a period of time we have built up a library of test routines to cover all potential situations.

REPEATABILITY

The real beauty of this unique facility is its repeatability. It responds just like the real plant, without human intervention to flick test switches and so on. And because the tests are automated, we have been able to uncover some aspects of the equipment’s behaviour, such as timing issues, that could not be picked up by manual testing.

The automated FAT provides us with a complete record of all the tests carried out and, on satisfactory completion, we can issue the NICAP panels with certification for delivery to site. Should there be any future queries about the way the equipment has functioned in practice, we can easily repeat the tests to check the exact circumstances. And, if necessary, the test plan will be updated to cover it for future FATs.

The facility at Stone has already proved invaluable for our WCML (West Coast Main Line) substation projects – recently the laboratory was filled with over 10 square metres of panels! And, as NICAP is set to grow in importance with both National Grid and DNOs (Distribution Network Operators), the automated FAT will become even busier.

A £130 million ABB contract with Statoil is the first in the world to bring power from the mainland to an offshore platform using HVDC Light technology. It offers cost and space savings, as well as environmental advantages.

Offshore power comes from the mainland

The Troll A pre-compression programme, run by production operator Statoil, has just been completed. The total project, which cost around £259 million, is part of a long-term plan to expand the capacity of the platform that supplies some 40 per cent of Norway’s total gas output and is a major source of supply to continental Europe.

The Troll gas development consists of a processing plant at Kollsnes, north of Bergen, and the Troll A platform some 70km offshore in the North Sea. This platform is the only installation on the Norwegian continental shelf powered by electricity transmitted from the mainland. Troll A, which is the tallest moveable structure ever built, started production in 1996. In 2002 a programme was begun to expand the compressor capability on the platform, raising processing from 85 million cubic metres to 100 million cubic metres per day. As wellhead pressure declines, further investment will be necessary. Two more phases are likely in 2010 and 2024.

The pre-compression installation contract with ABB includes the HVDC Light connection plus two 40MW compressors with certification for offshore delivery. It was completed over a period of last quarter of 2005.

According to Asmund Madland of ABB, Oslo, “Transmitting high voltage electricity as alternating current (AC) becomes impractical beyond 50km or so with power above a few tens of megawatts.”

“Conventional high voltage direct current (HVDC) systems have also been considered. These are well established on shore as conventional load-commutated transmission systems, but the size and weight of a typical HVDC station and the complexity of control during start-up have prohibited their use on offshore platforms.”

Over the past ten years, ABB has developed an alternative solution for high voltage transmission known as HVDC Light, based on state-of-the-art solid state power transmission technology. The main attractions of the system have already been demonstrated in several commercial onshore applications – namely good controllability, low maintenance, high efficiency and long lifetime in installations ranging from 40MW to 590MW.

Other characteristics make HVDC Light particularly suitable for offshore applications – notably that the equipment is relatively compact and lightweight and there is no physical limit on transmission distance. A new generation of subsea power cables is making underwater connections from the shore a more attractive option for economy and installation flexibility. ABB has an extruded polymer DC cable, which is highly reliable, cost-effective and flexible, and an important part of the HVDC Light concept.

Most critically, with HVDC Light the voltage variation in the cable is small, and the DC-AC inverter at the platform receiving end is able to compensate for this small variation so that AC voltage is effectively constant.

In February 2005, the two HVDC Light systems were successfully commissioned and tested ready for scheduled start-up of the Troll A gas pre-compression project in the last quarter of 2005.
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However, the high level of factory testing inherent in the NICAP approach does call for an even greater emphasis on quality assurance procedures. In particular, we need to provide a full audit trail that demonstrates that the factory-assembled equipment will function exactly as it has been designed to.

The automated FAT provides us with a complete record of all the tests carried out and, on satisfactory performance, we can issue the NICAP panels with certification for delivery to site. Should there be any future queries about the way the equipment has functioned in practice, we can easily repeat the tests to check the exact circumstances. And, if necessary, the test plan will be updated to cover it for future FATs.

The real beauty of this unique facility is its repeatability. It responds just like the real plant, without human intervention to flick test switches and so on. And because the tests are automated, we have been able to uncover aspects of the equipment’s behaviour, such as timing issues, that could not be picked up by manual testing.

LAND-GENERATED POWER SAVES MONEY, SPACE AND THE ENVIRONMENT

The decision to take power from the mainland rather than install generators on the platform was taken for economic and environmental reasons.

Conventional platform-based generation, with gas turbines or diesel generators, usually achieves just 25 per cent efficiency compared with land-based combined-cycle generation of 75–80 per cent. On-platform power generation produces large amounts of CO₂. In the case of Troll A it would amount to an estimated 230,000 tons of CO₂ and 230,000 tons of NOx, and potentially substantial climate tax liabilities.

According to Arnud Madland of ABB, Oslo, “Transmitting high voltage electricity as alternating current (AC) becomes impractical beyond 50km or so with power above a few tens of megawatts.”

“Conventional high voltage direct current (HVDC) systems have also been considered. These are well established on shore as conventional load-commutated transmission systems, but the size and weight of a typical HVDC station and the complexity of control during start-up have prohibited their use on offshore platforms.”

Over the past eight years, ABB has developed an alternative solution for high voltage transmission known as HVDC Light, based on state-of-the-art solid state power transmission technology. The main attractions of the system have already been demonstrated in several commercial onshore applications – namely good controllability, low maintenance, high efficiency and long lifetime in installations ranging from 40MW to 530MW.

Other characteristics make HVDC Light particularly suitable for offshore applications – notably that the equipment is relatively compact and lightweight and there is no physical limit on transmission distance.

A new generation of subsea power cables is making underwater connections from the shore to a more attractive option for economy and installation flexibility. ABB has an extruded polymer DC cable, which is highly reliable, cost-effective and flexible, and an important part of the HVDC Light concept.

Most critically, with HVDC Light the voltage variation in the cable is smaller, and the DC-AC inverter at the platform receiving end is able to compensate for this small variation so that AC voltage is effectively constant.

In February 2005, the two HVDC Light systems were successfully commissioned and tested ready for scheduled start-up of the Troll A gas precoring project in the last quarter of 2005.

A £130 million ABB contract with Statoil is the first in the world to bring power from the mainland to an offshore platform using HVDC Light technology. It offers cost and space savings, as well as environmental advantages.

Offshore power comes from the mainland

The Troll A pre-compression programme, run by production operator Statoil, has just been completed. The total project, which cost around £268 million, is part of a long-term plan to expand the capacity of the platform that supplies some 40 per cent of Norway’s total gas output and is a major source of supply to continental Europe.

The Troll gas development consists of a processing plant at Kollnes, north of Bergen, and the Troll A platform some 70km offshore in the North Sea. This platform is the only installation on the Norwegian continental shelf powered by electricity transmitted from the mainland. Troll A, which is the tallest moveable structure ever built, started production in 1996. In 2002 a programme was begun to expand the compressor capability on the platform, raising processing from 85 million cubic metres to 100 million cubic metres per day. As wellhead pressure declines, further investment will be necessary. Two more phases are likely in 2010 and 2024.

The pre-compression installation contract with ABB includes the HVDC Light connection plus two 40MW compressors with associated utilities located on the platform.

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The automated FAT provides us with a complete record of all the tests carried out and, on satisfactory completion, we can issue the NICAP panels with certification for delivery to site. Should there be any future queries about the way the equipment has functioned in practice, we can easily repeat the tests to check the exact circumstances. And, if necessary, the test plan will be updated to cover it for future FATs.

The facility at Stone has already proved invaluable for our WCML (West Coast Main Line) substation projects – recently the laboratory was filled with over 10 square metres of panel. And, as NICAP is set to grow in importance with both National Grid and DNOs (Distribution Network Operators), the automated FAT will become even busier.

Andy Osiecki and Natarajan Jayakumar carry out a NICAP test
Transformer oil sampling

As a blood test provides a doctor with a wealth of information about the health of a patient, a sample of transformer oil, taken correctly, can tell service engineers a great deal about the condition of a transformer.

Oil is used both to cool the transformer and to insulate internal components. Because it bathes every internal component, the oil contains a great deal of diagnostic information. So a laboratory analysis of a sample can provide advance warning of developing conditions such as transformer aging.

The best information is obtained by viewing trends. So it is useful to take a benchmark sample when a transformer is first energised, or when an oil treatment is performed, and to take further samples at regular intervals so that any variation in quality can be identified to indicate developing faults.

Typical tests carried out during the laboratory analysis of an oil sample include:

- Breakdown voltage (dielectric strength)
- Moisture content
- Dissolved gas analysis
- Oxidation
- Debris content
- Voltage ageing
- Allowing microanalytical technique
- Electrical conductivity
- Soluble solids content
- Dielectric losses
- Oil color
- Foaming properties
- Fouling tendency
- Free acidity
- Particulate content
- Insulation resistance
- Bearing quality
- Chain oiling
- Filtration rate

ABB’s dedicated HV test van carries a variety of sophisticated equipment for the fastest possible location and repair of faults in underground cables up to 11kV.

HV cable faults are inevitable, although quite rare, and are caused mainly by moisture ingress into damaged small third-party cables or cable joints. They can cause a protective device, such as a circuit breaker or switch-fuse, to operate with a consequent loss of supply. ABB’s service team will identify the faulty circuit by ERI (early fault indicator) operation, and switching and/or pressure testing, and restore the supply where possible. If temporary generators are needed, ABB has direct access to a supplier.

Once identified, the fault needs to be located and repaired as fast as possible. This is achieved using the dedicated ABB HV test van. Faults are generally either earth faults or open circuit faults, and can be permanent or intermittent.

Permanent faults are located using a combination of pulse echo, impulse current and capacitor discharge devices to provide a precise location. Excavation and jointing is then carried out to restore the network.

Intermittent faults can be made permanent by ’fault burning equipment’ that uses high current, but low voltage, to accelerate the degradation. The fault can then be located as normal.

The global IEC 61850 standard for communication in substations is set to bring open, interoperable systems and flexible architectures to substation automation applications.

As well as taking a leading role in drawing up the standard, ABB has developed a new common range of products that fully embrace IEC 61850, rather than simply upgrading older platforms. In creating this new 670 Series of protection, control and monitoring IEDs, ABB has adopted an evolutionary path that builds on its many decades of protection experience. So customers will be reassured to find that the protection and control algorithms, as well as parts of the hardware platform, have been carried over from the successful 500 Series – with over 40,000 units installed worldwide.

Currently, the 670 Series covers the following products:

- Line distance protection IED REL670
- Line differential protection IED RED670
- Transformer protection IED RET670
- Bus control IED REC670.

Each IED (Intelligent Electronic Device) is delivered ready-to-use, pre-configured and type-tested for different type of applications. This makes them easy to use, from selection to operation and maintenance. There are also three or four different option packages available for each product, enabling them to be easily adapted to meet specific customer requirements. The existing 500 Series of transmission and distribution products can also be used in 61850 data bases with corresponding protocol converters. This ensures seamless upgrades to the new standard as far as connectivity is concerned.

In addition to the 670 Series, ABB has released a number of other products that comply with IEC 61850, including: IEB 500 busbar protection V7.3; PCM 600 tool for the 670 Series; MicroSCADA Pro substation and network control products.

Each and every product, system component, application and tool is tested in a real-life system environment to prove its appropriate working and performance – functionally and interactively. Certain products have also been certified by independent agencies such as KEMA.

ABB has established a System Verification Centre to verify the correct implementation of IEC 61850 throughout its portfolio.
Transformer oil sampling

Just as a blood test provides a doctor with a wealth of information about the health of a patient, a sample of transformer oil, taken correctly, can tell service engineers a great deal about the condition of a transformer.

Oil is used both to cool the transformer and to insulate internal components. Because it bathes every internal component, the oil contains a great deal of diagnostic information. So a laboratory analysis of a sample can provide advance warning of developing conditions such as tapchanger arcing. However, the information generated from the oil analysis is only as good as the sample.

A key to good oil analysis is to take a sample while the oil is warm, and measuring the temperature so that the laboratory can then adjust the results for moisture content; pre-flushing the sample bag and running the oil quietly into a clean glass vessel to minimise degassing; and sealing the sample securely.

The best information is obtained by viewing trends. So it is useful to take a benchmark sample when a transformer is first energised, or when an oil treatment is performed, and to take further samples at regular intervals so that any variation in quality can be identified to indicate developing faults.

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- Dissolved gas analysis
- Oxidation.

The global IEC 61850 standard for communication in substations is set to bring open, interoperable systems and flexible architectures to substation automation applications.

ABB’s new 670 Series substation automation products conform to IEC 61850

As well as taking a leading role in drawing up the standard, ABB has developed a new common range of products that fully embrace IEC 61850, rather than simply upgrading older platforms. In creating this new 670 Series of protection, control and monitoring IEDs, ABB has adopted an evolutionary path that builds on its many decades of protection experience. So customers will be reassured to find that the protection and control algorithms, as well as parts of the hardware platform, have been carried over from the successful 500 Series – with over 40,000 units installed worldwide.

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As well as protection, each IED contains a powerful monitor to ensure the health of the circuit under control. It continuously monitors the circuit to ensure it is performing as it should. In the event of a fault or a problem, the IED automatically collects all available information and sends it directly to a control centre or the local engineer for analysis. Each and every product, system component, application and tool is tested in a real-life system environment to prove its appropriate working and performance – functionally and interactively. Certain products have also been certified by independent agencies such as KEMA.

Finding cable faults fast

ABB’s dedicated HV test van carries a variety of sophisticated equipment for the fastest possible location and repair of faults in underground cables up to 11kV.

HV cable faults are inevitable, although quite rare, and are caused mainly by moisture ingress into damaged small third-party cables or cable joints. They can cause a protection device, such as a circuit breaker or switch-fuse, to operate with a consequent loss of supply.

ABB’s team will identify the faulty circuit by EFI (earth fault indicator) operation, and switching and/or pressure testing, and restore the supply where possible. If temporary generators are needed, ABB has direct access to a supplier.

Once identified, the fault needs to be located and repaired as fast as possible. This is achieved using the dedicated ABB HV test van. Faults are generally either earth faults or open circuit faults, and can be permanent or intermittent.

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ABB’s 36kV XLPE cable will interconnect the wind turbines at Burbo Bank offshore wind farm and transport 90MW of power 6.5km to shore.

Offshore wind farm banks on ABB submarine cable

ABB has been awarded a multi-million pound contract by SeaScape Energy Limited to supply all the submarine cables for the 90MW Burbo Bank offshore wind farm project in Liverpool Bay. SeaScape Energy, which is jointly owned by Elsam IAS (Denmark) and EDF Energies Nouvelle (France), will begin construction in Spring 2006 on behalf of the owner and operator enXco.

ABB will deliver 40km of XLPE (cross-linked polyethylene) armoured 36kV three-core AC cable, with integrated optical fibre for remote monitoring and control. The cable will interconnect 25 3.6MW wind turbines on Burbo Bank, in Liverpool Bay at the entrance of the River Mersey, and transport the power 6.5km to shore. The wind farm is expected to produce some 315GWh per year, enough electricity for around 75,000 homes.

The XLPE cable will be manufactured at ABB’s specialised high voltage cable production facility in Karlskrona, Sweden. An ABB installation team will carry out the termination and testing work on each turbine. The project is expected to be completed towards the end of 2007.

For further information about any of these subjects please visit www.abb.com/ffwd or contact us as follows:

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ABB is a leading supplier of efficient, high quality cable systems with polymeric insulation at all voltage levels. Advantages of ABB XLPE cable include:

- maintenance-free
- low electrical losses
- environmentally friendly
- meets international standards
- state-of-the-art manufacturing facilities in Sweden
- choice of traditional lead or laminate foil coating
- ranges designed specifically for UK market
- cable design service enables ABB to provide the ideal solution to meet a customer’s needs for length and load, etc
- complete range of accessories, including sealing ends and joints.

XLPE cable facts

The wind farm will be 65km off shore