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

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# Powering the Gautrain express

An overview of ABB's contract to design, supply, install, test, commission and provide documentation for electrical substations providing power to the Gautrain Rapid Rail Link

The ABB logo is located in the bottom right corner of the page. It consists of the letters 'ABB' in a bold, red, sans-serif font. The letters are stacked vertically, with the top 'A' and 'B' being larger than the bottom 'B'. The logo is set against a white background.

# ABB powers the Gautrain express

Equipment and know-how critical in contract win.



The contract to design, supply, install, test, commission and provide documentation for electrical substations providing power to the Gautrain Rapid Rail Link was awarded to ABB South Africa in December 2006. Elias Maponga, ABB Project Engineer Power Systems and Substations, and Ferdinand de Bruyn, Project Manager, Power Systems Division, provide an overview of ABB's role.

## Power systems

The Gautrain Rapid Rail Link was initiated by the Gauteng provincial government. After the tendering process, the consortium selected to execute the project was Bombela, consisting of Bombardier, Bouygues Travaux Publics, Murray & Roberts SA and Strategic Partners Group. The overall contract value is more than US\$3-billion, including a 15-year maintenance and operating contract. The ABB contract with Bombardier ends in February 2010 while the overall project is scheduled to be completed nine months later in November 2011.

The 80km system has two main routes – a north-south line from Hatfield in Pretoria to Marlboro in Johannesburg and an east-west line that travels via Marlboro from Park Station in the Johannesburg CBD to OR Tambo International Airport.

ABB South Africa is responsible for the provision and commissioning of six substations: the main propulsion substation (MPS) and five autotransformer paralleling substations (APS). A feature of the contract is the need for high reliability and system redundancy and the use of locally manufactured components wherever possible. The availability specification is 99.99%

The MPS is situated near Allandale, off the N1 highway. It has four transformers rated at 40/24MVA, which will transform incoming alternating current from two Eskom 88kV

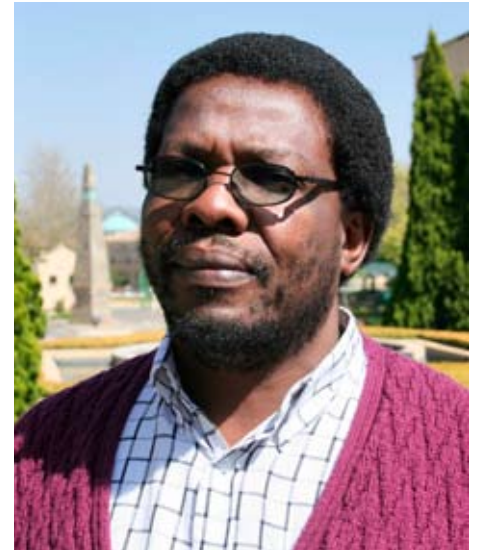
feeders to a nominal voltage of 55/27.5kV to propel the Gautrain.

To offer the high redundancy required by the design, only two of the transformers are required to be in service under normal operating conditions. Each of the two operating transformers will supply traction power for one side of the phase break. Manufactured locally by Powertech, the transformers reduce the 88kV incoming current to 27.5kV, which, as they are single phase, is somewhat unusual but fairly often required for railway systems.

The neutral of each transformer is connected to a common point via a neutral support structure, with a further connection going to the catenary – a system of overhead lines used to transmit the 27.5kV electrical energy required to propel the Gautrain at speeds of between 160 and 180km/h.

All five of the auto paralleling substations have been designed specifically to secure power supply from the MPS and are located at intervals along the railway line. They receive alternating current from the 55kV side of the MPS and the power is then delivered to the Gautrain units via the overhead contact wire.

The voltage conversion from 55kV to 27.5kV by the 5MVA autotransformers is connected to the overhead contact distribution system (OCDS), the power distribution cables and the running rails.



Elias Maponga, Project Engineer Power Systems and Substations.

The five APS points are within passenger stations or along the wayside of the Gautrain route. The APS stations are referred to as Marlboro, Rhodesfield (OR Tambo Airport), Samrand/Centurion, Pretoria/Hatfield and Pretoria.

The system works in the following way: a current collection device on the Gautrain presses against the underside of the lowest wire of the overhead line system, known as a contact wire. As the current collectors are electrically conductive, they allow current to flow through to the transformer of the train and back to the feeder station through the steel wheels and the running rails of the track.

The control panels for the substations – all housed in brick and mortar enclosures – were manufactured by the ABB South Africa Midrand factory and include protection equipment and systems as well as battery back-up as an integral part of the high redundancy requirement.

A dual mains protection system also contributes to the very high redundancy requirement. If one of the systems fails, the other takes over within 70 milliseconds to ensure continuation of supply and exceptional safety levels, regarded as a critical factor across the entire electrical supply system.

The autotransformer paralleling substations, being smaller, were installed in portable modules and thus can be moved as required. The 5MVA



Courtesy of Gautrain



Ferdinand de Bruyn, Project Manager, Power Systems Division.

transformers for the APS substations were supplied by ABB Finland. Circuit breakers were sourced from ABB Sweden and Switzerland and the isolators came from ABB India. The busbars, clamps, general cabling and power cabling were sourced locally.

Strict compliance parameters have been applied to the contract and the MPS and all the APS substations have been designed in such a way that they will comply with all requirements of SABS and IEC standards.

Environmental considerations have also been taken into account. All the APS equipment is able to withstand exposure to pollutants, including ozone, sulphur dioxide, hydrocarbons, oxides of nitrogen, salt, sand and airborne particulates. All the equipment also has to be suitable for deployment in Gauteng where the average altitude is 1 600 metres above sea level; and comply with the seismic conditions of the province (zone 6 on the Mercalli Scale).

Weather is also a factor, so the equipment is suitable for temperatures ranging from a minimum of -5°C and maximum (under shade) of 35°C. Substations and their equipment are protected against lightning activity – the Isokeronic (recording of lightning activity) strike level being 5.75 strikes per square kilometre a year.

The scope of ABB supply therefore included lightning arrestors and 12m high lightning masts.

To meet the electromagnetic interference compliance requirement, the system is designed to be immune to the electromagnetic environment associated with the intended service conditions. Also, it will in itself not contribute to interference conditions through excessive self-generated, conducted or radiated emissions.

Phase 1 of the Gautrain project includes stations at Sandton, Marlboro, Midrand, Rhodesfield

and OR Tambo International Airport. Phase 2 extends the system from Sandton to Rosebank and Park Station in Johannesburg and then from Midrand to Centurion, Pretoria and Hatfield to complete the 80km network.

The railway is being laid to standard 1.435mm gauge using continuously welded rail and concrete sleepers. In the tunnels, concrete slab track or sleepers laid into a concrete bed will be used. The rails will be elastically supported throughout to reduce noise and sound levels, even at the maximum 160–180km/h operation.

There will be a triangular junction at Marlboro, with the station located at the southeast point. Trains serving Johannesburg International Airport from the north will be able to bypass Marlboro station, while trains travelling east-west, west-east and south-north from Park Station to Hatfield will all be able to stop at Marlboro.

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