



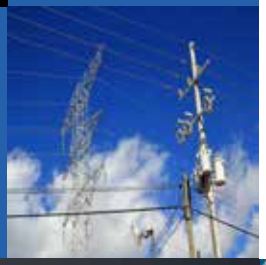

City Power
Johannesburg






Design and construction of the 1400 MVA Sebenza substation for City Power of Johannesburg from PSW Nyeleti JV

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EXECUTIVE SUMMARY

"Sebenza has unlocked industrial, commercial and residential development in the Eastern sector of Johannesburg both increasing employment and supporting economic growth"

Sebenza Substation (Sebenza) is a 1400 MVA 400/275/88 kV infeed transmission substation at the heart of the City Power of Johannesburg's (City Power) network.

Sebenza replaced Kelvin substation in supplying a large portion (eastern third) of the City of Johannesburg via a bulk power line corridor consisting of 16 power line circuits.

Sebenza has the equivalent capacity to supply an estimated, 700 000 households. It has unlocked industrial, commercial and residential development in the Eastern sector of Johannesburg both increasing employment and supporting economic growth.

The project team successfully constructed and incorporated Sebenza into the City Power network whilst maintaining supply to existing customers, catering for the additional load growth during the project and keeping within City Power's allocated budget.

This included the transfer of 2 x 275 kV and 16 x 88 kV existing power lines whilst catering for the restrictions and limitations presented by the existing Eskom and City Power network.

Despite multiple engineering and management challenges, the project team succeeded in completing the project within the original contract value, in time and with a standard of quality that met the Client's requirements.

A large portion (eastern third) of the City of Johannesburg has for many years been supplied with bulk electrical power at 88 kV from the Kelvin Power Station (Kelvin), via a bulk power line corridor consisting of 16 power line circuits.

Over the years the load has grown to the present ± 450 MVA. Kelvin currently has the capacity to generate 300 MVA into the City Power network.

To meet the increasing demand and load growth, the 300 MVA capacity at Kelvin was supplemented by the existing Prospect bulk infeed substation located in the far south-east of Johannesburg via a double circuit 88 kV transmission line, constructed during the mid-1960's.

Kelvin is an old power station and the generation is greatly dependent on the performance of their aging generation fleet.

Over the years, this dependency resulted in constraints on the available generation and sporadic over loading of the available transformer capacity at Prospect. As a major infeed substation to the city, the overloading at Prospect places the electrical supply to the whole City of Johannesburg at risk.

The integration of the planned new Modderfontein development into the Johannesburg Metro, with a forecasted ultimate load of ± 450 MVA, would also increase the demand on the City Power network considerably. The need for the urgent development of an additional bulk infeed point from Eskom, in close proximity to Kelvin was identified in the City Power Electrical Masterplan of 2005.

INTRODUCTION AND BACKGROUND

Eskom also came onboard, incorporating Sebenza substation into their Joburg East strengthening project, adding various requirements of their own.

In brief, Eskom needed a 12 bay, 400 kV, double bus-bar transmission station to cater for their long-term planning. Whilst City Power similarly identified the need for a 1000 MVA, 132 kV, double bus-bar substation with a minimum of 22 outgoing circuits to cater for future needs.

In addition, Kelvin, in terms of their PPA with City Power, were contracted to supply 450 MVA generated power in an N-1 configuration to the City via the new Sebenza substation with the option to upgrade to two 250 MVA supplies in the future.








PSW Consulting Engineers (PSW), as a strategic partner of City Power of Johannesburg (City Power), was appointed in 2007, to conduct a feasibility study on the optimal positioning for such a new infeed substation.

Several alternative positions and substation configurations were considered during this study, such as physical position, traditional outdoor layout versus compact configurations, as well as full indoor alternatives.

Through a thorough investigation of the area surrounding the existing Kelvin substation PSW identified a few sites with sufficient vacant land to house the substation and associated equipment.

A traditional outdoor transmission substation meeting all the above stated requirements amounts to an estimated 10 to 11 hectares of land.

However, the only location identified by PSW. that was in close proximity to both Kelvin power station and the existing 88 kV power line corridor (which consisted of 16 existing circuits), was limited to only 5.8 hectares. This resulted in an area 50% less than what is usually available for a substation of this magnitude.

To accommodate the reduced land area the PSW design engineers had to utilise their 40+ years of experience to produce a solution that met all the Client's and stakeholder's requirements, was implementable, of a high quality standard and as compact as possible.

"The most critical engineering challenge of the Sebenza project was to balance and integrate the needs of all the related parties"

Once the recommendations from the feasibility study was accepted, PSW Nyeleti JV were appointed as the consultants on the Sebenza substation project and were required to take responsibility for the full project delivery process.

The most critical engineering challenge of the Sebenza project was to balance and integrate the needs of all the related parties into a single bulk infeed substation, on a relatively small site and at a reasonable cost.

Another major challenge was to plan the construction and incorporation of the new Sebenza substation into the City Power network whilst maintaining full supply to existing customers, catering for the additional load growth during the project and keeping within City Power's allocated budget.

"Kelvin currently has the capacity to generate 300 MVA into the City Power network.."








DETAILED ENGINEERING REQUIREMENTS, DESIGN CHALLENGES AND SOLUTIONS

During the detailed design stage, the following requirements and specifications with reference to Eskom, City Power and the existing Kelvin Power station were established by PSW consulting engineers.

As the appointed design engineers, PSW was fully responsible for providing a design solution and specification which catered for the short, medium and long term needs of the Client as well as the various stakeholders.

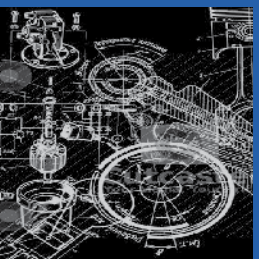
PSW had to utilise the information gathered when they compiled City Power's 20 year transmission masterplan for the area, to design Sebenza in such a way that it would seamlessly integrate into City Power's existing network while catering for their medium and long term network expansions. The design also needed to keep within limitations presented by the size of available land and the capability of available equipment.

Eskom Primary Requirements

Eskom confirmed their requirements for a total of 12 x 400 kV switch bays to cater for four incoming circuits (two from Northrand DS and two from Jupiter substations), for two outgoing circuits (One to Delta and One spare), four transformer circuits to City Power and space for two future generator circuits from Kelvin.

Due to the limited area, Eskom agreed with PSW's proposal that a 'breaker-and-half 'fully outdoor scheme could be adopted to achieve the most compact design layout for the required 400 kV double bus-bar switchyard. Although the yard had to be designed and constructed at 400 kV to cater for Eskom's future needs, the substation would be operated at 275 kV for the short to medium term. The masterplan layout of Sebenza substation is available separately.

Budget constraints at Eskom delayed the project going ahead on the Eskom side. However, in order to meet their load growth and maintain network stability, City Power could not delay the project until Eskom could carry out their portion of the work.

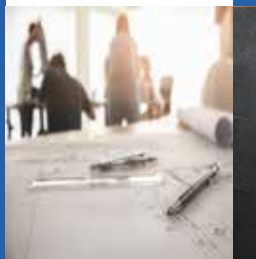


In a process led by PSW consulting engineers, Eskom approved City Power's application to 'Self Build' a major component of the 400 kV switch yard as an integral part of the overall substation project and agreed that the associated cost would be recovered through future connection fees payable to Eskom.

Sebenza thus became the first Eskom Transmission self-built project in the country.

Whilst the short to medium term 275 kV fault levels were limited to 31 kA, Eskom confirmed that the longer term 400 kV fault levels were expected to rise to 45 kA.

In keeping with this the entire 400 kV yard was designed and constructed, in close consultation with the Eskom engineers, to cater for a fault capacity of 60 kA. The Sebenza substation designs were completed, in compliance with all relevant Eskom designs, specifications and approvals. Only Eskom approved suppliers of equipment were utilised for the Eskom 400 kV yard.



City Power Primary Requirements

City Power confirmed the requirement for the substation design to provide for 4 x 315 MVA, 275/88 kV power transformers, fully controllable by City Power themselves, for their short to medium term needs, to ensure the required 1000 MVA capacity under the N-1 configuration.

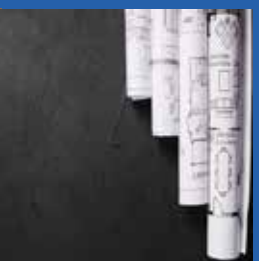
It was decided that only three of the final four transformers would be installed during the first phase of the substation development, as shown in Figure 6 and Figure 7 below. Should Eskom upgrade to 400 kV in future, the upgrading of the transformers to 400 kV would be at the cost of Eskom.

However, the transformer enclosures have been designed and constructed to cater for this future upgrading of the transformers to 400 kV.

During the early design phase, it became clear that Eskom was experiencing financial constraints, resulting in a substantial delay in their planned bulk supplies to Sebenza.

Due to City Power's critical need to relieve the Prospect substation transformers of the Kelvin related load, City Power needed to adjust their plans to exclude the planned Eskom bulk supplies at Sebenza.

Although the existing transmission line between Prospect and Kelvin was rated for 275 kV, it was being operated at 88 kV by City Power.



It was concluded that upgrading the supply from 88 kV to 275 kV would greatly relieve the strain on Prospect and provide much sought after stability to the City Power network.

Designs were put into place to extend the Prospect 275 kV switchyard south wards by two additional 275 kV switch-bays, to allow for transfer of the two existing Eskom incoming feeders to this southern extension, and thereafter transfer of the two Kelvin transmission line feeders at Prospect from the present 88 kV bus-bar to the 275 kV bus-bar.

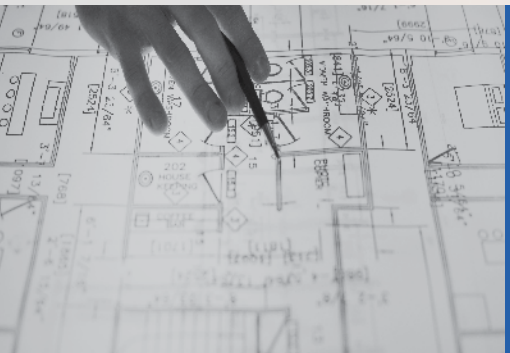
The Prospect substation 275kV bus-bar extension and line transfer was then integrated into the original design and tender documentation for the Sebenza project.

DETAILED ENGINEERING REQUIREMENTS, DESIGN CHALLENGES AND SOLUTIONS

Although, City Power is presently in the process of upgrading the existing 16 outgoing 88 kV overhead line circuits to the city from 100 MVA to 200 MVA capacity, by means of new technology high temperature overhead line conductors. The need to increase the number of outgoing circuits from the new Sebenza substation, from the existing 16 to 22, was identified.

This catered for the four new circuits to the new Modderfontein development and two additional spare feeders for future long term expansion.

City Power's requirement for Kelvin Power, to maintain the capability of 450 MVA supply to City Power in a N-1 configuration, necessitated four additional 150 MVA interconnector feeders between Sebenza and the existing Kelvin 88 kV switchyard.



This implied that the designed N-1 safe capacity of Sebenza increased to 1400 MVA, making Sebenza substation one of the largest metropolitan bulk supply in-feed transmission substations in Africa.

With the required four bus-bar configuration of the new Sebenza 132 kV bus-bar, the four associated bus-coupler and bus-section circuit breakers, as well as the required four switch-bays for final power factor correction, the number of 132 kV switch-bays for the substation summates to a total of 38.

This requirement could not be accommodated in a traditional outdoor configuration on the limited area available for this substation, resulting in the selection of compact, double bus-bar, SF-6 Gas Insulated Switchgear (GIS) for the project design, as shown Figures 8-10 below. This in turn resulted in Sebenza substation housing the largest 132 kV GIS switch-board in the Southern hemisphere to date.

In view of the expected long term 400 kV Eskom fault levels discussed above and the present limitation of 40 kA on available 132 kV GIS switchgear technology, the impedance of the four power transformers had to be designed accordingly to ensure that these limits are maintained both in the short as well as the long term.

In addition, the fault level of the old Kelvin Power station 88 kV switch-yard (constructed in approximately 1955), now to be interconnected to the new Sebenza substation, is limited to only 16 kA.

In order to ensure that the Kelvin yard fault level is not exceeded due to this interconnection, it became essential to design and install a set of series reactors in the 4 x 150 MVA interconnectors, with suitable impedances to suit the site and operational limitations.

INTER-CONNECTING FEEDERS

With the two 275 kV, 630 MVA overhead line feeders from Prospect substation approaching Sebenza substation from the south, crossing of the 16 existing outgoing circuits in the power line corridor to the City became unavoidable.

In order to eliminate the need to turn the entire City off to establish this essential crossing, the design was adapted to allow for two 630 MVA, 275 kV, underground interconnector cable feeders over an average distance of approximately 250 m, crossing underneath these existing circuits, from a new 275 kV line-to-cable transition yard into the high voltage switch yard.

These two circuits are planned to be recovered once the main Eskom supplies are finally established.

Because of the relatively compact design of the new technology SF-6 GIS switchboard, the incoming and outgoing overhead line circuits, with their much larger electrical clearances, cannot practically be terminated directly into the switchgear.

It thus became essential to allow for the following appropriately rated 132 kV underground interconnector cable feeders between the new GIS board, the 132 kV line-to-cable transition yard and the several main substation components in the design and tender documentation.

1. 4 x 315 MVA Incoming Transformer Feeders,
2. 20 x 200 MVA Outgoing Line Feeders.
3. 4 x 150 MVA Incoming Kelvin Power Interconnector Feeders and
4. 50 MVA Power Factor Correction Bank Feeders.
5. The two feeder bays at the extreme ends of the GIS switchboard was retained in outdoor format (with outdoor pot-heads), to allow for both HV-AC testing and possible future line extensions.

With the convergence of all these relatively large capacity cable feeders into the single switch house, the risks associated with thermal independence of this large number of feeders within the ground outside the switch house had to be carefully engineered, not to put any feeder at risk in future. In addition, the marshalling of all these cable feeders in the cable basement below the switchgear was a huge engineering challenge

In addition to the transfer of the existing 275 kV double circuit Kelvin/Prospect transmission line at both Prospect as well as at Sebenza substations, all 16 of the existing 88 kV distribution lines to the City had to be transferred from the existing Kelvin switchyard into the new Sebenza Bulk Infeed substation.

For this specific reason 20 bays of 132 kV, 'line-to-cable' transition yards were also included into the project, for terminating the respective overhead distribution lines into cable circuits for continuation into the switchgear.

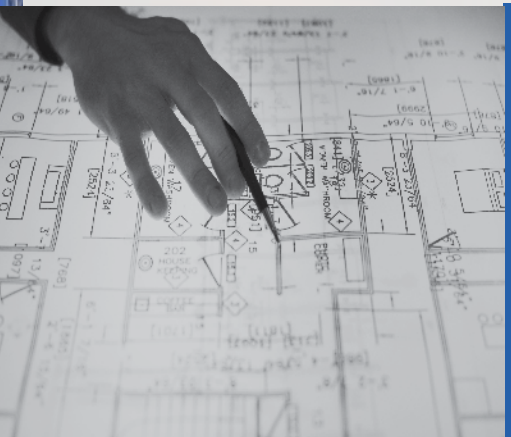
SPECIAL CIVIL CONSIDERATIONS

Due to the size of the HV yard platform and drainage of cable ducts a special subsoil drainage system needed to be designed and implemented.

Due to the size of the transformer, the abnormal load could not be accommodated by a crane, therefore a special skid concrete based needed to be designed and constructed to cater for the placement of the transformers onto the transformer plinths.

Special turning circle radii for the access road needed to be designed and implemented to cater for the access of the transformer “abnormal” delivery truck. Images are available showing one of the Sebenza transformer bays during construction.

The GIS building floor needed special civil design considerations and ingenuity to achieve the level of accuracy and tolerances required to accommodate the 38 bay GIS board discussed above.



DESIGN DOCUMENTATION, PROCUREMENT, BUDGET RESTRICTIONS AND PROJECT SAVINGS

The detailed design, drawings and associated documentation was completed by PSW and submitted to the Technical Evaluation Committee (TEC) of City Power in June 2011 for final consideration. Based on the feedback from City Power's TEC, the tender documentation was adjusted accordingly and handed over to the Supply Chain Division of City Power for tendering. In order to ensure optimal project co-ordination between the various disciplines (project management, civil and electrical) involved on the project,

As a bulk infeed substation of this magnitude, the overall cost of Sebenza substation at tender stage, was estimated at a total of R 840 million (including estimated escalation to completion).

The construction period for the project was estimated at 3 years. To tie in with the various financial responsibilities of an entity like City Power, PSW split the project into 4 workable portions to be phased over 4 financial years, with planned completion in the 2016/17 financial year.

Each phase needed to be adaptable enough to cater for ongoing network conditions and restrictions and stay in keeping with the municipal budget restrictions. After careful design and financial considerations,

PSW defined the 4 phases of the project in detail in the tender documentation for the tenderers to cost accordingly.

Tenders were publicly called for in November 2011 with closure by mid-January 2012. Four tenders were received and adjudicated, with the final contract being awarded to Consolidated Power Projects Pty (Ltd) (Conco) by May 2012, as the tenderer with the highest adjudicated score.

The land on which Sebenza substation was intended to be built belonged to Kelvin Power and needed to be purchased from them by the City of Johannesburg. Unfortunately, at the stage of handing the site over to Conco, it was discovered that the Lands & Rights Division of the City of Johannesburg, responsible for the land transaction with Kelvin on behalf of the City, had not concluded the land deal.

This resulted in the construction stage of the project being put on hold until conclusion of the land deal and the required land transfer to City Power.

The land issue resulted in a project delay of approximately two years, and the Contractor thus only obtained access to site by late September 2014, with the contractual completion date thus being extended to end October 2018.

The two year delay resulted in the final contract value escalating to an estimated R 980 million (including escalation throughout the contract to completion).

The final contract and installation was composed of the latest state of the art technology equipment from across the world, with both EHV and HV switchgear from Europe and as far as Brazil, locally manufactured power transformers from Actom Power Transformers SA, EHV and HV cables from the UK and CBi African Cables (CBi) in Vereeniging, local transmission line equipment and civil works. All project management, protection equipment and construction labour were provided by Conco, throughout.

During the above mentioned two year site access delay, CBi the EHV and HV cable supplier to the project, successfully type tested the required HV cables for both the 315 MVA transformers and the 200 MVA 132 kV outgoing feeders. The passing of CBi's cable in the type tests allowed the project team to negotiate the replacement of the imported copper conductor feeder cables from the UK, with the approved locally manufactured equivalent aluminium conductor feeder cables.

This not only resulted in a substantial reduction of the imported content and associated rate of exchange adjustment to the project saving City Power several millions of Rands, but in addition resulted in increased job opportunities to the South African people and a substantial reduction in the risk of cable theft and associated power outages.

A similar investment in local content, which also reaped the benefits discussed with the CBi cables above, was the placement of the order for the 315 MVA transformers with local manufacturers Actom Power transformers situated in Wadeville, Johannesburg.

The 315 MVA transformers manufactured for the Sebenza project were the second of its magnitude manufactured locally in the history of South Africa. A similar set of transformers were manufactured once before by Actom Power Transformers for the eThekwini municipality.

During the above mentioned two-year delay in site access, the original design engineers of the 275 kV Prospect transmission line were engaged, and it was established that the foundations of the existing 275 kV angle structure No 3 on site could not handle the mechanical loading condition under complete de-loading of one side of the structure, (i.e. removal of conductors toward Kelvin) as originally intended. PSW then amended the original planned 275 kV 'line-to-cable' transition yard, to a vertical down dropper bus-bar configuration to retain the foundation loading of the existing line structure.

Eskom also established that transferring the existing 275 kV transmission lines at Prospect Substation, would require substantial extensions and modifications to their existing OPGW communication system for which they did not allow, and thus requested City Power to integrate this extended OPGW requirement into the overall Sebenza project.

As with the rest of the project, PSW was responsible for obtaining the design approval from Eskom, co-ordination with Eskom and overall project management.

PROJECT MANAGEMENT AND CONSTRUCTION

In addition, Eskom found that their existing control room at Prospect could not accommodate the planned new protection extensions and transfer of their 275 kV feeders, and thus likewise requested City Power to extend the Sebenza project to provide a new control building for Eskom at Prospect substation at the tendered building rates.

A line audit of the existing Prospect/ Kelvin transmission line, commissioned by City Power, found that (although only operated at 88 kV) the 275 kV porcelain insulation on the lines had deteriorated since its construction in 1965.

The insulation had deteriorated to the extent that it could not safely be energized at 275 kV without risk to the City and its people. As the sole supply to a large portion of the City, this line could not be switched out for any extended period of time, especially not for the time required to replace all of the insulators.

Thus, re-insulation of this line had to be carried out under ˜live-line' conditions by specialist teams. The existing Sebenza contract was extended to include the insulation upgrade of this 275 kV double circuit line and became an integral component of the overall Sebenza project.

The delayed access to site imposed major constraints on the civil work and associated programme. It also meant that the Civil contractor would commence their civil work in the rainy season as opposed to the dry season.

The sensitivity of the building classification required a concrete roof to be installed, due to the height of the building and time constraints discussed above, a pre-fabricated concrete roof was specified and installed by means of a mobile crane. Refer to Figure 21 below for a side view of the completed GIS Building.



Despite all these engineering and management challenges, as well as the additional work required by Eskom to be integrated into the project, the project team succeeded in completing the project within the original budget.

Taking into account approved delays and force majeure circumstances, the entire project, with the inclusion of the additional work required by Eskom discussed above, was completed within the original contract period.

In addition to the above two major cost and time achievements by the project team as a whole, Conco and their sub-contractors need to be applauded, on completing this major project over a four-year period with an almost 1 000 000 man-hour major injury free record.

Finally, the dedicated team of City Power personnel, who assisted in both the overall management, as well as the final integration of the major substation into the City Power network, on both the 275 kV as well as 88 kV transmission level, protection, control and supervision, all need to be commended on their dedication and extended hours spent on the project, especially during the last few months of commissioning and handing over.

PROJECT COMPLETION

RESPONSIBILITIES AND RISKS PRESENTED BY THE PROJECT

As the appointed consultants on the Sebenza substation project, PSW Nyeleti JV were responsible for the entire project delivery process, from inception to close out.

It was the responsibility of PSW Nyeleti JV to ensure that Sebenza substation was designed and constructed in such a way as to be of beneficial use to the Client within the required time frames and allocated budget.

It was the responsibility of PSW Nyeleti JV to represent the Client, and to the best of their ability maintain the Client's respect and trust by always being alert and responsive to the Client's needs and ensuring that the project is completed successfully.

In response to this obligation PSW Nyeleti JV provided a solution and service to the Client that clearly demonstrated their high standard of care and dedication while applying their skill, knowledge and experience.

Barring inputs and approvals from the relevant technical committees at City Power and Eskom,

PSW consulting engineers were wholly responsible for the detailed design of the substation.

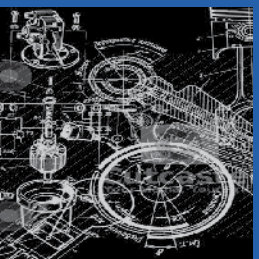
To mitigate this risk, Sebenza substation was designed in accordance with industry based best practice.

It consists of high quality equipment and material obtained through referencing and specifying client approved local and international standard specifications.

City Power's network restrictions as well as budget restrictions had a major impact on the offered design solution and subsequent project implementation. The design catered for City Power's short term, medium term, long term and future configuration and plans. Special consideration was given to existing conditions and network limitations.

The substation design, construction and commissioning needed to be seamlessly integrated into the existing network, even though the transfer and transition from 88 kV to 275 kV was a major change to the existing network.

A major risk was the availability of information. Some assumptions needed to be made during the design phase.



Should any new information be obtained at a later stage it was factored into the design or the construction as and when necessary.

One of the risks of long term projects like Sebenza, which spanned over a period of ± 45 months, is loss of key personnel.

During the critical commissioning stage of the project, PSW had to change over project managers as the designated PSW project manager immigrated to another country.

Aside from the major changes in project management within PSW, many key role players from City Power, Eskom and the main contractor changed as well. As representatives of the Client, PSW had to be responsive and adjust to the constant changes with as much flexibility and adaptability as possible.

The ultimate success of the project is owed to the good work ethic and exceptional teamwork between all major role players on the project.

The diverse project team, which consisted of seasoned engineers, young professionals, candidate engineers and technicians, project managers, facilitators and operators as well as a good ratio between males and females from various ethnic groups, assisted greatly in change management and making the project a success.

As discussed above, Sebenza substation is intended to be a 400 kV to 88 kV, however Eskom was not ready to come into the substation at 400 kV yet. Therefore, the substation was designed for 400 kV but PSW adjusted the design to allow City Power to operate it at 275 kV in the interim.

The interim design was done in such a way that the abortive costs of the interim arrangement were minimised. The interim design also allows City Power to operate the substation independently while Eskom constructs the remainder of the 400 kV yard in the future.

Allowing for a seamless switchover once Eskom bring in their own 275 kV supply and eventually 400 kV from their North Rand DS and Jupiter substations.

A major infeed transmission substation like Sebenza is designed to service load for extended periods of time i.e. the substation must remain beneficial to City Power for a minimum of 40 years. Therefore, the design lifetime of all the equipment used for the Sebenza substation varies between 40 to 50 years. However, if maintained properly the actual lifetime of the substation may be 60 years or more.

SUSTAINABILITY

The transformers 3 x 315 MVA transformers boast state of the art Digital Gas Analysers, which constantly samples the oil of the transformers and notifies City Power system control should any anomalies be detected within the transformers.

This assists the City Power operations and maintenance department greatly in ensuring that the risk of failure is limited, and the lifetime of the transformers are extended.

In the unlikely event of the transformer experiencing a catastrophic internal failure, another advance technology that is installed on the transformer is a fully integrated Sergi transformer protection system, which immediately injects liquid nitrogen into the transformer to extinguish any internal arch and cool down the oil which minimizes the chance of the transformer exploding and causing extensive damage to the public, environment and substation equipment.

To avoid potential failure of the protection system and non-operation due to loss of DC supply, Sebenza substation has a fully redundant battery system with 3 independent AC supplies to the battery charger system.

The ± 100 outdoor cable terminations boast environmentally friendly silicon oil as the form of insulation, as opposed to the traditional mineral oil based system, therefore in the unlikely event of an oil spill from the cable terminations there will be little to no impact on the surrounding environment.

Although Sebenza substation is designed for a minimum lifetime of 40 years, as discussed above, the financial lifetime is 25 years. Sebenza kicked off with a 450 MVA start-up load, which is to 32 % of its design capacity, this means that City Power would be able to recover their invested capital and loans within a 25 year period.

The Sebenza substation load is expected to reach 1000 MVA (71.5 % of its design capacity) 25 years from its commissioned date in November 2018.

The design capacity caters for the existing 450 MVA load, annual city load growth of 3 % and the addition of 450 MVA load from the development of vacant land in the Modderfontein area.

A state of the art security system protects the City's ± R 1 billion asset by providing perimeter and internal security and CCTV, assisting in ensuring safe operation of the substation without vandalism and theft.

Prevailing conditions in South Africa makes copper theft in substations, public electrical switchgear and transformers an everyday occurrence. Barring a few exceptions e.g. LV cable, all cables on the Sebenza project consists of aluminium conductor.

As far as possible the earth mat consists of copper cladded steel a special type of conductor which substantially reduces the value of the metal and likelihood of theft.

Where copper was used to earth equipment, special ducts were embedded in the equipment foundations so that the earth tails could be fully covered and remain inaccessible to thieves.

SOCIAL RESPONSIBILITY

It was always of highest priority that extended outages to the City Power customers be minimised during construction. The major challenge was that 16 existing 88 kV power lines circuits had to be disconnected and reconnected to their new positions to be supplied from Sebenza.

PSW designed, planned and managed a temporary 88 kV busbar system under the 16, 88 kV circuits "downstream" from the transition yard, to allow for the temporary supply of the affected feeders.

Thus, allowing the temporary supply of the feeders whilst they were reconnected into their final positions at the transition yard.

To prevent extensive outages in the Joburg area, each transferred circuit required detailed planning and careful consideration for the current network conditions, current network configuration, protection settings and active communication links. It was only through the great teamwork between PSW, Conco, the City Power engineers, coordinators and operators that the massive task of swinging 16 key circuits on the City Power network into Sebenza was achieved with minimal outages and network disruptions.

Due to the age of Kelvin Power station, it was initially planned that Kelvin would eventually be phased out completely. However, in recent years Kelvin Power upgraded their system to enable a generation capacity of 300 MW. Due to the current constraints on the Eskom network, Eskom and City power rely greatly on the 300 MW generation from Kelvin to supplement their supply to the City Power network.

Therefore, Sebenza substation as Kelvin Power's new infeed point to the city, assists in avoiding load shedding and keeping the lights on.The substation design, construction and commissioning needed to be seamlessly integrated into the existing network, even though the transfer and transition from 88 kV to 275 kV was a major change to the existing network.

At its full capacity Sebenza has the equivalent capacity to supply an estimated, 700 000 households. It has unlocked industrial, commercial and residential development in the Eastern sector of Johannesburg both increasing employment and supporting economic growth. This was confirmed by the mayor of Johannesburg, the Honorable Herman Mashaba at the official opening of Sebenza substation on 7 February 2019.

The opening was attended by, Lael Bethlehem the City Power chairperson, Lerato Setshedi the Managing Director of City Power and Nico de Jager the MMC Environment and Infrastructure Services for City of Johannesburg.

In an official statement to the media he stated that the project will address unemployment and contribute to the economy. He commended City Power on its great work which it achieved despite financial challenges,

It was noted on national television on Afro Worldview that, “The Sebenza substation is going to assist the City of Johannesburg with electricity outages as well as assist Eskom with load shedding”.

CONCLUSION

Aside from job creation, another major social component of the Sebenza contract was the training and upskill of the City power engineers, technicians and operators.

The relevant City Power personnel received training on the various components of the substation, its operation as well as the latest specifications of the equipment.

This report clearly demonstrates how the design and construction of the 1400 MVA Sebenza substation for City power of Johannesburg submitted by PSW Nyeleti JV, meets the 12 applicable award criteria the CESA AON awards 2019 in the category, “projects greater than R 250 million”.









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