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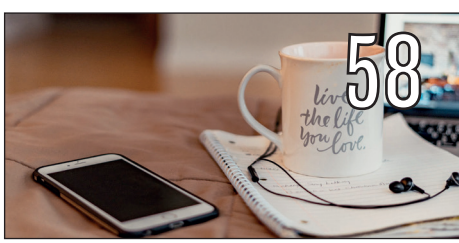

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ISSN: 1991-0452

2019 Q4 - 13 496

With the lightning season upon us in South Africa, we thought it apt to produce this lightning issue for you.

Our first feature article, "Lightning and surge protection for rooftop photovoltaic systems", informs us that well above a million PV systems are installed in Germany. Based on the fact that self-generated electricity is generally cheaper and provides a high degree of electrical independence from the grid, PV systems will become an integral part of electrical installations in the future. However, these systems are exposed to all weather conditions and must withstand them over decades. Find the article on page 40.

Our second feature article, written by Prof Gomez of Wits University, shares with us "Lightning Protection of Structures: how to do it wrong". There are several types of non-conventional lighting protection devices; the most commonly used are the early streamer emission (ESE) devices. Thus, in this article, we look into this technology with a critical eye. Find the article on page 50.

We pay tribute to a Powerhouse. It is with heartfelt sadness that we note that Dr Ian Campbell McRae died in the Linksfield Hospital on Sunday 12 July (at the age 90 years and ten months) after a short illness, which was aggravated by the COVID 19 virus. Find his eulogy on page 10.

We also showcase the essays of the 2 South African winners of the 2020 IEC Young Professional Essay Competition, Mr Mphumumuzi Khoza and Mr Tristan Kuisis. As one of their prizes, they will attend the IEC Young Professional workshop online, which takes place in Geneva from 9-13 November 2020.

The SAIEE has been very busy with webinars in the past month, and I urge you to click here to see our upcoming events/webinars or go to page 67 to find a comprehensive calendar which includes our very successful online CPD Training Courses, powered by the SAIEE Academy.

The next **watt**now Tech Talk will take place on the 22 September 2020 at 13h00. Watch out for the announcement.

This online version of wattnow is interactive. So, on the contents page, click on the page number of the article you are interested in, you will be taken directly to the page. When you are finished reading, select the endnote (wn) which will return you to the contents page.

Here's the August issue,
enjoy the read!

Minx

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Cummins AME PD&I is committed to delivering power to customers despite the Covid-19 pandemic

While most of us are working from home because of the Covid-19 pandemic, the Cummins AME PD&I team was working tirelessly to integrate a Phase 2 project of nine C3000D5E units into acoustic enclosures and testing them remotely for a key global customer

At the end of 2019, Cummins Africa Middle East (AME) was contracted by a leading provider of cloud and computing web services to supply nine C3000D5E units enclosed in customised acoustic enclosures. The Cummins team had to leverage relationships inside and outside the organisation to expedite the necessary resources to complete the project on time.

The genset packaging process inside the acoustic enclosures started early, based on the customer's strategic global requirement. In addition to the early start, the project's delivery schedule had to be reviewed to find areas where the build could be expedited to meet the customer's delivery milestones.

The project faced comprehensive design-related and implementation challenges in the previous phase. These challenges had to be addressed in Phase 2. Over three-week period, several stakeholders were involved in developing a comprehensive list based on the previous two years of operation to ensure that all design and operational deficiencies previously identified were resolved. The task was further complicated as the delivery schedule was very tight, which necessitated that the design improvements happened concurrently while the enclosures were being built.

Adding to the difficulty was the travel restrictions imposed due to the Covid-19 pandemic. In place of a more effective and easy face-to-face meetings, the AME team had to rely solely on Skype and Zoom to work with the design and factory teams at the manufacturing plant for the process of issue identification, redesign and improvement implementation. It was new and challenging for the AME team having to deal without direct contact on drawing reviews and trying to articulate problems/concepts via remote viewing, while adding to intermittent connectivity of the web.

The Project Design & Implementation (PD&I) commissioning team is always in the front line supporting customers to test, commission and deliver power on-time. The team is hard at work behind the scenes with the aim to support customers to be 'Always On'. During the pandemic, members of the commissioning team worked at the vendor's premises to test the full integration of the generator package inside the acoustic enclosure.

After completing all the internal tests, the team conducted three full days' virtual witness testing with the customer, who was based remotely. The team used three cameras to stream the test from all angles to enable the customer to witness the test. Moreover, the virtual test was video-recorded, and the video shared with the customer. The customer witness test included a 12-hour full load test, in addition to functional tests for all the other subsystems. wn

BOOYCO CONTINUES TECHNOLOGY DRIVE DESPITE COVID-19

While the Covid-19 lockdown has forced many companies serving the mining sector to downscale, Booyco Electronics is continuing to apply and develop its technologies for safer, more productive mining operations.

With its nationwide team of some 180 field technicians serving opencast and underground mines – by far the largest footprint among players in this field – the proximity detection specialist has remained hard at work. While supporting those coal mines that worked through Level 5 and Level 4, the company has also been assisting customers to ramp up to full production after the initial stoppage.

According to Booyco Electronics chief executive officer Anton Lourens, the lockdown has even given his engineering team some welcome breathing space for their technology development. With collision avoidance standards in mines becoming stricter, technology is responding rapidly.

"Our plans to grow our engineering team from 18 to over 30 experts this year remains on track, giving us added capacity to meet industry needs," says Lourens. *"Even under lockdown restrictions, this expanding team has continued its work on new features and functionality for our products."*

The move to the Level 4 lockdown allowed opencast operations to resume and underground mines to move to 50% production. Booyco Electronics was on hand to assist with the required pre-start inspections and equipment checks, which then accelerated with the relaxation to Level 3.

"While the lockdown restrictions were disruptive to everyone, we have learnt valuable lessons and increased our efficiencies over recent weeks," he says. *"This has left us stronger and better prepared to support customers in the field."*

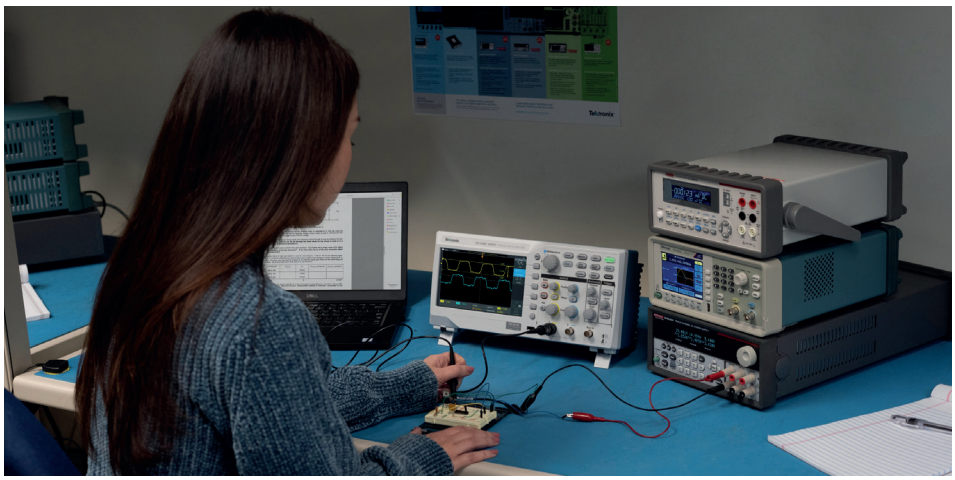
Lourens says the company has not rushed to bring employees back to its offices in Level 3, taking the safer route of allowing only one third back in June. Where employees were not required to physically touch a product, they continued to be deployed at home.

"To date, we have used the lockdown as a valuable opportunity for training and refresher courses," he says. *"It has also been vital to communicate constantly with staff and entrench our safety procedures for future continuity."*

Lourens warns that the lost production on mines will mean heightened pressure on the correct implementation of collision avoidance strategies. The anticipation of tighter safety regulations had led many mining companies to target the end of 2020 for proximity detection upgrades.

"In these tough economic times – and with time lost due to Covid-19 – mines cannot afford to get it wrong when executing projects to apply these technologies," he says. *"Detailed planning will be vital in defining and implementing each mine's specific collision avoidance solutions. The 2020 deadline may now in fact be very difficult for many mines to meet."* wn

Hitachi ABB Power Grids commences operations



Tektronix Enhances Entry Solutions Portfolio with Expanded TBS1000C Dig-ital Storage Oscilloscope

The new TBS1000C series is designed to meet the needs of today's educational institutions, em-bedded design engineers and maker community

COMTEST is pleased to announce the availability of the new Tektronix TBS1000C Digital Storage Oscilloscope, a cost-sensitive addition to the test and measurement company's entry portfolio and an expansion of the TBS1000 series. The TBS1000C series boasts a 7-inch WVGA color display with up to 1 GS/s sample rate and band-widths from 50 MHz to 200 MHz. This series also includes Tektronix's HelpEvery-where® system, which provides useful tips and hints throughout the user interface, in-creasing approachability for new users. In addition to the TBS1000C series, Tektronix released the 3 Series Mixed Domain Oscilloscope in 2019 and the TBS2000B Digital Storage Oscilloscope series earlier in 2020, broadening its portfolio of benchtop solu-tions.

"It's important that Tektronix is continually providing new and enhanced solutions that help grow and develop the next generation of engineers," says Chris Witt, vice presi-dent and general manager at Tektronix. *"We are excited to show our commitment to reimagining our entry solutions offerings through these new and enhanced instru-ments."*

Tektronix's entry portfolio of oscilloscopes offer tiered functionality and cost. The TBS1000C Digital Storage Oscilloscope is the most introductory series, designed for quick hands-on learning and easy operation. In addition to a 7-inch WVGA color dis-play, the graticule with 10 vertical divisions and 15 horizontal divisions enables users to see more signals per screen. This series has dedicated front panel controls to pro-vide easy access to important settings and new large menus with clearly labeled on-screen information allowing users to easily find data of interest. The TBS1000C Oscil-loscope also provides an innovative courseware system that integrates lab exercises with step-by-step instructions for student use.

Next, the TBS2000B Digital Storage Oscilloscope, launched earlier this year, adds a layer of sophistication with a range of expanded key features. This instrument has a large 9-inch WVGA display,15 horizontal divisions, 5M point record length, 200 MHz bandwidth and 2GS/s sample rate to capture and display significantly more signal to debug and validate designs faster. New on-waveform cursor readouts with search and mark features enable easy identification of events that occur in the acquired waveform. Plus, the TBS2000B's new lower-noise front end design offers better signal integrity and more accurate measurements.

Rounding out the portfolio, the 3 Series Mixed Domain Oscilloscope bridges entry-level with higher performance oscilloscopes, offering the most advanced technology of its entry portfolio. The 3 Series MDO is intended to be a versatile test instrument, cov-ering a wide range of debugging and validation tasks. Boasting an 11.6-in HD capaci-tive touchscreen display, the largest in its class, this new series features up to 16 digi-tal channels and the industry's only built-in spectrum analyzer option, which offers hands-on experience with RF measurements and the opportunity to learn about mixed signal design. wn

WATCH

Schneider Electric shows they are acting to build a green and inclusive future for all through H1 extra-financial results

Schneider Electric, the leader in digital transformation of energy management and automation, announces their financial and extra-financial year results. Each quarter, Schneider Electric publishes 21 indicators from the Schneider Sustainability Impact (SSI) which measures their progress towards their sustainability commitments from 2018-2020. These objectives are closely aligned with the United Nations (U.N) Sustainability Development Goals (SDGs) and summarize the extra-financial performance of the Group.
This quarter, Schneider Sustainability Impact reached a 7.71 out of 10 score. They are confident that they will meet their end of year target through the programs they have in place.

Gilles Vermot Desroches, Sustainability Senior VP at Schneider Electric commented that, *"The crisis will not compromise the achievement of our sustainability goals for 2020. We will keep the bar high for our 2030 commitments: to embark our worldwide ecosystem to fight climate change and uphold our responsibilities towards inclusive growth.*

As we continue to respond to those most in need through the Tomorrow Rising Fund - more than one million people so far in 65 countries - our focus for H2 is supporting the recovery of education and training programs. I want to give a special thanks to our employees who are giving so much of their time volunteering to support our local partners."

Olivier Blum, Chief Strategy & Sustainability Officer at Schneider Electric commented our future outlook, *"This year is pivotal. Whilst Earth Overshoot day has moved to August 22, more than three weeks later compared to last year, we know there is more to do to build a safer, greener and truly inclusive world. Collectively, we need to contribute. This is why we have collaborated with like-minded companies on initiatives such as the CEO Initiative for Europe's Recovery, Reform and Resilience. Supporting recovery post COVID-19 is one step but the aim is green recovery for all. The future relies on innovation that brings digital and energy together to fight climate change everywhere, for everyone."* wn

DR IAN MCRAE - 15 SEPTEMBER 1929 – 12 JULY 2020

Because of the strict lockdown restrictions to prevent the spread of the coronavirus, no family member could be with him when he died. For anyone – regardless of status - to pass away in such a cruel, unfeeling way, is an additional source of the hurt and grief suffered by his son Donald, his nephew Brian Statham and other close members of the McRae family.

The tribute presented here has been written in the first person, to make it more readable and personal. I got to know Dr McRae in the late 1970s and worked closely with him on various confidential assignments until about 1984. I, therefore, feel that the inclusion of some comments on what it was like to work with and for him are appropriate.

OBSERVATIONS AND OPINIONS

Dr Ian McRae became a colossus - indeed a veritable titan - and a towering figure in the electricity supply industry after his forty-seven years with ESKOM. His influence was profoundly positive and tangible not only in ESKOM and the local electricity supply industry but also in the Regional (Southern Africa) and International technical organisations.

He rose from the humble starting position of an unindentured fitter and turner to be Chief Executive of ESKOM through his high intelligence (both analytical and emotional), innate ability,

We say Goodbye to a Powerhouse...

It is with heartfelt sadness that we note that Dr Ian Campbell McRae died in the Linksfield Hospital on Sunday 12 July (at the age 90 years and ten months) after a short illness, which was aggravated by the COVID 19 virus. His family are grateful that he did not suffer a painful and lingering illness. His son, Donald McRae, who lives in the UK, was prevented by the lockdown restrictions from coming to South Africa. He was, however, in daily telephonic contact with his father, right up the night before he died.

PREPARED BY A C BRITTEN (FSAIEE)
ASSISTED BY: J W GOSLING (FSAIEE), M CLARKE (FSAIEE) AND PROF P NAIDOO (FSAIEE)

work ethic, humility, and above all, his gifts as a visionary leader.

His creation of the NER (National Electricity Regulator, now NERSA (National Energy Regulator of South Africa)) has ensured that the licensing of electricity providers is professionally managed and increases in electricity tariffs can be controlled and adequately motivated. However, the question of the rationalisation of electricity supply industry into Regional Electricity Distributors (REDS) is still to be resolved finally.

Whatever challenges he tackled, he always applied his attributes of personal charisma and an outstanding ability to lead and motivate people to high achievement. He was able to teach the staff a sense of passion through visionary leadership, and so inspire high levels of loyalty to himself and ESKOM. He will be remembered primarily for the conception and realisation of the visions of "electricity for all", transforming Eskom into a world-class electric power utility, and facilitating the creation of the Interconnected Southern African grid.

Dr McRae's career as a hands-on engineer followed the well-recognised and accepted phases of progression in a hierarchy, such as ESKOM, from being very technically and operationally focussed during his early years, to his gradual entry into the management

From left: Hein Vosloo. Tony Britten, John Gosling, Dr Ian McRae and Malcolm Fawkes.
The picture is provided by Malcolm Fawkes, and was taken by Johanna Nkuna (Carer for Tony Britten)

of strategic issues and achieving excellence in the performance of people and plant. He will be remembered for his achievements during the period (1985–1994) as the visionary Chief Executive of ESKOM.

Dr McRae would have been the first to concede that his achievements in his various senior positions in climbing the "organisational ladder" in ESKOM were the result of his ability to articulate and focus on the operational goals of the organisation. From that, he provided the necessary leadership and empowerment of people, and finally, the right amount of benevolent guidance to ensure that goals were achieved.

The core elements of his attributes as an excellent, and successful technocratic leader, are his ability to listen to what people feel and to respect their contributions, and in so doing, motivate them to higher achievement.

REVIEW OF HIS EXPERIENCE

The positions held by Dr McRae throughout his ESKOM career are listed in Table 1.

What can be deduced from the progressive increase in his responsibilities is that he "grew" with the job. By 1984 he was qualified - by virtue of his in-depth exposure to problems occurring at the "coalface" and the management of power stations and interconnected transmission grid - to assume the role of Chief Executive of ESKOM.

This gave him the platform from which he was able to develop and facilitate the implementation of the main elements of his visionary Leadership.

The reader's attention is drawn to the chronology of his early technical training: he completed and passed the first year of the BSc in Mechanical Engineering in 1946 at the University of the Witwatersrand (Wits); note that he had only just turned 17 years of age! When it became clear that his parents would be suffering financially to cover the cost of the remaining three years of university tuition, and since no bursary was available, he enrolled in 1947 as an apprentice on a 5-year apprenticeship to become a fitter and turner. He firmly believed that he should get some qualification, albeit as an artisan.

Towards the end of the fourth year of his apprenticeship, in late 1950, he successfully applied for a bursary university study (he was the first recipient of an ESKOM bursary in engineering) which would come into

DATE	JOB TITLE	REMARKS/COMMENT
1946	1st year BSc Mech Eng	Wits University
1947-1951	Apprentice fitter and turner	Rosherville Workshops
Jan-June 1951	Apprentice fitter and turner	Completion of the academic content and trade test
1951-1953	2nd,3rd and 4th year BSc Mechanical Engineering	Wits University; obtained his degree in December 1953
1954-1955	Pupil Engineer	Various Power Stations (PS)
1956	Shift Engineer grade 2	Rosherville and Taaibos PS
1957	Assistant Resident Engineer	Taaibos Power Station
1958-1960	Senior Assistant Resident Engineer	4Highveld Power Station
1960-1965	Resident Engineer	Komati Power Station
1965-1966	Assistant Generation Engineer (East)	Melhof Braamfontein (Near ES-KOM Centre).
1967	Generation Engineer (East)	Head Office for the remainder of his career with ESKOM ie Megawatt Park
1967-1968	Senior Assistant Generation Engineer (OPS)	As Dr McRae was very mobile, the location of his home base did not greatly impede his mobility unduly!
1969-1971	Generation Engineer (OPS)	
1972-1976	Manager Central Generating Undertaking	
1976-	Assistant Senior Manager (OPS)	
1976-1980	Senior Manager (Operations)	
1980-1984	General Manager (Operations)	
1984	General Manager (Engineering)	
1984-1985	Deputy Senior General Manager	
1985-1994	Chief Executive of ESKOM	
1994 1997	Chief Executive of NERSA	
1997 -2020	Various directorships and retirement: ad hoc consultancy	He expressed on several occasions his disappointment to me that his offer to mentor and give technical guidance to the younger managers, who were being appointed to senior positions, had not consulted him at all, since his retirement from NERSA. This reluctance really rankled with him. By way of contrast, one of the first actions taken by Mr Andre de Ruiter, the new CE, was to visit Dr McRae to seek his advice on how to communicate effectively with staff, amongst other issues.

Table 1: Positions held in ESKOM and Industry by Dr I C McRae in the period 1946 to 1997

effect in 1951. Since this meant that he could not complete his apprenticeship – and would, therefore, after four years, have nothing to show for his efforts – he decided to complete his apprenticeship by working during weekends and holidays, and he duly qualified as an indentured fitter and turner in mid-1951.

The drive and character showed by Dr McRae in completing his apprenticeship – in parallel with his university studies – are a vital part of his personality. It was a harbinger of the intellectual stamina and mental tenacity which served him so well in communicating, driving and achieving his visions for ESKOM.

Another indicator of his academic abilities and potential is that he completed the BSc in mechanical engineering in 4 years. According to the Dean of the Built Environment at Wits University, on average only about 16 to 20% of engineers graduate in 4 years.

I am surprised that Dr McRae did not enrol for the MSc degree; I feel sure that he would've been able to find suitable topics and deliver outstanding work. However, universities in the 1950s and 1960s were not geared up to offer curricula which allowed MSc degree to be done part-time. (There was no Electrical Power Engineering Institute (EPEI) programme which now tries to ensure that all ESKOM's younger engineers are obliged to obtain the MSc degree, and in some cases, the PhD degree.)

EXPERIENCE AT "THE COALFACE"

During his apprenticeship in the Rosherville Workshops, he would have got his hands "very dirty", and probably had to endure the tyranny of the traditional foreman. The latter tolerated no nonsense from young, boisterous apprentices. He would also have learned self–discipline and the need for precision in performing exacting tasks.

His time in the Rosherville Workshops and very hands-on approach he took in the operation of the smaller power stations gave him the confidence of knowing what he was talking about. This earned him the respect of both artisans and professional people alike and was an essential element of his ability as a visionary leader.

SCOPE OF HIS STRATEGIC INITIATIVES AND ACHIEVEMENTS

One can only marvel at what Dr McRae and his management team accomplished in his nine years as Chief Executive of Eskom. See Table 2.

PERSONALITY, CHARISMA AND LEADERSHIP ABILITY

I have touched on Dr McRae's personality and how this makes him such a charismatic and inspiring leader of not only the proverbial "men" but also of "people". He exudes Leadership and conveys an aura that earns the respect of all who interact with him. First, and foremost, is his physical presence: he radiates leadership and looks like a charming, un-threatening person; as soon as he talks, he creates an impression of humility and folksy warmth; secondly, his speech which is not "stilted" and without any arrogance, also helps to put one at ease; thirdly, his composure is very reassuring. In my interactions with him, as well as having observed him in many meetings and presentations, I never saw him once lose his dignity. He excelled, mainly because of his excellent technical skills in the mechanical discipline and his unique ability to lead, manage and motivate technical staff to perform well, and so achieve objectives collectively.

Good Leadership is a subtle and elusive quality - not always easy to define - it is a blend of attributes that Dr McRae possessed in abundance. Perhaps what contributed to making his leadership so effective, pervasive, and credible is that he clearly understood the differences between leadership and management. He wrote in his book [1] "Leadership is the ability to cope with change. Leaders need to have a vision and a strategy. Leaders need to achieve alignment of people and to move towards the achievement of this vision. Management is the ability to cope with complexity. In coping with complexity, managers develop organisations, structures, goals, targets, plans and budgets, allocate resources, and measure and take action to beat targets and budgets."

The core elements of his attributes as an excellent, and successful technocratic leader are his ability to listen to what people feel and to respect their contributions, and in so doing, motivate them to higher achievement; Dr McRae succeeded brilliantly.

I can state without hesitation that he is the best leader I worked for in my 43 years as an Engineer with ESKOM.

POLITICAL FACTORS

Dr McRae was the Chief Executive of ESKOM during a time of massive political changes in the country, especially in the period 1989 to 1994.

CONCLUDING REMARKS

The career of Ian Campbell McRae is fundamentally about the successful exercise of visionary and charismatic leadership. In this role, he performed

AWARDS AND HONOURS YEAR	NATURE/TITLE OF THE AWARD
1988	• Honorary Fellow of the South African Institute of Measurement and Control
1989	• Honorary Doctorate in Engineering (Wits University)
	• Top Five Businessmen of 1989: Sunday Times Award
1990	• Communication and Leadership Award in Southern Africa from the Business School of the World
	• Human Resources Man of the Year: Institute of Personnel Management
1991	• Business Statesman of the Year Award from the Harvard Business School of South Africa: for his outstanding contribution to the economy of Southern Africa".
	• Honorary Fellowship of the Institution of Nuclear Engineers: awarded "for his contribution to the nuclear programme in South Africa".
	• Gold Medal Award: for his contribution to the profession of mechanical engineering by the South African Institution of Mechanical Engineers
	• Fellow of the College of Engineers of the Society of Professional Engineers, Engineer of the Year Award
1992	• The Servant Leadership Award is given in recognition of his service to humanity and the application of Christian values high ethical standards in the workplace. Awarded by Samford University, Birmingham, Al, USA
1993	• South African Engineering Association (SAVI) Award "for singular contribution to the promotion of technology in South Africa".
	• Business Day Achievement Award: awarded inter alia, for electrification of rural areas.
	• National Electrification Banquet Award: "for the value of Dr McRae's vision to South Africa and her people".
	• Presidency of WANO
1994	Germiston Rotary Club: he received the Paul Harris Award "for outstandingly serving the community".
1996	South African National Committee of the World Energy Council (SANCWEC) award was given in recognition of his leadership in promoting the influence of the WEC in the Southern African Region.
1998	Engineering Newsmaker of the year: Engineering News
2003	The Fossil Fuel Foundation Award for "his contribution to the efficient usage, understanding and knowledge of fossil fuel".
2006	Honorary Fellow of the South African Institute of Electrical Engineers: awarded in recognition of his lifetime achievements in the practice of Engineering and his contributions to the well-being of South Africa and all its peoples.

Table 2: Listing of the Major Awards received by Dr McRae in the period 1988 - 2016

DR IAN CAMPBELL MCRAE
1929 - 2020

and succeeded brilliantly. To quote from the final paragraph of chapter 31 ("Some reflections on leadership") of his book, he asks, and not rhetorically either: "The question I asked over and over again in the many visions I developed in ESKOM, NELF, Sadelec, NERSA, and ROTEK was: did I pass the leadership test in extracting the greatness that existed in the staff, developing communities, suppliers and others? I humbly hope I did." [1, p173]

That he succeeded brilliantly in this endeavour is the complete assessment of the South African Institute of Electrical Engineers. wn

Thank You.

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Symphony of Power
Condition Monitoring

EDITORS NOTES

Ian McRae's values powered the "Electricity Supply Commission", and in return, the company posted sterling business results. His exceptional values included:

MUTUAL RESPECT:

In a diverse and changing South African environment, mutual respect glued all the employees together into a formidable workforce.

TOP UTILITY

A relentless drive for technical excellence across the entire value stream of the electricity supply industry; from Koeberg's nuclear-powered electricity generation to Margate's 11kV urban reticulation performance.

ELECTRICITY FOR ALL

His vision embraced, without reservation, that full access to electricity is a fundamental right for a better quality of life for all the citizens of South Africa. He vigorously pursued this dream, and today, South Africa boasts almost 100% national electrification to all customers.

WORLD'S LOWEST COST

Irrespective of international sanctions and the national economic hardship, he relentlessly drove down the real price of electrical energy to customers; to achieve in global terms, South Africa's position as the world's lowest-cost provider of electrical power. Simultaneously, he posted the best profitability and credit rating of the company that even exceeded that of the sovereign rating. In 2001, the New York-based Financial Times awarded Eskom, The Global Power Utility status.

SOUTHERN AFRICAN REGIONAL GRID AND POWER POOL

Whilst politicians debated South Africa's re-admittance to the international community, Dr McRae found ways to go cross borders and sow the seeds for a regional interconnected power system - from Cahorra Bassa in Mozambique to Inga in the Democratic Republic of Congo. Today, the Southern African Power Pool is 25 years old and continues to post strong results on both the bilateral and competitive market platforms.

CUSTOMER FOCUS

His purpose of business was to serve customers. He completed a formidable build programme and handed to South Africa a company having excess generation capacity to fit the new and emerging democratic South Africa. A peaceful transition followed as the country continued to work as the politicians chartered a new path for a democratic new order.

Motors I Automation I Transmission & Distribution I Energy Solutions I Electrical Construction

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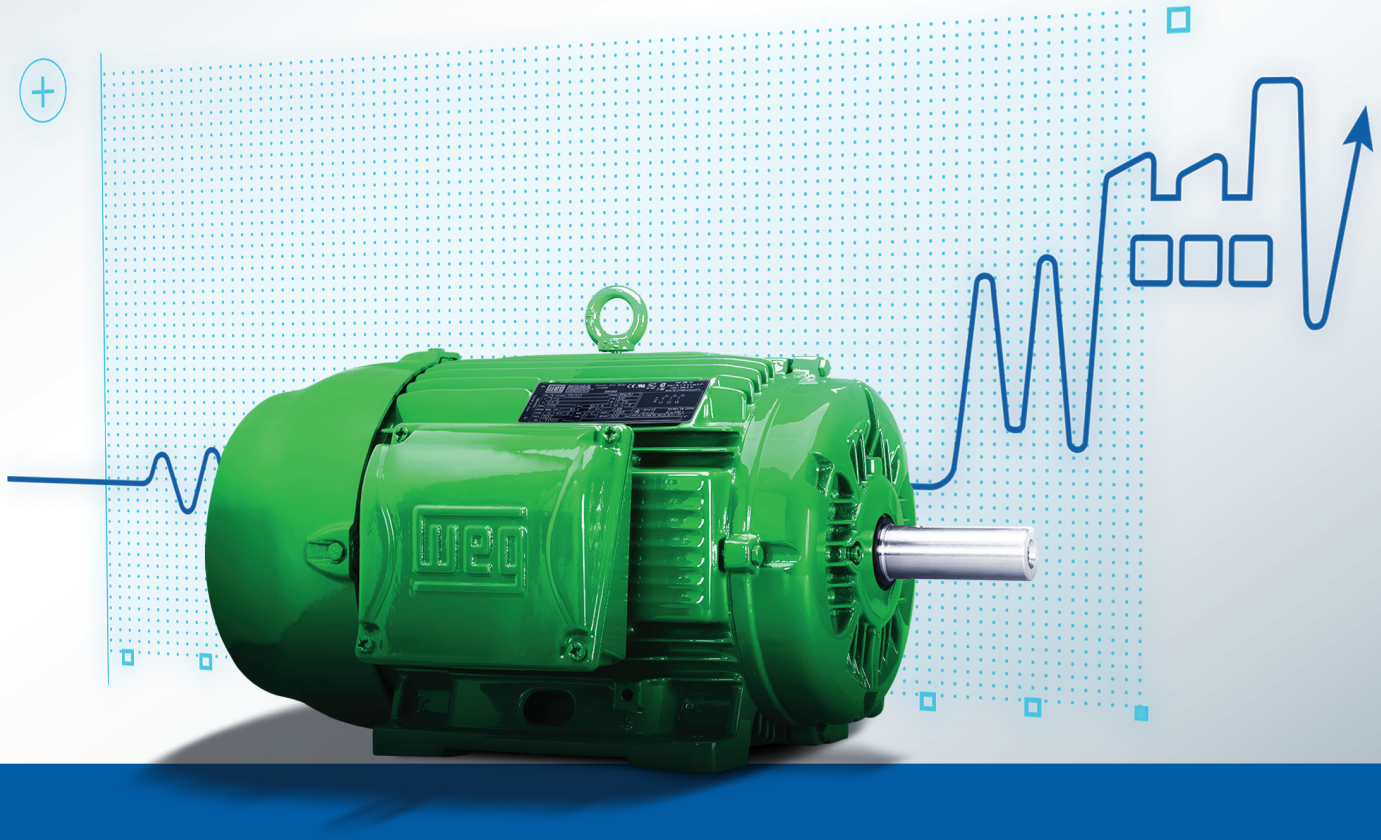

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Repositioning Women for the energy transition

an opportunity for an equitable industry

Like other sectors in the economy, the South African energy sector has gone through steps to try and achieve transformation, in a particular race and gender equity. The industry remains mostly unchanged with women representation remaining marginal.

BY | MAKGOLA MAKOLOLO
CHAIRPERSON
SAIEE WOMEN IN ENGINEERING CHAPTER

A 2018 Ernest & Young report indicated that women constituted only 20% of the energy workforce management, 17% of senior leadership and only 9% of executive leadership. At this rate, it would take at least a century to achieve gender equity in the sector.

The global energy landscape is going through a significant disruption driven by climate change response strategy to reduce carbon emissions and renewable energy technologies that are maturing and becoming more competitive. In the case of South Africa, the changing landscape is further propelled by the impending decommissioning of a large proportion of coal-fired power plants that have reached their economic life.

The most significant contributor to carbon emissions in South Africa is primarily the production of electricity through coal. Currently, South Africa produces about 90% of electricity from thermal coal power plants. The emissions reduction commitments and the decommissioning of Eskom coal power plants will result in the use of coal declining significantly in electricity production and other technologies such as renewables and gas playing a more significant role in the energy mix.

Government has published an integrated resources plan (IRP 2019) that outlines the mix of electricity generation technology options in the future. By 2030, a significant number of Eskom coal plants will be decommissioned, and renewable energy will contribute at least 30% of the country's electricity generating capacity. By 2050, about 34GW of the current 42GW of capacity will be decommissioned. This is a significant shift in energy policy for South Africa, which will present both challenges and opportunities.

The energy transition from a dominant coal fleet to a mix of technologies will no doubt disrupt the electricity supply industry as we know it within the next decade. Energy provision will become increasingly decentralised, decarbonised and democratised as consumers continue to have a choice of what to consume and at what rate (energy efficiency). The reality is that the new "energy order' will disrupt the current value chains. Current job opportunities will decline, new jobs will emerge, existing coal towns will decrease, and new economic

activities will emerge. This is perhaps one of the significant challenges that labour unions in the coal sector have raised and increasingly put pressure on the government to produce a plan for a "Just Transition" into this new reality. A Just Transition means securing the livelihoods of workers and communities as the economy shift to these new technologies.

In the current realm, there have been various successes in increasing the representation and participation of women in the energy sector. Companies like Eskom have achieved with the middle management at about 40% female. However, a lot needs to be done across the value chain. For women in this sector, the struggle for representation and more significant opportunities continues.

The emergence of the renewable energy sector provides an opportunity to start anew with opportunities for all. This is an opportunity to create a new and equitable industry that will, for the first time, realise what women have been asking for, equal opportunity. This is the moment to recognise the commitment we have heard from the government to increase the participation of women across the value chain. Alternatively, this will be the moment that will expose the underlying rhetoric that the world doesn't believe in an equitable society.

The CSIR conducted a survey (Mkhwebane, 2019) on opportunities for SMMEs ranging from manufacturing to professional services etc. in the renewable energy sector. The report identifies specific opportunities and interventions required for greater integration of South African entities into the renewable energy value chain. To quote the statement, "The renewable energy industry is at its infancy in South Africa. A certain degree of reliance on international expertise is expected; however, with time, skills transfer needs to take place to allow local participation." South Africa has the opportunity to use this new sector to industrialise and entrench the participation of women.

In recent history when, in response to BBBEE requirements, corporate South Africa was challenged to increase the number of black engineers in its ranks. It soon had to abandon the strategy of going into the labour market to seek candidates that were not being produced by academia at the required rate. So, instead of circulating the same faces in the labour market, corporate South Africa, in particular, the heavy industries embarked on a process of creating a pool of engineers through various bursary schemes. Within many years, a pool of black engineers had increased and somewhat met the demand and therefore improved tenure of black engineers.

The same argument must be made for the creation of value chains for new energy technologies in South Africa. In particular, identifying specific opportunities by all key stakeholders such as the financial sector, multinationals, local industry and government to support female enterprises. There has to be concerted effort to create this capacity of women-owned enterprises and female leaders for the sector. The emergence of new energy technologies is a long haul game. South Africa's strategy cannot be restricted to being a consumer of foreign developed and manufactured technologies.

We need to develop a plan to identify specific areas of the technology value chain, which can be localised. Of course, for such a program to be viable and sustainable, the government has to commit to a pipeline of projects to give certainty of demand. Absence this, no industry will survive. The lost opportunity with the closure of the wind turbine facility in SA is testament to this.

South Africa has an excellent opportunity to make this a truly transformative and inclusive program embraced by all. This is an opportunity to realise women industry leaders through entrepreneurship, corporate leadership and, as some argue, through social ownership of renewable programs.

We cannot leave the outcome of an equitable new sector to chance. There must be a concerted effort of all stakeholders, which must be led by the government, to create this new outcome. Such an achievement would rightly be considered a "Just Transition" for women in this sector.

Successful testing of 2nd 500MVA transformer unit for ESKOM

SGB-SMIT POWER MATLA Pretoria achieves another milestone

SGB-SMIT POWER MATLA is an established South African company with strong regional advantages, strengthened with the global knowledge and expertise of the SGB-SMIT Group. The company has more than 70 years proven track record and successes to design, manufacture, test, install and commission a wide range of power and distribution transformers.

The Pretoria plant is home to a fully equipped laboratory, with the testing and analysis capability for various materials (including transformer oil), which complements the project and service department, in addition to also supporting external companies for lab services.

The Cape Town distribution manufacturing plant manufactures distribution transformers from 16kVA up to and including 5MVA 36kV, miniature substations, LNER's, NECRT's and other related equipment for customers in Africa.

The Pretoria plant has a manufacturing capacity from 10 MVA up to and including 800 MVA and up to 420 kV. The manufacturing range covers power and specialist application transformers such as furnace transformers, rectifier transformers, traction transformers, shunt reactors and related equipment. The production facility includes a fully accredited testing facility, which is currently the largest facility of its kind in Africa. This testing facility is a strategic advantage and all transformers manufactured are tested according to international standards (IEC 60076).

The company has a successful track record of manufacturing and testing high voltage transformers with the most recent 500 MVA/400/132/22 kV unit passing all factory acceptance tests at the end of July 2020. This is the second 500MVA 400kV unit successfully passing FAT in 2020! The Pretoria plant presently have 3 additional similar units in production, all which are destined for the national utility to support and augment the power grid.

The latest success of SGB-SMIT POWER MATLA is the result of great teamwork - both in the Pretoria factory and within the wider SGB-SMIT Group: the international cooperation amongst group members involved in all steps starting from design to production right the way through until the test phase.

This achievement demonstrates the commitment, knowledge and experience within the local South African team, which are bolstered by the Group's technical specialists. The technical support of the entire Group represents a tremendous competitive advantage and is a crucial aspect for the South African team to continue on

the path of continuous improvement. The latest success also demonstrates the South African capability to provide sustainable solutions for the African continent.

Playing to regional strengths and increasing global expertise is an important factor for SGB-SMIT POWER MATLA, and instilling confidence in our company and strengthening relationships with our customers and continuing to be a dedicated partner for our customers. wn

Jet Demolition encourages diversity and nurtures talent

While the Covid-19 pandemic has had a devastating impact on all industries globally, it is a temporary situation. The focus must therefore be on survival during these challenging times. "We continue to prepare for the future as best we can, and will weather this storm." This is the message from Liz Brinkmann, who with husband Joe Brinkmann are at the helm of Jet Demolition.

Joe and Liz met at the Missouri School of Science and Technology in the US, where he was studying mining engineering and she metallurgical engineering. The young pair came to South Africa in the hope of entering academia, but changed their plans with establishing Jet Demolition in 1994.

"Joe and I are very different people, but also complement each other exceptionally well. We also have a common goal and vision. This enables us to collectively approach life from different angles, while working toward aligned objectives," explains Liz.

The company *"is fundamentally founded and driven by a sense of care: for team mates, clients, the environments in which we work, and our industry. By approaching our business and our lives from this point of departure, it is only natural for Jet Demolition to have evolved to being a business with family values at its core."*

Echoing this philosophy at Jet Demolition is Contracts Manager Kate Bester (NDip Civil Engineering), who believes that the industry in general is already diversifying and becoming more inclusive. *"We are especially focused on nurturing talent and encouraging active participation, irrespective of your background or gender. This results in a diverse group of people collaborating on some of the most challenging and exciting projects, while growing our skills pool within our structure,"* elaborates Kate.

An example of such up-and-coming talent is Nontobeko Zwane, who completed her National Diploma in Mechanical Engineering at the Tshwane University of Technology in 2017. She is currently completing her BTech in Mechanical Engineering at Unisa. Nontobeko applied for in-service training at Jet Demolition in 2016, and has been working there ever since. As part of the technical team, she is actively involved with technical management, project planning, scoping, tenders and project administration.

Working at the company is a privilege, especially due to its reputation as the

Liz Brinkmann
Jet Demolition Director

Kate Bester
Contracts Manager

Nontobeko Zwane
Trainee Project Manager

premier demolition specialist in Africa. *"I have the opportunity to work with exceptional mentors who take pride in skills transfer and ensure I get the best experience in my career as a young professional in the demolition industry."*

Nontobeko thrives on being involved in all stages from inception to completion. *"As a young professional, it is remarkable how much one learns from each and every project."* Her future plans include registration with the Engineering Council of South Africa as a professional project engineer.

Liz concurs that every project undertaken is inherently different. While many companies locally and internationally specialise in a single facet, Jet Demolition considers each project on its own merits and specific challenges.

"We have a very detailed, engineered approach to what we do: Continuously assessing how to improve the safety profile of the task at hand, how to improve the outcome for our clients, and how to improve the manner in which we work. The diverse environments in which we work certainly is a challenge, but is one we embrace."

Kate reveals: *"The beauty of our industry is that there are no 'typical' days! We get to see some of the most interesting processes and facilities out there, and get to meet and work with incredibly interesting and talented personalities. I love the sense of adventure a new project brings, but also the detail with which every project is planned and executed.*

"To be able to walk the path with a client from a pre-demolition study to rehabilitation also affords us the opportunity to see the industry for what it is – we have heard the most interesting stories from days back when, and then get to share in the excitement of the new facilities to come. In all, I feel incredibly privileged to have such a diverse and exciting career, and to meet such incredible people along the journey," Kate affirms.

In terms of the challenges faced by women in such a niche field, Kate points out that demolition does not present any more challenges than other STEM fields. *"Yes, there are days that require you to get dirty or to travel to remote sites, and sometimes to face very challenging situations that you had not expected, but the vast majority of those challenges can neatly be side-stepped with confidence and support from your team."*

While the world of engineering remains male-dominated, Nontobeko pays tribute to Jet Demolition for giving female engineers opportunities to become leaders and pioneers in the industry. *"The world is there for the taking; you just need to grab it with both hands,"* she concludes. wn

Bureau Veritas Technical Center Africa consolidates technical competence

Bureau Veritas is on hand to support mining, power, oil and gas, and rail to manufacturing and process across the globe with technical excellence in a safe and trustworthy manner.

Bureau Veritas, a global leader in testing, inspection and certification (TIC) services, continues to spark the interest of clients across all industries with engineering expertise drawn from a global group of professional engineers from a range of sectors spanning mining, power, oil and gas, rail and manufacturing to processing, automotive and ports and harbors.

The company, renowned for services and innovative solutions to ensure client products, infrastructure and processes meet standards and regulations in terms of quality, health and safety, environmental protection and social responsibility; has recently consolidated its intellectual capacity and skills to create a technical center representing expertise from Africa.

The highly proficient Center of Excellence comprises professionals from various engineering disciplines based across Africa, to deliver on customer needs globally, providing a wide range of engineering-related services designed to meet and exceed expectations. The core team is based at the Council for Scientific Research in Pretoria, South Africa under the leadership of Heinrich Stander.

Marc Roussel, President of Government Services & International Trade & Senior Vice President for Africa commented: *"As always, our role as an expert, independent third party is crucial to creating the conditions for trust amongst our stakeholders. Bureau Veritas is committed to deploying our teams worldwide to preserve people, assets, and the environment by identifying, preventing, managing, and reducing risks. Our Technical Center Africa continues to support clients with geography-specific specialized engineering expertise drawn from our Centers of Excellence developed to meet market demand. Africa needs to be autonomous even when it comes to high-end engineering."*

The Bureau Veritas Technical Center Africa provides customers in Africa and elsewhere in the world with technical excellence, supporting them in designing and operating assets that are safe and reliable. It serves as an independent third-party certification body, providing advice and support for clients in achieving compliance. Collaboration and smooth co-ordination amongst experts from all over the Continent ensure the needs of customers from all over the world

are met timeously and professionally, reinforcing trust and third-party commitment.

Sal Govender, Vice President for Bureau Veritas Southern Africa, commented: *"Our Technical Center Africa consolidates highly skilled technical expertise to provide world-class performance that meets the needs of our customers in a fluid professional manner. We remain accessible to our clients by providing advice and support with our hallmark engineering expertise and impartiality."*

The Technical Center's objectives are to provide solid and reliable engineering expertise and technical support across all major industries:

- Oil & Gas - provide technical support where operational safety is key whilst keeping a sharp focus on costs. Safety, asset integrity and design review are at the forefront of our focus
- Mining - Technical Center engineers provide support to ensure clients achieve two main objectives: maintain production, and reduce costs and improve efficiencies; against a backdrop of Health & Safety protocols
- Power & Utilities - provide technical expertise to ensure the Reliability and Asset Integrity Management of clients' power assets are maintained. The Technical Center forms the backbone of in-depth expertise required for Bureau Veritas' Boiler Specialist Services
- Aerospace – the Technical Center supports aerospace companies throughout the value chain by addressing three key focus areas: quality and regulatory compliance with aircraft manufacturers, optimization of manufacturing costs, and on-time delivery throughout the supply chain
- Rail – the Technical Center engineers provide support for rail operators, owners, and manufacturers to lower risk, ensure conformity and achieve business growth
- Manufacturing – Providing industrial clients compliance assessments for assets equipment, throughout the life of industrial facilities, ensuring operational performance, safety, reliability, and profitability

The Technical Center Africa Head, Heinrich Stander, commented: *"Our bouquet of services is centered around customers' needs: conformity assessment and certification; functional safety and reliability; risk and safety; and asset integrity management. Our recently consolidated Technical Center Africa offers a network of expertise hailing from all over Africa which ensures clients benefit from the same core service offering wherever they are in the world in a cost-effective manner. Our mission is to provide technical excellence at each stage of asset design, construction, and operation; with our core focus on ensuring safe asset availability and client satisfaction. We are here to ensure our client's goals and ambitions are met in a sustainable and efficient manner."*

The Bureau Veritas Technical Center offices are based in Pretoria and Johannesburg in South Africa; whilst the head office for the company's Southern Africa region is in Johannesburg; with branches in Cape Town, Centurion, Durban, and Pretoria; and laboratories in Cape Town, Centurion, Durban, Johannesburg, and Richards Bay, South Africa. wn

IEC YOUNG PROFESSIONALS PROGRAMME WINNERS ANNOUNCED

On the 30th of July this year South African Bureau of Standards (SABS) ran an essay competition for the International Electrotechnical Commission (IEC) Young Professionals (IEC YP) Programme where candidates were required to write an essay about the following topic:
Industry 4.0 offers an opportunity to monitor and control industrial machinery remotely. What are the threats associated with this, and how should this process be mitigated and integrated into the standardisation process?

There were two winners of this competition, namely: Mr Mphumuzi Khoza & Mr Tristan Kuisis.

ABOUT THE IEC YOUNG PROFESSIONALS PROGRAMME:

The IEC Young professionals' (YPs) programme was started by the International Electrotechnical Commission (IEC) in 2010, targeting engineers working in the electrotechnical industry in the age group between early 20s to mid-30s.

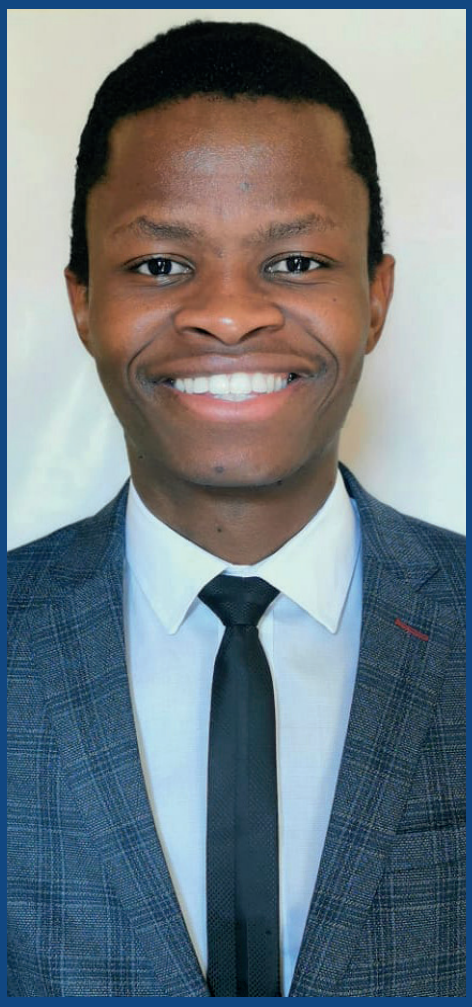
The objective is to ensure that the technical work of the IEC would be future-proofed with a growing number of new generation technical experts familiar with standardisation and the role of the IEC.

The first IEC YP programme took place in 2010, and South Africa was represented then and every year. Since 2013, the South African National Committee (SANC) of the IEC has been organising this competition every year and select two candidates to represent South Africa at the IEC Young Professionals programme which is held in conjunction with the IEC General Assembly meeting.

The interest in the competition and the local South African journey of IEC Young Professionals has been growing each year. This year nine essays received and evaluated.

Two local participants obtained the highest scores from their essays, and they won the prize. The prize for this competition included attending the IEC Young Professionals workshop virtually (online) which will be held in Geneva, Switzerland on the 9-13 November 2020. As part of the South African delegation and these candidates were also allowed by SABS to become part of the National Technical Committee of South African of their choice.

The two South African IEC Young Professional delegates will participate in the five days workshop where they will learn about the following IEC work and its objective: IEC Strategy overview presentation, Foundation for leadership, IEC Standards development processes, Advanced management of standards development, Simulating of an IEC technical meeting exercise, IEC Conformity Assessment System.



Mphumuzi Khoza
ACTOM MV Switchgear
(Trainee Tendering Engineer)

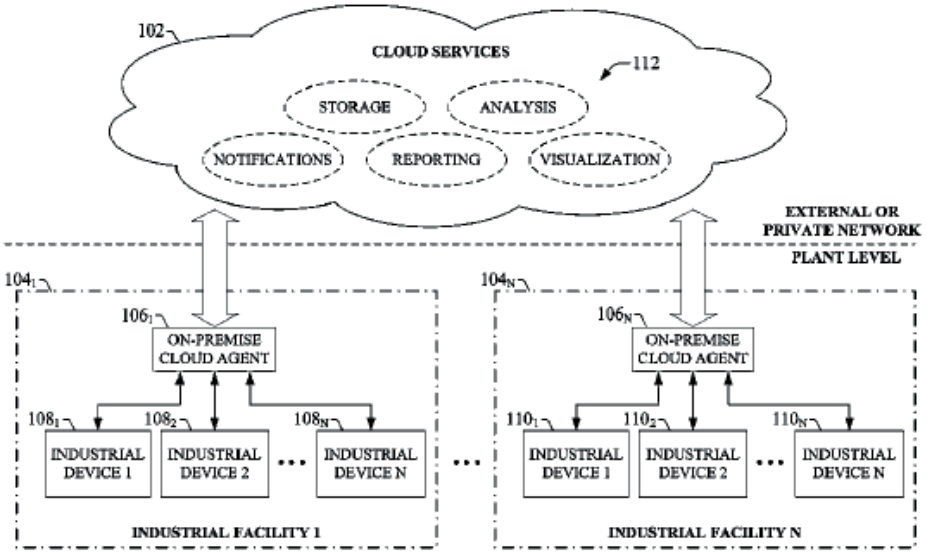


Figure 1: Remote Monitoring system [3]

INTRODUCTION

Quite a lot of benefits can be derived from industry 4.0. This includes the advanced remote model systems with the intelligence to identify and solve abnormalities and predicts events, improves the efficiency of operation and improves system availability and reliability to allow the regular monitoring and control of industrial machines. Industry 4.0 will provide intelligent control methods of the production in companies. [2]

Remote control, observing, programming or even service of industrial machines is expected to be the modern standard solution in the contemporary industry with the introduction of industry 4.0.

This solution is expected to provide advanced and improved functionality to improve the effectiveness and efficiency of work in the industry. It cannot be ignored that the introduction of such technology has threats that will come along and if not mitigated production in the industry may be harshly disturbed significantly affected [1].

Standardisation is required to avoid the possible complications associated with the operation of such technology. This paper presents the threats such technology may cause, how these may be mitigated and how such systems can be integrated into standardisation.

CONTROL SYSTEMS

HOW DOES REMOTE MONITORING AND CONTROL OPERATE IN INDUSTRIES?

Remote monitoring systems require data storage which can be in means of cloud storage or hard storage. The cloud storage has considerable advantages over hard storage such as the information accessible anytime and anywhere with the requirement of internet access. While the hard storage must be carried and has high risk of being lost or the memory storage device being faulty hence the industry 4.0 will have a requirement of cloud storage data centre to allow remote control and monitoring of industrial machines. Remote control of industrial machines involves the operation of modern control systems. The control systems interact with field devices in the plant to control the automated processes, controlled

by a few operating personnel and to perform the desired operation of the particular machines.

The control systems perform a wide range of tasks to fulfil the necessary process; those tasks include material handling, supervisory control, batch processing, etc. The control systems process the user-defined control programs to allow decision making in connection with the controlled process. Such control systems can include but are not limited to ladder logic: function block diagrams: function charts: structured text and a lot more programming structure. Refer to figure 1 for details of a typical control system process. [3]

THREATS, SOLUTIONS AND STANDARDISATION INCORPORATION METHOD

In engineering analysis, risks may be anything that can cause damage to the system and cause the system to malfunction. Risks can be either intentional or unintentional.

The unintentional threats are considered to be caused by human error whilst intentional threats refer to harmful action which may be the result of the theft of the hardware, computer resources and data and disturb the operation of the system. The risks to the remote monitoring and control of industrial machines maybe, but not limited to:

VULNERABILITIES

The operational technology that will be used under industry 4.0 will have several weaknesses that are a threat to the smooth operation of the system. These threats include:

- the lack of knowledge in SCADA protocols,
- protection required,

Figure 2: Exemplary planning disaster management method [6]

- human errors such as mal-programming that will disturb production,
- disaster recovery plan under instances where the system has experienced a breakdown,
- lack of compatible forensic tools for field devices,
- skills and training of the personnel,
- inadequate procedures and policies etc.

The threats mentioned above may affect the application of remote monitoring and control of industrial machinery.[2]

To have reliable control systems, companies will have to implement training management systems for employees. These systems should be relevant to their field of speciality so that they will be equipped with the knowledge to control the order and offer a robust response to problems and things that threaten the reliability of the system.

The control system may break down at times and in such instances, require a strategic approach to follow when attending to the problem. Hence a disaster recovery plan will have to be in place so that employees will know how to respond to the disaster at hand.

The standardisation committees will have to incorporate the disaster recovery methods and training management systems in the development of the standards for industry 4.0. The economy of the country may be affected by companies that suffer breakdowns and have no methods in place to quickly resolve the disruption.

UNRELIABLE POWER SUPPLY

Remote-controlled machinery in the industry will require a reliable power supply for them to operate efficiently for the anticipated production. The power supply to such systems may be more than one type, e.g. direct current (DC) for the control systems and alternating current (AC) for the actual machine; both these supplies will have to be reliable at all times.

An unreliable power supply can be mitigated by installing renewable energy systems (e.g. solar systems) in combination with energy storage (e.g. batteries) that have a changeover to

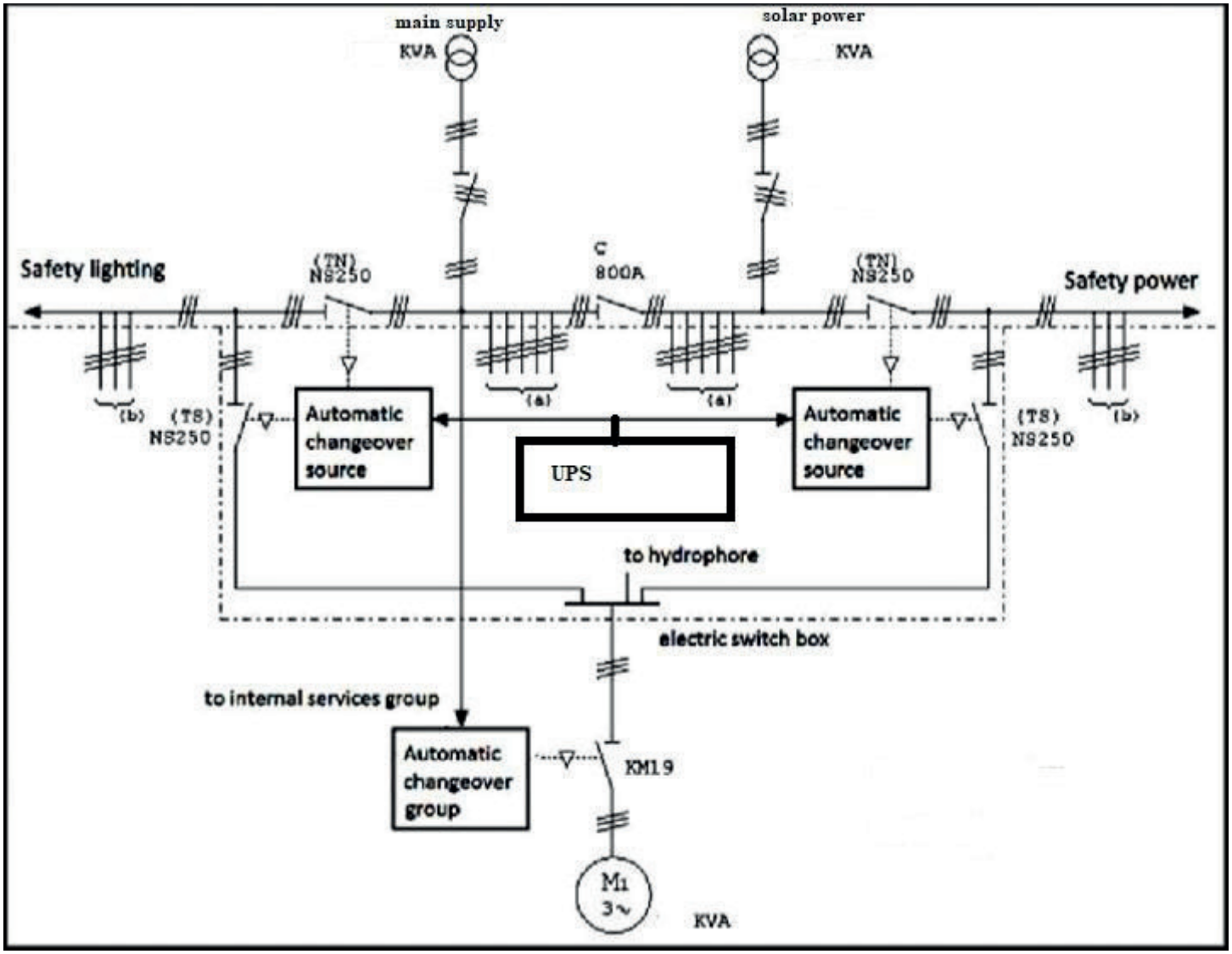


Figure 3: Recommended power supply method[5]

the council supply. Doing this provides maximum security of supply and prevents time-consuming restarts of the control systems when switching between power supplies. See figure 3 .

This power supply method will increase the reliability of the power supply and can be incorporated into the standardisation of industry 4.0.

CYBERSECURITY

Do companies have confidential strategies on their computer systems to control and monitor their machines for production remotely? Therefore the implementation of such systems will require optimisation so that the systems can be made secure against possible data attacks or computer networks attacks. The most common cyber-attacks may be from competitors, domestic or international terrorism activities, recreational hackers, or a disgruntled employee.[2]

The production or health of the company may be compromised when un-authorised personnel gains access to the control server networks; such access may result in data tampering, identity theft, system virus and malfunctioning of the system by sending the Daniel of Service attack (DoS)? etc.

The companies will have to implement security risk assessments at least every week to have strategic defence methods to be performed on their systems. The defence strategy would have to cover all the dependencies, inter-connections and all cyber-assets to be considered; the risk assessments will provide the information technologists with an idea of layers of protection and monitoring required per company system.

Figure 4: Cyber security-protected system

Control methods will have to be implemented to have natural control access for the employees. The company would have to take safety measures to prevent unauthorised access to the control systems by:

- Using access control and physical security and surveillance measures.
- All the physical and logical ports that are not used must be disabled.
- Employ intrusion detection systems (IDS) along with intrusion prevention system
- (IPS), such solutions will monitor and raise alarms once there is traffic beyond regular operation on the network.[4]
- Also, the reliability of the protection systems can be improved by continually
- performing packet inspection of SCADA traffic in the control system

The cybersecurity threat in the industry 4.0 remote monitoring and control of machinery in the industry can be incorporated in standardisation by compilation of standards such as IEC62351-1-13, IEEE 1686, IEEE 1402, IEC 62443-1-4 and NRC currently used in substation automation to form the new standard.

Research institutions can provide solutions on other unknown security methods that can be applied to the control systems and also new knowledge the engineers are not yet aware of.

MAINTENANCE

Industry 4.0 will define a new trend of production in companies as it will introduce the latest strategies to operate the machines or even teach the machines to self-operate. The remote monitoring and control of machines will be made up of the advanced automation systems using smart operation systems, data and the learning of machines. This new technology will be utilising the cloud storage servers and stores a considerable amount of data for the processing of machines and allowance of remote-control; this massive data would have to be managed by data specialists. [7]

Data specialists within companies would have to use the data in servers

Figure 5: Steps to create a robust preventive maintenance procedure. [7]

to determine the possible causes of possible failures on automation systems and this data can also be used to identify the root causes of inefficiency and losses so to reduce operation costs and front line processes.

The maintenance of such sophisticated systems poses a threat to the smooth operation of such systems. Companies would have to implement the preventive maintenance but which may not be possible as there will be no experts to formulate the preventive maintenance of this new technology. This issue of maintenance will then increase the controlling costs since the rise of the problems will delay the processes and production itself. [7]

Therefore companies would have to develop strategies to master preventive maintenance and install technology that will assist them with fast-tracking the strategy to implement a successfully working preventive maintenance plan.

Before the preventive maintenance is put in place, companies will need a predictive maintenance strategy in place.

PREDICTIVE MAINTENANCE (PDM)

This method of maintenance allows companies to predict failure of equipment and take measures to prevent it. This method keeps maintenance frequency low and manageable and decreases time spent on unplanned maintenance, the benefits of this maintenance are but not limited to; less downtime, improved safety, etc.

With the remote monitoring and control of machines, companies will have to purchase expensive tools and technology to implement this maintenance method so to have the benefits aforementioned. This technology would include computer systems incorporated with sensors which can detect a change in normal machine operations and schedule preventive maintenance and notify technicians by short message sending. Therefore if such maintenance systems are not installed, and there are not enough practical technicians to maintain these machines and systems companies will surfer more downtimes

and losses in unexpected faults which in return may cost companies and country economy.

It is therefore recommended that the standardisation committee design standard that will detail the maintenance procedure and standardise the technology to be used when implementing remote monitoring and control of machines.

It is also understood that industry 4.0. will introduce complex computer systems which may quickly crumble when there is no solid foundation of maintenance; therefore, standardisation may create a standard process and recommend tools to form an undefeated preventive maintenance procedures.[7]

There are eight steps which may create a robust preventive maintenance procedure in the industry 4.0 technology, see figure 5 below.

This procedure covers the implementation of goals and guidance on the know-how to construct a strategy for maintenance.

CONCLUSION

Industry 4.0 will introduce the simple methods of operations in the industry but with the introduction of sophisticated technology which will require specialised skills of computer and computer science. Employees will have considerable flexibility in their work since they can perform their work while at home by logging in the company online working centre. Machines will be connected to sophisticated computer systems which will determine the time for maintenance. The network protection methods will be implemented with new skills being developed in industries. The threats to this technology can, therefore, be mitigated and incorporated in the standard to produce new working procedures with new policies. wn

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THE IMPACT OF AN ALWAYS CONNECTED WORLD AND INDUSTRY 4.0

Technology has been the driving force behind much of the progress that society has covered over the past few hundred years. This is evidenced by an increase in living conditions—and quality of life—for every person on earth, with varying degrees based on several factors. This standard of living can easily be measured by the level of wealth, comfort, material goods, and necessities that individuals or societies have access to [1]. The quality of life is also highly correlated with the life expectancy in populations, which over the last century, has seen increases that previous centuries have not seen. Many of the benefits of this increased standard of living are attributable to technology.

To understand how technology has impacted the way humans live, it is essential to look back over the last few hundred years and observe the technological innovations and breakthroughs that occurred and link these up to the progression of the world and its societies as a whole. Observing and analysing the previous revolutions provide great insight into how to plan for further revolutions as history is often said to repeat itself.

Over this period, several stages are marked as significant advances for populations and societies; these step changes are often attributed to specific and targeted ideas, innovations and processes that sparked a so-called revolution in the way of living and working. These step changes are commonly referred to as industrial revolutions, the change brought about by the introduction of several technological innovations which quickly spread throughout the world. These changes often introduced better living conditions, which in turn led to an increase in population growth, which led to further developments in the economic stability and growth [2].

This essay discusses what the previous industrial revolutions were, how they impacted people's lives, and how society has changed because of it, for good or bad. A brief description of what industry 4.0 is, and how it was conceived, is discussed. The essay then looks into what industry 4.0 is currently defined to be from a standards point of view and what it should aim to look like.

A relevant example of where standards have failed in this space is discussed, and how the role of standards in this space seeks to intercept these types of situations re-occurring.

Finally, some potential issues that are often observed in the standards process and how the process can and should be restructured to avoid the problems in the future are discussed. This focuses on the fact that society often resists, and even defies, the changes brought about by such revolutions, and how instead, this should be a collaborative effort to engage and create a just transition for all.

To date, there have been three such significant steps; these are known as the first, second, and third industrial revolutions.

The first industrial revolution is marked by the introduction of new methods of manufacturing. The use of steam and water power created the ability to transition from hand tools to larger machines, mechanising many jobs and processes. This mechanisation of

many jobs and tools resulted in many countries quickly industrialising and building out at an unprecedented scale.

The second industrial revolution is marked be a continuation of the first; however, in this case, it was as a result of many separate players adopting several standards. Different manufacturers and industries could interoperate with greater ease, furthering the integration of many industries. The building of railways from steel enabled the transport of people and materials much more efficient. Lastly, the creation of the telegraph, the technology that allowed the quick and cheap capability to communicate over long distances with many different people enabled a much higher spread of information.

The last industrial revolution, the third, is still hotly debated what technologies or systems created this revolution; it may be many years before consensus is reached on the specific markers of this revolution.
However, it is generally agreed that this revolution began, and is partially marked with the introduction of the internet age, where communication and information sharing became open and accessible to all. This has also allowed for globalisation, where companies and industries are no longer constrained to artificial borders enforced by governments, and physical borders. Air travel, highly interconnected railways and roads all assist in the acceleration of this.

These revolutions were not brought about by a centralised community that created these tools and techniques. They were spawned and accelerated by the observation that their benefits were massive. Therefore there was no world in which these revolutions did not happen; the upsides were too significant.

The format of progress occurred by companies, governments, and individuals observing what worked in certain instances, and attempting to revolutionise or evolve what was the current trend to benefit; money is a significant influencer for paths.

Throughout these industrial revolutions, as connotations of the word portray, there has been much societal upheaval and reticence to progress. This is often because these times mean the loss of jobs for individuals and industries that are perceived to be redundant or are eliminated by the new system with new and better methods.

A vast improvement in productivity in the system as-a-whole meant that going back to the old system would not happen, even with significant increases in unemployment as many employees become displaced and general discontent rises in the general populous. In many cases, the benefits accrued by the few far outweighed the voices of the many.

The rise of Luddites, individuals who impeded the progress of the system, was symbolic of the societies that were killed off in these times.

The massive economic growth and progression of systems as a whole was a forcing function to the process, which meant that going back was not ever going to happen. The world has seen this over and over in each of these revolutions, each observed in different ways.

This prior knowledge sets the scene to understand how exactly industry interfaces with the rest of society, that it is incredibly integral to any functioning society and system as a whole.

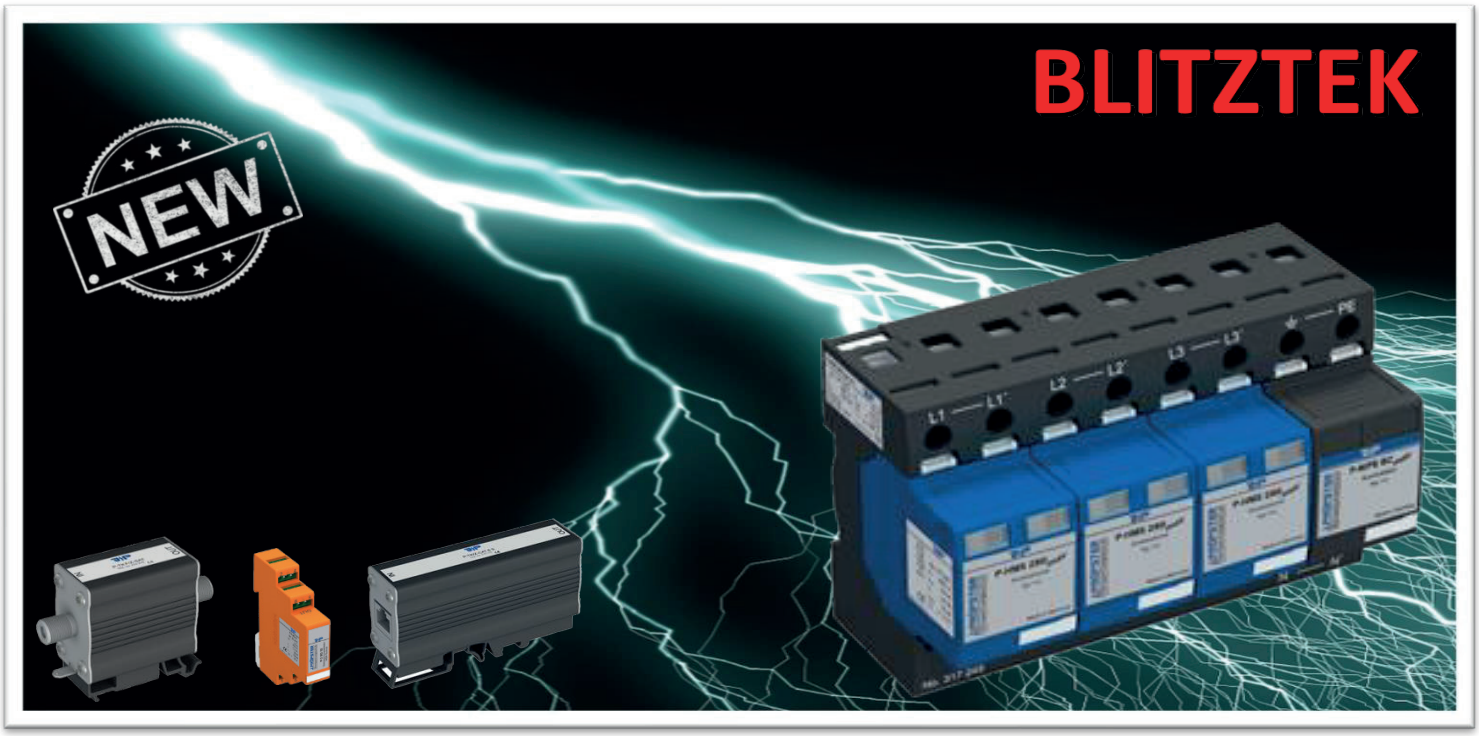
The changes brought about by such revolutions have consequences good and bad, so it is essential to understand and learn from previous failures; to predict, plan around, and act on outcomes before they happen.
This is where the role of standards has been seen to be a significant controlling and unifying concept. The process in which standards are developed should involve all relevant stakeholders, relying on equitable decisions to be made.

The markers that are associated with these industrial revolutions are beginning to surface; the rise of new technology that reduces the complexity in specific tasks that commonly were done by humans and the massive economic benefits to moving in this direction are explicit identifiers.

Such talk about industry 4.0 implies that significant change is about to, or is already taking place.

Industry 4.0 said to be a subset of the fourth industrial revolution, is seen to have some of the markers of the previous revolutions. It enables massive and globally reaching utilisation of devices that are integrated at every level of a system is seen as the key marker of the industry 4.0. Each of these devices can have a diverse set of sensors and functionality installed in them, their abilities far exceeding anything used before, all at a fraction of the cost of technology that may only be a few years old.

Recent developments in communication and sensor capabilities have allowed for factories and systems



SURGE PROTECTION

BLITZTEK in partnership with HHK earthing and lightning protection specialists is proud to announce the launch of our exciting new range of lightning and surge protection devices, never before seen in Southern Africa. Our lightning and surge protection devices are designed, manufactured and tested in Germany by some of the smartest minds in the surge protection industry.

BLITZTEK lightning and surge protection devices boast a dynamic and vast range of class 1, class 2 and class 3 devices, ensuring that no matter the surge protection need, we at BLITZTEK will always have a solution. Our complete product range fulfills all relevant guidelines of the SANS and IEC codes of practice .

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- *Leakage current free due to series connection of technologies*
- *Combined lightning and surge protection units*
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- *High backup fuse values*
- *German design and quality.*

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to be run semi-autonomously. These devices, so-called the Internet of Things (IoT), will enable the ability for manufacturers to automate their operations further to become less dependent on human workers. These devices are more reliable, less prone to make mistakes, and can work all hours of the day, every day.

It creates businesses where the actual order of business can take place anywhere in the world, completely separate from where the product is built, the data is stored, or the data analysis takes place.

This technology can benefit wide-ranging parts of society, from agriculture to mining, manufacturing, transportation, research, etc.
Human labour is often seen as the highest cost in any process, and as such, companies often seek to reduce this cost. The rise of the tools and procedures associated with industry 4.0 appears to be a perfect solution to this. Take note here that the solution for one problem creates a cascade of further issues to resolve, and in this particular case, it is the decreasing requirement for human labour.

This is precisely where the role of standards attempts to place itself in the industry. The idea behind the standards is to ensure that the technologies and processes developed and used worldwide, are consistent in as many ways as possible. This is to allow for greater integration in vertical and horizontal value chains everywhere [3].

It is these standards which allow a single factory to make use of tools from many different original equipment manufacturers (OEM's), and to be safe, secure, and sure that their system will work, and continue to work as expected for its guaranteed service life.
It is this highly integrated, and extensive communication system, where threats can abound if not appropriately managed. The concept of industry 4.0, as defined above, relies on many devices communicating with each other to form networks that cooperate to perform some end goal.

The IEC highlights that the most critical impact that standards can make is that of *"allowing systems of different manufacturers to interconnect and interoperate without the need for special integration efforts"* [4].

This goal, outlined by the General Secretary and CEO of the IEC, is far more complicated than merely setting rules for researchers, designers, and manufacturers; it is a call to all standards bodies and stakeholders to collaborate. This highlights the importance of removing the historical construction of information silo's, where everything operates in a closed system, each system isolated from the next.

What is left unsaid in that quote is that all of these systems need to "interconnect and interoperate" safely and securely. This is a central tenet of the role of standards.

The highly integrated design of systems now requires this level of collaboration to ensure the standards can maintain a level of consistency and security at all levels.

It is precisely where this system fails, that allows bad actors into the system, where they can take advantage of flaws and vulnerabilities in the system. The following example highlights how a single design gap, or critical vulnerability in one part of the system, can compromise the entire chain.

The pace of technological process in this space results in higher adoption of the technology, which in turn increases the demands for more performance, more capabilities, more interconnectedness. This spawns a continuous feedback loop which drives the tools and techniques.

This, new move fast, and break things mentality, is beginning to show vulnerabilities. This is increasingly seen to be adopted by companies that observe that this competitive progress has proved to work.

Industry, the backbone to many economies and livelihoods require the exact opposite of this mentality, they enforce strict safety and security requirements in their entire process, or at least, they aim to do so. This pragmatic approach has served them well, incremental benefits that accrue over many years. This slow adoption of technology, once it has proven itself, is how the industry has continued to perform and drive economies.

This stands in stark contrast to the current trend that many see as a danger to the way things have been done. However, these technologies - these disruptors - are not slowing their pace; they are forging ahead. This has, in turn, forced industry to take an active role in the path decision process.

It is where industry and other stakeholders do not cooperate, where this process falls apart. A particularly relevant example is the increasingly frequent occurrences of IoT devices being hijacked by bad actors in the system either from vulnerabilities, or baked into the design at a system level.

October 31st, 2016, saw an unprecedented impact on the internet resulting from a distributed-denial-of-service (DDOS) attack on critical servers which service the backbone of the internet [5][6]. The attack saw many parts of the internet stop working. The source of the attack? A collection of compromised IoT devices around the world, coordinated by an attacker (or group of attackers), were directed to spawn multiple requests from specific parts of the internet, causing massive congestion and eventual failure of the equipment.

This example is particularly relevant, and the industry should learn from the mistakes of such cases. The devices used in the attack span a wide range of methods used in people's homes. The methods bought and installed, often by semi-tech savvy users, are designed and configured to work out of the box, this is to increase the adoption of as many users as possible.

This means relaxing some safety and security features to get people to more easily get it up and running. This includes removing the need to have passwords to log into the device or setting up accounts to manage it. Each of these decisions by the equipment designers, and in turn, the end-users, results in a highly compromised product. They are opening the door to hackers all over the world. This universal access is part and parcel of the IoT devices; they are always connected to the internet; they need to be to provide the services that the customers are looking for. It is this simple installation and uses that accelerates the adoption of such devices; without it, the benefits enabled by these devices would not be possible.

In this circumstance, the infection of devices, often in people's homes, were used by an external party to enact damage, not on the people or their homes themselves, but instead were targeted at another source, which in this case appeared to be a critical functional part of the internet.
These attacks are becoming more prevalent due to the continual rise of globally internet-connected devices which do not comply with current standards.

The introduction of IoT device standards have been slow to pick up; it is only recently that large manufacturers, the likes of Apple, Microsoft, and Amazon, has there been a concerted effort to collaborate on forming standards [7].

The companies have seen that, in addition to their decreasing ability for different connected devices to communicate, have noticed that there is a significant benefit to adopt a similar system where they can take advantage of increased security, as observed in their press releases. They see security as a vital component of the standard.

The nature of these devices, the fact that they are often installed in homes—one of the most private spaces for people—while having capabilities to record video and audio, snoop on communications on the network, means that these devices have increasingly personal and private data access.

This is also true when the technology is used in industry, except here, the devices often have a higher level of access and control as they are required to manage and automate systems. These devices are purposefully installed in highly critical areas. A lot of trust is placed on the current designs of technology.

Industry plays an essential role in society; many parts provide basic needs for populations, including water, electricity, gas, communications. These amenities are critical to the functioning of any system and society. Consequently, if any of these systems were to become infected, or compromised, the bad actor in the system could wreak havoc.

So, observing the threats that this technology poses to industry, and in turn, society, how can it be combated? There are several solutions to this problem, the first being to not adopt and embrace the technology. This is a foolish approach, and the spread of the technology is inevitable; any industry that backs away from the technology is increasingly at risk of being disrupted and will eventually lose their role.

This example, where bad actors can take advantage of the technology is a single example. Luckily it did not lead to the loss of human life. Merely having access to these devices opens up a world of possibilities; they become capable of infiltrating the system further, stealing intellectual property, extorting companies and individuals, etc.

How technology is adopted, and the follow-up of standards can often be observed as a model that is similar to the "tick-tock" effect that is seen in computing power [8].

Semiconductor technology progresses in steps where the new fabrication process is often met with high costs and sophisticated manufacturing processes. As time passes, the designers and engineers observe ways in which to refine the process which brings down the costs and intricate processes that were initially required.

This tick-tock effect is also observed in the technology to the standards system. New technology is invented or designed, several industries then adapt it until finally, the standards bodies see an increasing trend of adoption. Then they begin the process of creating a standard that will, hopefully, become adopted over time.

Standards often take years to be theorised, formed, edited, commented on, and introduced. This results in a significant delay between when the technology is first invented, to when the standards process catches up to it. This can be many years, resulting in an unstable state, where the technology continues its inevitable progress, and industry flails and attempts to take advantage of new systems without guidance from standards bodies, or does not adopt the technology and falls behind.

The old method of how standards progress has been highly critiqued. The process in which standards have been created historically is not fit for the current trend in the pace of technological advancement.

This precipitates the current trend, that the IEC is embracing, to jump ahead and create standards and put systems in place ahead of time to reduce the probability of disasters down the line. The previous industrial revolutions are a clear lesson to learn here. These previous revolutions were met with much hesitation, which often sparked a public outcry. The former revolutions created a lot of benefit to societies, but also a lot of pain for parts of society. This is precisely where standards can attempt to plan a path fraught with less trouble.

Of great concern, and not particularly commented on in this essay, is the fact that further mechanisation of the workforce will continue to happen, replacing current jobs with machines, and displacing many workers. This is a challenge facing the entire world, and one that standards cannot solve alone, it will need the combined effort of many parts of society, in addition to standards bodies, to collaborate and ensure that this transition continues with minimal adverse effects.

Another topic that is particularly relevant in this space is that of privacy. The rise in always-connected devices, the increase of data in every sphere, poses significant concerns for individuals and companies to maintain a level of privacy that before was simply a given.

The possibilities that the technologies reveal is endless as the previous revolutions have shown. There are countless benefits to society, as well there are endless downsides to consider as well.

Technology is an amoral force; it comes down to the individuals, teams, companies, workforces, and societies to decide how the technology can be harnessed, for good or bad [9,10,11,12].

So, if the technology is left to continue its path unchecked, history may repeat itself. This is particularly relevant when looking at the example that has already left a mark.

People need to decide before, or at least timeously, how technology is created and harnessed so that the consequences are attenuated or avoided altogether.

Once society works together, with eyes wide open to how the world is changing, only then can progress be made equitably and ethically.

It is only with the historical knowledge of previous revolutions and understanding the earlier shortfalls that previous generations encountered can a path forward be planned. This does not mean that there will be failures in the implementation of standards bodies in their work, this is inevitable; it is with the structured and pragmatic approach that standards bodies use that many of histories failures can be avoided. It is with the concerted effort of individuals everywhere that these disasters can be avoided, and in the case that they do happen, their effects reduced. wn

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At present, well above a million PV systems are installed in Germany. Based on the fact that self-generated electricity is generally cheaper and provides a high degree of electrical independence from the grid, PV systems will become an integral part of electrical installations in the future. However, these systems are exposed to all weather conditions and must withstand them over decades.

The cables of PV systems frequently enter the building and extend over long distances until they reach the grid connection point. Lightning discharges cause field-based and conducted electrical interference. This effect increases in relation to the length of the cables and the size of the conductor loops. Surges not only damage the PV modules, inverters and their monitoring electronics, but also devices in the building installation. In industrial buildings, production facilities may be damaged causing production to come to a standstill.

If surges are injected into systems that are far from the power grid, so-called stand-alone PV systems, the operation of equipment powered by solar electricity (e.g. medical equipment, wa- ter supply) may be disrupted.

NECESSITY OF A ROOFTOP LIGHTNING PROTECTION SYSTEM

The energy released by a lightning discharge is one of the most frequent

Lightning and surge protection for rooftop photovoltaic systems

causes of fire. Therefore, personal and fire protection is of paramount importance in case of a direct lightning strike to the building.

At the design stage of a PV system, it is evident whether a lightning protection system is installed on a building. Building regulations in some countries require public buildings (e.g. places of public assembly, schools and hospitals) to be equipped with a lightning protection system. In case of indus- trial or private buildings, whether or not a lightning protection system needs to be installed depends on their location, the type of construction and utilisation. To this end, it must be determined whether lightning strikes are to be expected or could have severe consequences. Structures in need of protection should be provided with permanently effective lightning protection systems.

According to the current state of scientific and technical knowledge, the

installation of PV modules does not increase the risk of a lightning strike. Therefore, the request for lightning protection measures cannot be derived directly from the mere existence of a PV system. However, substantial lightning interference may be injected into the building through these systems. Therefore, it is necessary to determine the risk resulting from a lightning strike as per IEC 62305-2 (EN 62305-2) and to take the results from this risk analysis into account when installing the PV system.

The DEHNsupport Toolbox software is specially designed to calculate this risk and produce a clear, easily understandable analysis. It compares the risk with the technical expenditure and suggests economically optimised protection measures.

As a general rule, rooftop photovoltaic systems must not interfere with the existing lightning protection measures.

NECESSITY OF SURGE PROTECTION FOR PV SYSTEMS

In case of a lightning discharge, surges are induced on electrical conductors. Surge protective devices (SPDs) which must be installed upstream of the devices to be protected on the AC, DC and data side have proven very effective in protecting electrical systems from these destructive voltage peaks. Section 8 of IEC 61643-32 calls for the installation of surge protective devices unless a risk analysis demonstrates that SPDs are not required. According to IEC 60364-4-44 standard, surge protective devices must also be installed for buildings without an external lightning protection system such as commercial and industrial buildings, e.g. agricultural facilities. IEC 61643-32 and IEC TR 63227 ** provide a detailed description of the types of SPDs and their place of installation.

CABLE ROUTING OF PV SYSTEMS

Cables must be routed in such a way that large conductor loops are avoided. This must be observed when combining the DC circuits to form a string and when interconnecting several strings.

Moreover, data or sensor lines must not be routed over several strings and form large conductor loops with the string lines. This must also be observed when connecting the inverter to the grid connection. The important thing is that the power (DC and AC) and data lines (e.g. radiation sensor, yield moni- toring) are routed together with the equipotential bonding conductors along their entire route.

EARTHING OF PV SYSTEMS

PV modules are typically fixed on metal mounting systems. The live PV components on the DC side feature double or reinforced insulation (comparable to the previous protective insulation) as required in the IEC 60364-4-41 standard. The combination of numerous technologies on the module and inverter sides (e.g. with or without galvanic isolation) results in different earthing requirements. Moreover, the insulation monitoring system integrated in the inverters is only permanently effective if the mounting system is connected to earth. Information on the practical implementation is provided in IEC TR 63227 standard.

Functional earthing should be established if the PV system is located in the protected volume of the air-termination systems and the separation distance is maintained. Section 7 of IEC TR 63227 requires copper conductors with a cross-section of at least 6 mm^2 or equivalent for functional earthing (Figure 1). The mounting rails also have to be permanently interconnected by means of conductors of this cross-section. If the mounting system is directly connected to the external lightning protection system due to the fact that the separation distance s cannot be maintained, these conductors become part of the lightning equipotential bonding system. Consequently, these elements must be capable of carrying lightning currents. The minimum requirement for a lightning protection system designed for class of LPS III is a copper conductor with a cross-section of 16 mm^2 or equivalent. Also in this case, the mounting rails must be permanently interconnected. The requirements on natural components according to IEC 62305-3 (EN 62305-3) apply here (Figure 2).

UNI earthing clamps (Figure 3) can be fixed on all common mounting systems. They connect, for example, copper conductors with a cross-section of 6 or 16 mm^2 and bare round wires with a diameter from 8 to 10 mm to the mounting system in such a way that they can carry lightning currents. The integrated stainless steel (V4A) contact plate ensures corrosion protection for the aluminium mounting systems.

SEPARATION DISTANCE S AS PER IEC 62305-3 (EN 62305-3)

A certain separation distance s must be maintained between a lightning protection system and a PV system. It defines the distance required to avoid uncontrolled flashover to adjacent metal parts resulting from a lightning strike to the external lightning protection system. In the worst case, such an uncontrolled flashover can set a building on fire. In this case, damage to the PV system becomes irrelevant.

Details on calculating the separation distance s can be found in chapter 5.6 and of our Lightning Protection

Guide and are easily and quickly calculated using the DEHN Distance Tool software.

CORE SHADOWS ON SOLAR CELLS

The distance between the solar generator and the external lightning protection system is an important aspect to be con- sidered in order to prevent excessive shading. Diffuse shadows cast by, for example overhead lines, do not significantly affect the PV system and the yield. However, in case of core shadows, a dark clearly outlined shadow is cast on the surface behind an object, changing the current flowing through the PV modules. For this reason, it should be ensured that solar cells and the associated bypass diodes are not influenced by core shadows. This can be achieved by maintaining sufficient distance. For example, if an airtermination rod with a diam- eter of 10 mm shades a module, the core shadow is steadily reduced as the distance from the module increases. After 1.08 m only a diffuse shadow is cast on the module (Figure 4). Annex A of IEC TR 63227 provides more detailed information on the calculation of core shadows.

SPECIAL SURGE PROTECTIVE DEVICES FOR THE DC SIDE OF PHOTOVOLTAIC SYSTEMS

The U/I characteristics of photovoltaic current sources are very different from those of conventional DC sources: They have a non-linear characteristic (Figure 5) and cause longterm persistence of ignited arcs. This unique nature of PV current sources not only requires larger PV switches and PV fuses, but also a disconnector for the surge protective device which is specially designed for the purpose and capable of coping with PV currents. The selection of suitable SPDs is described in sub-section 9.2 of IEC 61643-32 or in Section 5.6 of IEC TR 63227.

Type 1 DC arrester for use in PV systems: Multipole type 1 + type 2 combined DC arrester, DEHNcombo YPV With their proven fault-resistant Y circuit, DEHNcom- bo YPV (FM) combined arresters (Figure 6) fulfil the above mentioned requirements. PV generators with up to 10,000 A can be protected by DEHNcombo YPV (FM) without an additional backup fuse. This arrester combines a lightning current arrester and a surge arrester in a single device, thus ensuring efficient protection of terminal equipment. With its discharge capacity Itotal of 12.5 kA (10/350 µs), it is very flexible and can even be used for the highest classes of LPS. DEHNcombo YPV (FM) is available for voltages UCPV of ≤ 1200 V and ≤ 1500 V and has a width of only 4 modules. It is therefore the ideal type 1 combined arrester for use in photovoltaic power supply systems.

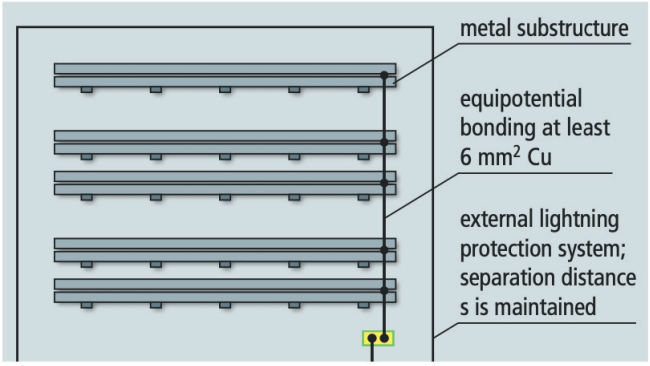


Figure 1

Functional earthing of the mounting systems if no external lightning protection system is installed or the separation distance is maintained (IEC TR 63227)

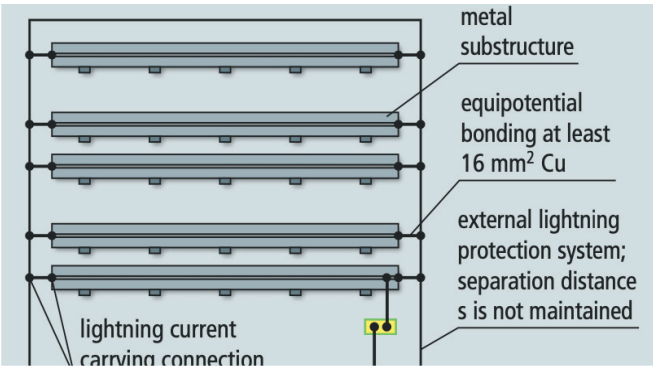


Figure 2

Lightning equipotential bonding for the mounting systems if the separation distance is not maintained

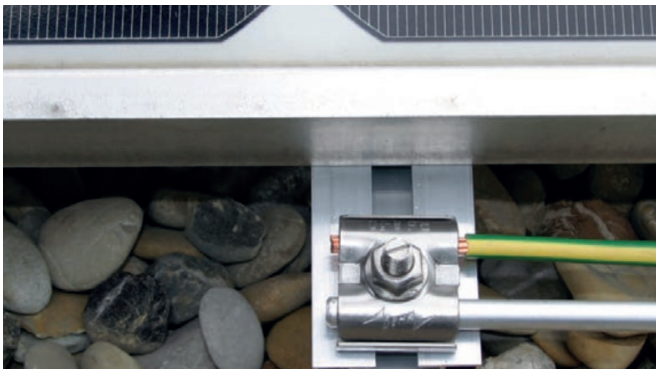
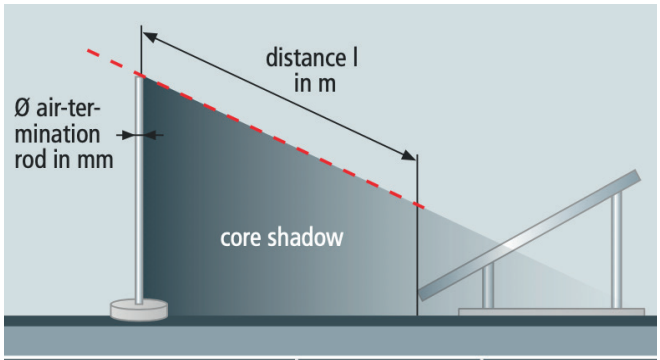


Figure 3

UNI earthing clamp: A stainless steel intermediate element prevents contact corrosion, thus establishing reliable long-term connections between different conductor materials



Ø air-termination rod	x factor	= distance l
10 mm	108	1.08 m
16 mm	108	1.73 m

Figure 4
Distance between the module and the air-termination rod required to prevent core shadows

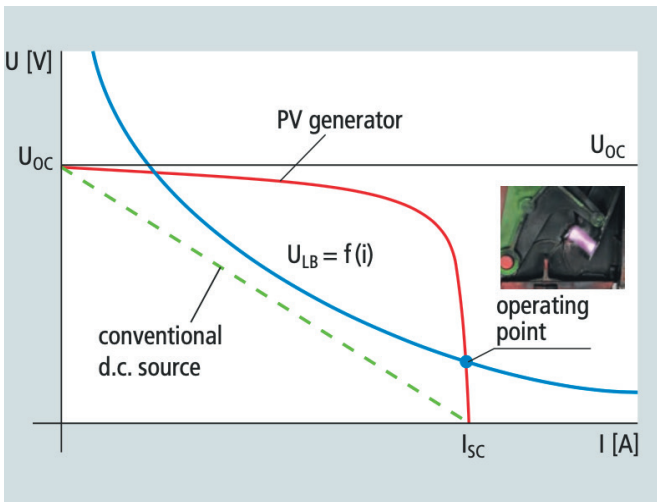


Figure 5
Source characteristic of a conventional DC source versus the source characteristic of a PV generator. When switching PV sources, the source characteristic of the PV generator crosses the arc voltage range

TYPE 2 DC ARRESTER FOR USE IN PV SYSTEMS: DEHNGUARD M YPV AND DEHNCUBE YPV

Reliable operation of SPDs in DC PV circuits is also indispensable when using type 2 surge protective devices. To this end, the DEHNguard M YPV SCI ... (FM) and DEHNcube YPV SCI ... surge arresters also feature a fault-resistant Y protective circuit (Figures 7 and 8).

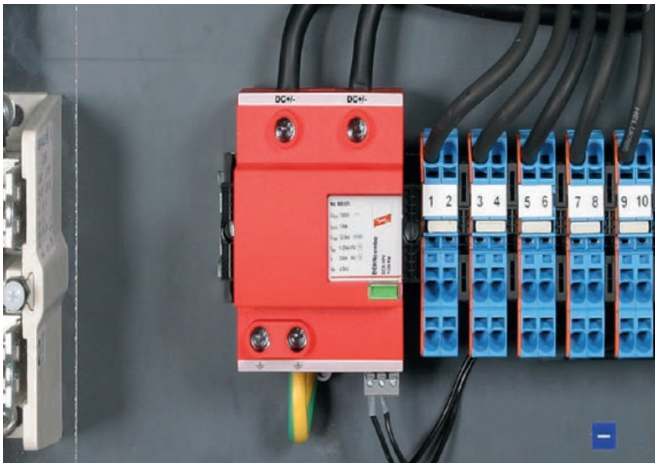


Figure 6
DEHNcombo YPV type 1 combined arrester for protecting photovoltaic systems from surges and partial lightning currents

SELECTION OF SPDS ACCORDING TO THE VOLTAGE PROTECTION LEVEL U_P

The operating voltage on the DC side of PV systems differs from system to system. At present, values up to 1500 V DC are possible. Consequently, the dielectric strength of terminal equipment also differs. To ensure that the PV system is reliably protected, the voltage protection level U_p of the SPD must be lower than the dielectric strength of the PV system it is supposed to protect. The IEC 61643-32 standard requires that U_p is at least 20 % lower than the dielectric strength of the PV system. Type 1 or type 2 SPDs must be energy-coordinated with the input of terminal equipment. If SPDs are already integrated in terminal equipment, coordination between the type 2 SPD and the input circuit of terminal equipment is ensured by the manufacturer (Figure 9).

APPLICATION EXAMPLES:

BUILDING WITHOUT AN EXTERNAL LIGHTNING PROTECTION SYSTEM (SITUATION A)

Figure 10 shows the surge protection concept for a PV system installed on a building without an external lightning protection system. Dangerous surges enter the PV system due to inductive coupling resulting from nearby lightning strikes or travel from the power supply system through the service entrance to the consumer's installation. The SPDs can be installed at the following locations:

- DC side of the modules and inverters
- AC output of the inverter
- Main low-voltage distribution board
- Wired communication interfaces

Class of LPS and max. lightning current (10/350 µs)		Number of down conductors of the external lightning protection system			
		< 4		≥ 4	
		Values for the voltage-limiting type 1 SPDs or type 1 combined SPDs (series connection) based on a selection of $I_{8/20}$ (8/20 µs) and $I_{10/350}$ (10/350 µs)			
		$I_{SPD1} = I_{SPD2}$ $I_{8/20}/I_{10/350}$	$I_{SPD3} = I_{SPD1} + I_{SPD2} = I_{total}$ $I_{8/20}/I_{10/350}$	$I_{SPD1} = I_{SPD2}$ $I_{8/20}/I_{10/350}$	$I_{SPD3} = I_{SPD1} + I_{SPD2} = I_{total}$ $I_{8/20}/I_{10/350}$
I or unknown	200 kA	17/10	34/20	10/5	20/10
II	150 kA	12.5/7.5	25/15	7.5/3.75	15/7.5
III and IV	100 kA	8.5/5	17/10	5/2.5	10/5

Table 1

Selection of the minimum discharge capacity of voltage-limiting type 1 SPDs (varistors) or type 1 combined SPDs (series connection of varistors and spark gaps); according to IEC 61643-32 (Table A.1) and IEC TR 63227 (Table 2)

Every DC input (MPPT) of the inverter must be protected by a type 2 surge protective device, for example DEHNguard M YPV 1200 FM, that reliably protects the DC side of PV systems. The IEC 61643-32 and the IEC TR 63277 standards require an additional type 2 DC arrester to be installed on the module side if the distance between the inverter input and the PV generator exceeds 10 m.

If PV inverters and further electronic components like, for example, AC coupled battery storage systems, are situated no further than 10 m away from where the arrester is installed at the grid connection point (low-voltage infeed), they are sufficiently protected. In case of greater cable lengths, an additional type 2 surge protective device must be installed.

For the grid connection point we recommend installing the combined type 1 + 2 arrester DEHNventil Basic. Reliable spark gap technology means that it can be used upstream of the meter.

If inverters are connected to data and sensor lines to monitor the yield, suitable surge protective devices are required. BLITZDUCTOR XTU, which features terminals for two pairs, for example for incoming and outgoing data lines, can be used for data systems based on RS 485.

BUILDING WITH EXTERNAL LIGHTNING PROTECTION AND SUFFICIENT SEPARATION DISTANCE S (SITUATION B)

Figure 11 shows the surge protection concept for a PV system with an external lightning protection system and sufficient separation distance s between the PV system and the external lightning protection system.

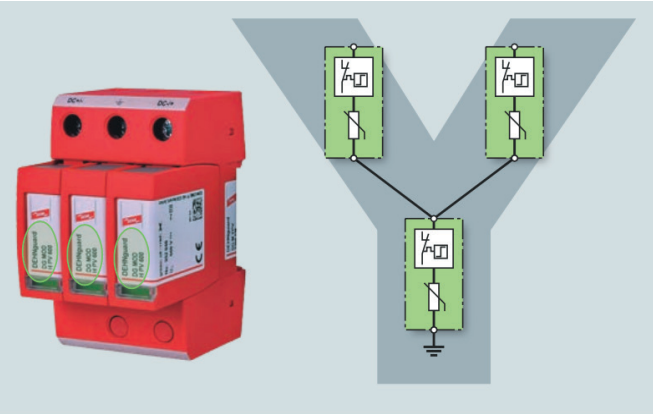


Figure 7

Modular DEHNguard M YPV ... (FM) type 2 surge arrester with fault-resistant Y circuit

Figure 8

Ready-to-install type 2 DEHNcube YPV SCI 1000 1M surge arrester

Figure 9
DEHNguard type 2 SPD integrated in the inverter for the DC side

The primary protection goal is to avoid damage to people and property (fire) resulting from a lightning strike. In this context, it is important that the PV system does not interfere with the external lightning protection system.

Moreover, the PV system itself must be protected from direct lightning strikes. This means that the PV system must be installed within the protected volume of the external lightning protection system. This protected volume is formed by air-termination systems (e.g. air-termination rods) which prevent direct lightning strikes to the PV modules and cables. The protective angle method (Figure 12) or rolling sphere method (Figure 13) as described in subsection 5.2.2 of the IEC 62305-3 (EN 62305-3) standard may be used to determine this pro- tected volume. A certain separation distances must be maintained between all conductive parts of the PV system and the lightning protection system. In this context, core shad ows must be prevented by, for example, maintaining a sufficient distance between the air-termination rods and the PV module.

Lightning equipotential bonding is an integral part of a lightning protection system. It must be implemented for all conductive systems and lines entering the building which may carry lightning currents. This is achieved by directly connecting all metal systems and indirectly connecting all energised systems via type 1 lightning current arresters to the earth-termination system. Lightning equipotential bonding should be implemented as close as possible to the entrance point into the building to prevent partial lightning currents from entering the building. The grid connection point must be protected by a multipole type 1 SPD, for example a spark-gap-based DEHNventil combined arrester. This arrester combines a lightning current arrester and a surge arrester in a single device. If the length of the cables between the arrester, the inverter and further electronic components like, for example, AC coupled battery storage systems is less than 10 m, sufficient protection is provided. In case of longer cables, additional type 2 DEHNguard M surge protective devices must be installed upstream of the devices to be protected.

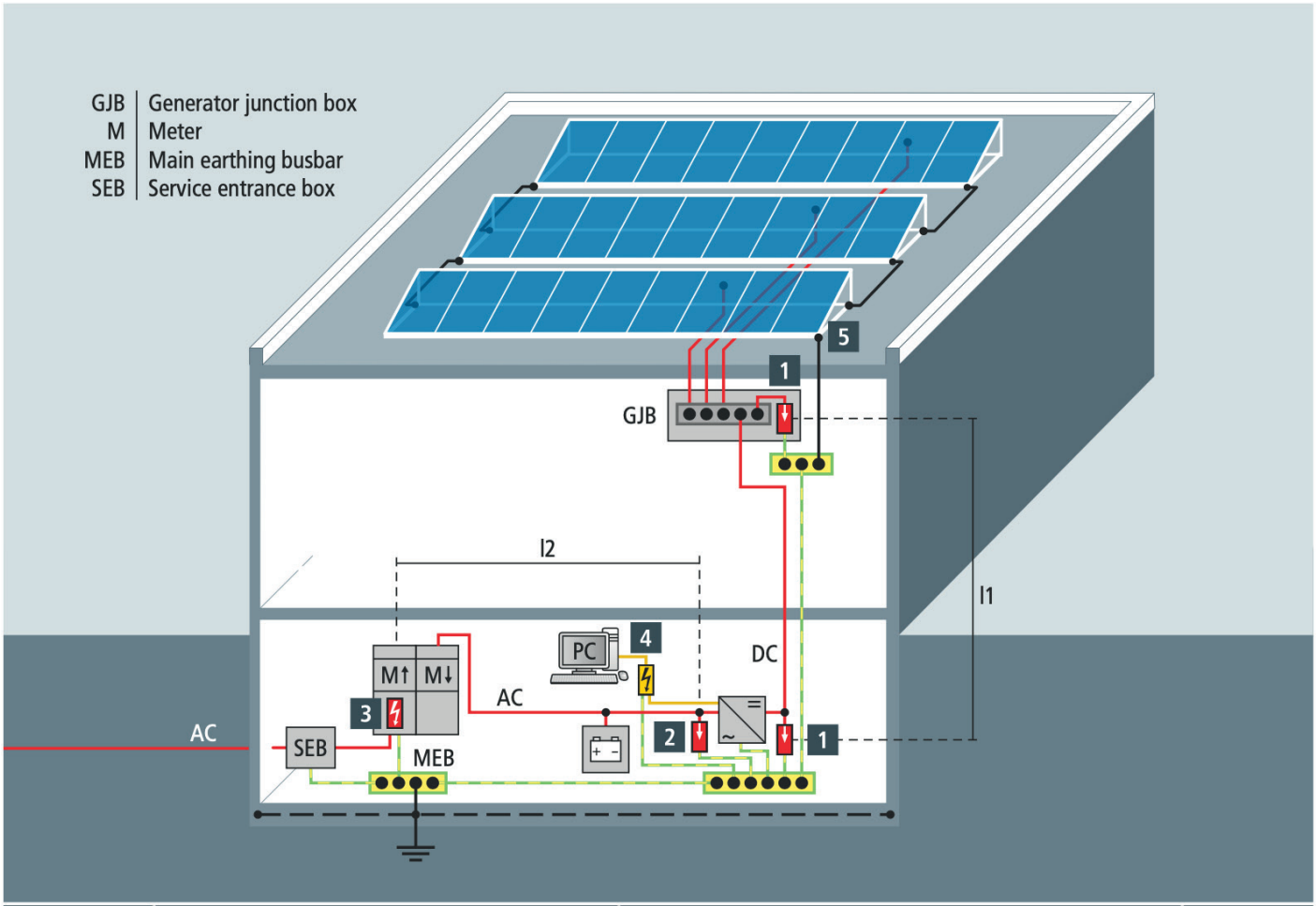
The DC side of the inverter must be protected by a type 2 PV arrester, for example DEHNcube YPV SCI ... (Figure 14). If the inverters are connected to data lines, for example to monitor the yield, surge protective devices must be installed to protect data transmission. BLITZDUCTOR XTU with actiVsense technology can be used here to protect both lines with an analogue signal and data bus systems such as RS485. It automatically detects the operating voltage of the useful signal and adjusts the voltage protection level to this operating voltage.

HIGH-VOLTAGE-RESISTANT, INSULATED HVI CONDUCTOR

Another technical solution for keeping the separation distance s is to use high-voltage-resistant, insulated HVI Conductors which make it possible to maintain a separation distance s up to 0.9 m in air. HVI Conductors may come into direct contact with the PV system downstream of the sealing end range. More detailed information on the application and installation of HVI Conductors is provided in our Lightning Protection Guide or in the relevant installation instructions.

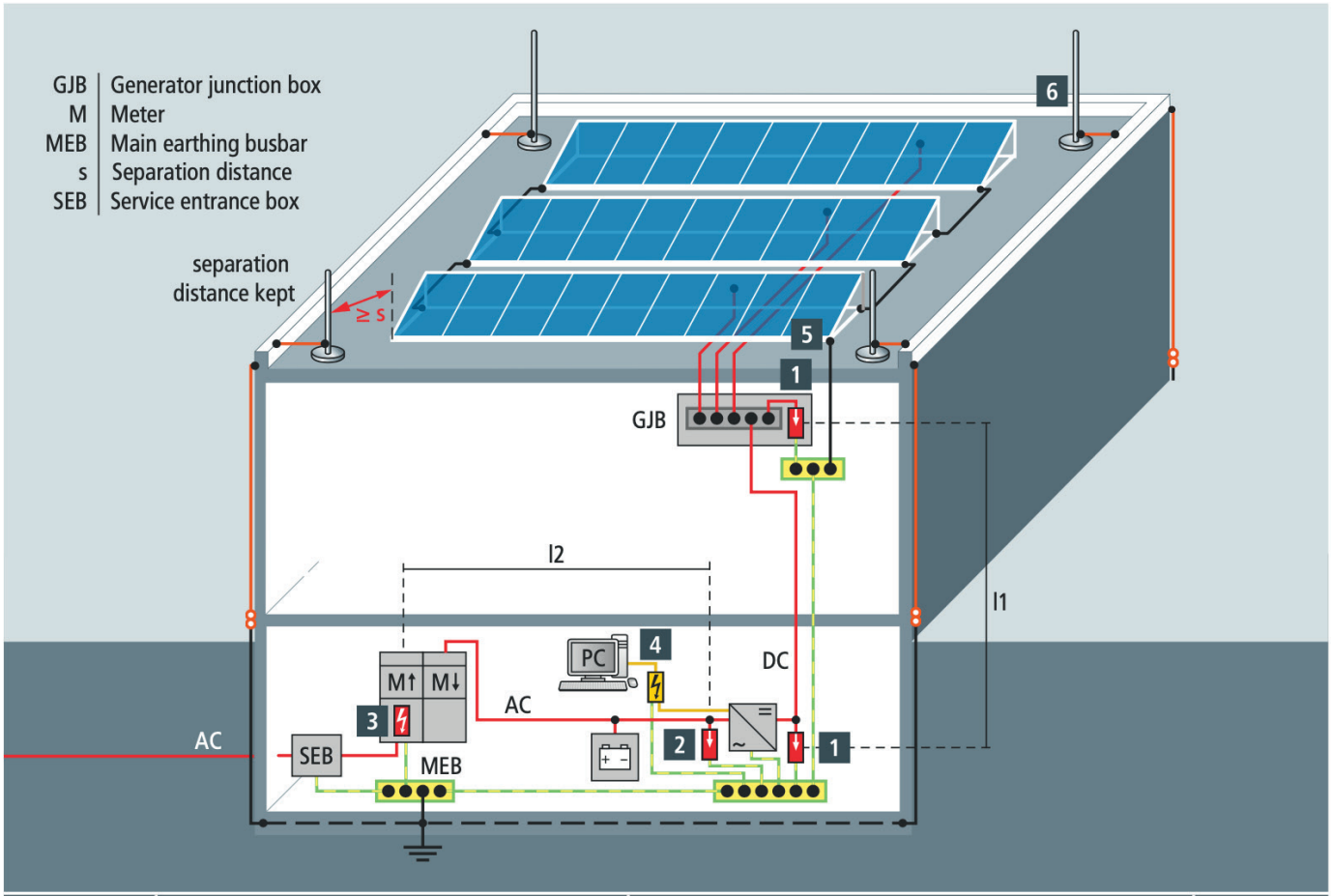
BUILDING WITH EXTERNAL LIGHTNING PROTECTION AND INSUFFICIENT SEPARATION DISTANCE S (SITUATION C)

If the roofing is made of metal or is formed by the PV system itself, the separation distance s cannot be maintained. The metal components of the PV mounting system must be connected to the external lightning protection system in such a way that they can carry lightning currents (copper conductor with a cross-section of at least 16 mm^2 or equivalent). This means that lightning equipotential bonding must also be implemented for the PV lines entering the building from the outside. According to IEC 61643-32 and IEC TR 63227, DC lines must be protected by a type 1 SPD for PV systems.



		SPD * FM = Floating remote signalling contact	Part No.
DC input of the inverter (if l1 > 10 m, additional SPD required for the PV generator)			
1	For 1 MPPT	DEHNguard DG M YPV 1200 FM*	952 565
		DEHNcube DCU YPV SCI 1000 1M	900 910
	For 2 MPPTs	DEHNguard DG M PV2 SCI 1000 FM*	952 519
		DEHNcube DCU YPV SCI 1000 2M	900 920
AC output of the inverter (required, if l2 > 10 m)			
2	TN-S system	DEHNguard DG M TNS 275 FM*	952 405
Low-voltage input			
3	TN-C system	DEHNshield Basic TNC 255 FM	941 306
	TT system	DEHNshield Basic TT 255 FM	941 316
	TN-S system	DEHNshield Basic TNS 255 FM	941 406
Data interface			
4	Two pairs, even with different operating voltages up to 180 V	BLITZDUCTOR BXTU ML4 BD 0-180 + BXT BAS base part	920 349 + 920 300
Functional earthing			
5	Functional equipotential bonding	UNI earthing clamp	540 250

Figure 10 : PV system installed on a building without external LPS



		SPD * FM = Floating remote signalling contact	Part No.
DC input of the inverter (if l1 > 10 m, additional SPD required for the PV generator)			
1	For 1 MPPT	DEHNguard DG M YPV 1200 FM*	952 565
		DEHNcube DCU YPV SCI 1000 1M	900 910
	For 2 MPPT	DEHNguard DG M PV2 SCI 1000 FM*	952 519
		DEHNcube DCU YPV SCI 1000 2M	900 920
AC output of the inverter (required, if l2 > 10 m)			
2	TN-S system	DEHNguard DG M TNS 275 FM*	952 405
Low-voltage input			
3	TN-C system	DEHNventil DV M TNC 255 FM*	951 305
	TN-S system	DEHNventil DV M TNS 255 FM*	951 405
	TT system	DEHNventil DV M TT 255 FM*	951 315
Data interface			
4	Two pairs, even with different operating voltages up to 180 V	BLITZDUCTOR BXTU ML4 BD 0-180 + BXT BAS base part	920 349 + 920 300
Functional earthing / External lightning protection system			
5	Functional equipotential bonding	UNI earthing clamp	540 250
6	Air-termination system	Air-termination rod with concrete base (8.5 kg)	101 000 + 102 075

Figure 11 PV system installed on a building with external LPS and sufficient separation distance

Figure 12
Determination of the protected volume using the protective angle method

Figure 14
DEHNcube YPV SCI 1000 1M type 2 arrester for protecting inverters (1 MPPT)

For this purpose, a type 1 and type 2 DEHNcombo YPV (FM) combined arrester is used. Lightning equipotential bonding must also be implemented in the low-voltage infeed.

If the inverter and, for example, the battery storage system, are situated more than 10 m from the type 1 SPD installed at the grid connection point, an additional type 1 SPD must be installed (e.g. type 1 + type 2 DEHNshield ... 255 combined arrester). Suitable surge protective devices must also be installed to pro- tect the relevant data lines for yield monitoring.

BLITZDUCTOR XTU surge protective devices are used to protect data systems, for example based on RS 485. wn

*** IEC TR 63227 ED1 „Lightning and surge voltage protection for photovoltaic (PV) power supply systems" has been approved by TC 82 "Solar photovoltaic energy systems" and will be published within 2019.*

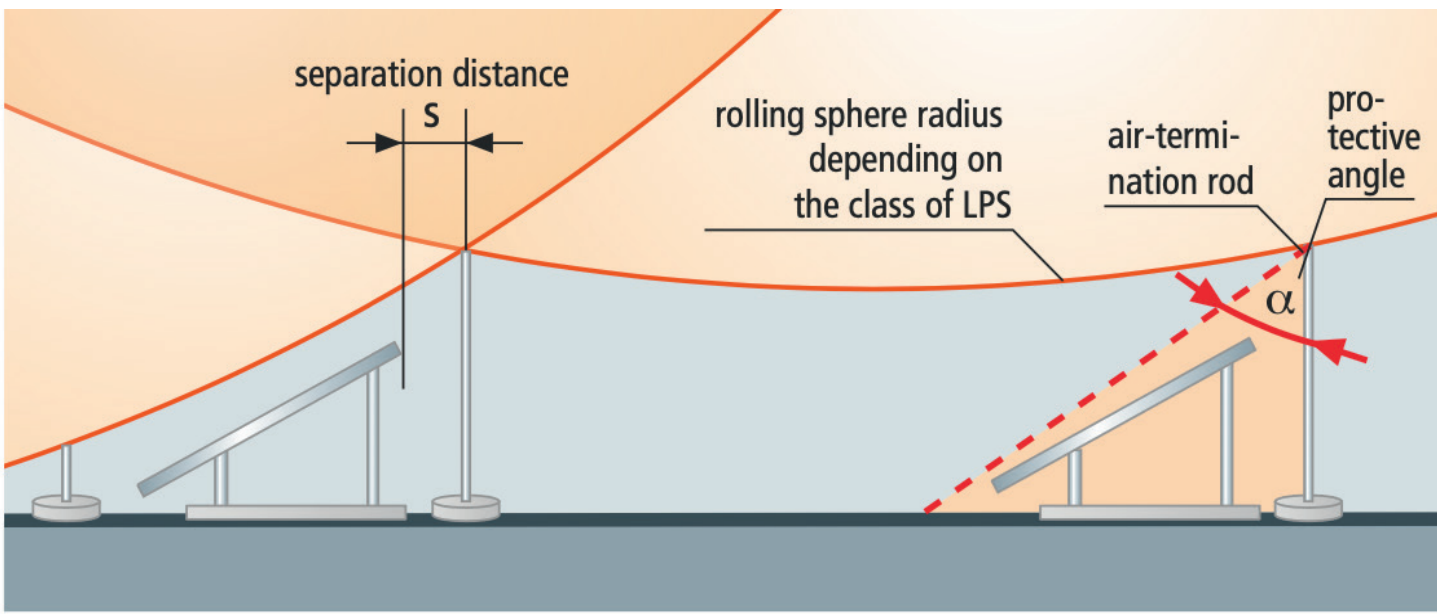
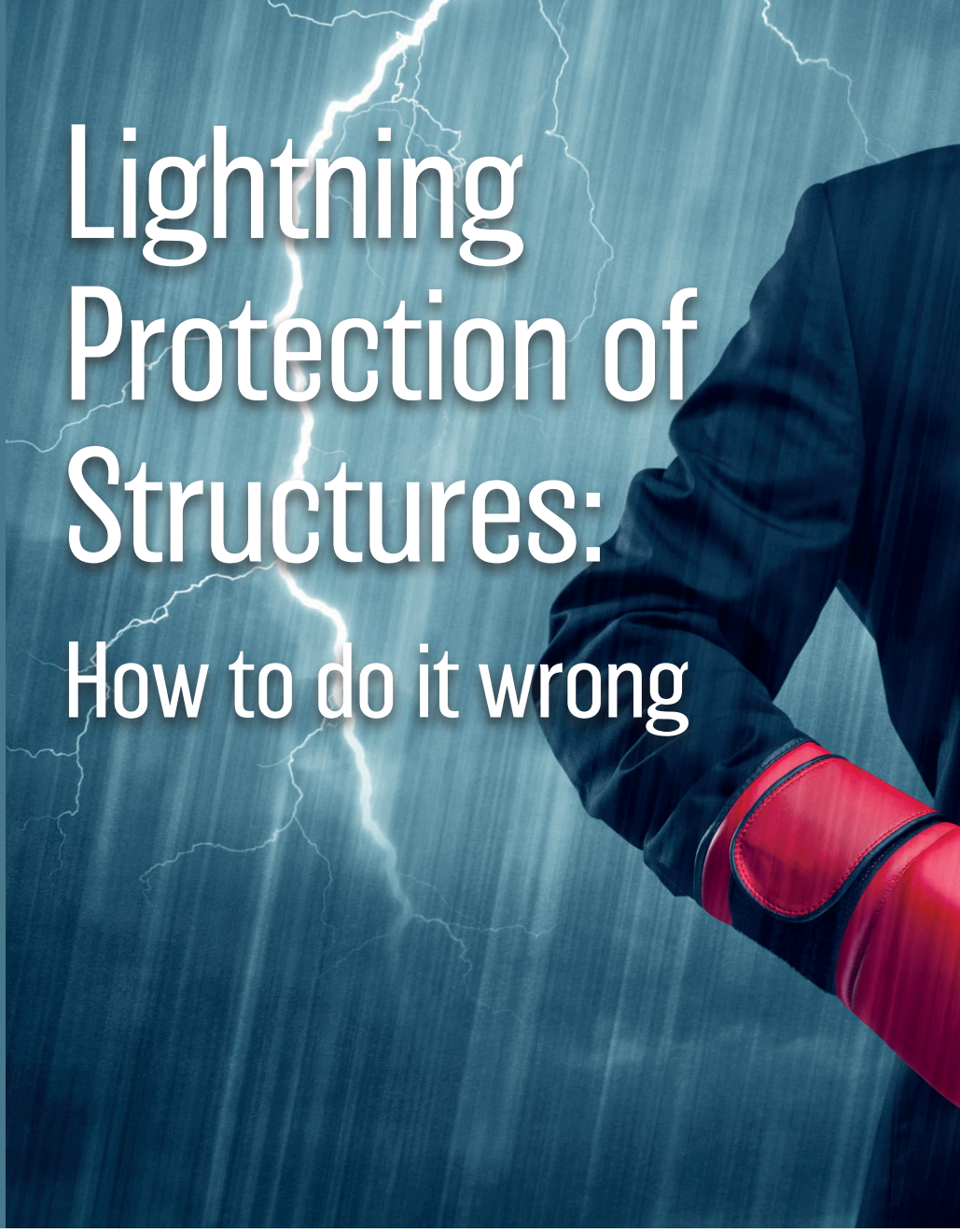


Figure 13
Rolling sphere method versus protective angle method for determining the protected volume

Lightning Protection of Structures:

How to do it wrong



Most parts of South Africa records high lightning occurrence levels, as per the lightning ground flash maps issues by several agencies. The country is also not short of a towering figure of lightning-related human/ animal accidents and property damage, including power outages.

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The situation is not very different in other neighbouring countries in the sub-Saharan region. Similar to many lightning dense countries in the world such as Malaysia, India, Bangladesh, Colombia, Brazil, Venezuela etc., in South Africa as well some highly populated and vastly industrialised areas are located in lightning red zones. These areas are exposing both living beings and man-made systems into utmost danger and high level of risk of being affected by lightning.

The high lightning density, human and livestock casualties, and property damage attract not only genuine Lightning Protection (LP) providers but many fraudulent and products, erroneous techniques, unethical and unscrupulous vendors and incompetent designers, consultants, advisers etc. as well. Such a situation leads the general public not only to spend their money superfluously but also to place them at utter danger due to a false sense of safety. The failure of the timely intervening of governments, statutory bodies and experts in educating the public and imposing strict regulations on LP measures, caused the flooding of unscientific products which are not recommended either by International (IEC) or national standards. For an example - by the time the Malaysian government issued regulations on installing LPSs, only that are recommended by the Malaysian Standards (MS IEC 62305-2011), almost 75% of the LPSs in the country were beyond the scopes of recommendations given by the national standards. Malaysia dearly paid for this delay with a large number of buildings being damaged by lightning despite having these unscientific systems. The damaged properties include a lightning-caused fire at a major hospital

in the country (Putrajaya hospital) and several other critical installations. However, Malaysia remains one of the few (if it is not the ONLY) countries that have taken the bold step of banning these non-standard systems being implemented in the country.

The lessons learned by the scientific community in Malaysia and many other countries demand timely steps and precautionary measures to be taken in Africa, which is mostly unfiltered by these scientifically unacceptable products at the moment. The South African standards (SANS 62305- 2011) which are the most comprehensive such standard in the continent, do not recommend such unscrupulous technologies and the majority of the scientific community also strongly condemn such. Thus, it is the high time to educate the relevant policymakers and public to be vigilant on adopting Lightning Protection Systems (LPSs) only that are recommended by the national standards.

Although there are several types of non-conventional (not recommended by IEC Standards or SANS) LPS, the most commonly used of them are the early streamer emission (ESE) devices. Thus in this article, we look into this technology within a critical frame of view.

THE LIGHTNING THREAT

Lightning impulse current lasts for a few hundred microseconds. However, due to the immense peak value, very short rise time and the long continuing currents that frequently follows the impulse component of lightning currents could bring various adverse effects to the structure through which the current flows.

Peak voltage and time derivative of the current (rate of rising of current) gives rise to the potential gradient along with the structure of the current passage, which may cause side flashes and touch potential hazard. A massive poetical difference between the upper parts of the current path and any nearby conducting object connected to the ground directly or indirectly may give rise to an arcing from the former to the latter. The temperature rise of the surrounding due to a few meter arc could be several thousand Celsius. Thus it may trigger fire and explosions. A person touching a higher point of the current path while his feet are in contact with the ground will draw a part of the lightning current through his body, which is termed - "touch potential". Similarly, as the current is injected into the ground, a potential gradient is generated in the vicinity, that could knock-off a person whose feet are along the poetical gradient. This is popularly known as "step potential".

The peak current and the duration of the current pulse are two determinants of the energy dissipated in the current passage. The integration of the square of the current with respect to time, which is termed the "action integral" or "specific energy" provides the amount of energy dissipated per unit resistance of the current path. The continuing current, which has a few hundred amperes of amplitude but several to several tens of milliseconds, significantly contributes to the total energy dissipation.

When the lightning current travels along a bad conductor, such as wood, a massive potential gradient, in the order of few Giga volts per meter is developed along the current path. If the lightning current enters a good conductor, this potential gradient, due to the resistive component, reduces to few Volts per meter. However, due to the path inductance, the potential gradient may still rise to a few tens of kilovolts per meter.

Similarly, when lightning current enters a bad conductor, the energy dissipation may be in the order of tens of Giga Joules per meter. In contrast, for a good conductor, it may be a few tens of Joules per meter.

THE THEORY OF PROTECTING STRUCTURES AGAINST LIGHTNING

The above information shows that by ensuring that lightning current passes into the earth without any adverse effects, it should be driven through few parallel metal paths which are well-grounded. Therefore, a structural protection system is designed so that the building to be covered with a certain minimum number of air-terminations, down conductors and a comprehensive earthing system. The SANS 62305-3 (2011) described how to select the number of air-terminations and to design the placement of them to optimise the interception of a lightning-stepped leader at a given level of protection. An air-termination is either a vertical rod or a horizontal tape made of a suitable metal such as copper, aluminium etc. The vertical rod type air-terminations are usually termed Franklin rods, to honour its inventor, Benjamin Franklin. However, it is nothing but an ordinary metal rod of which the dimensions are specified in SANS 62305-3 (2011).

It is imperative to understand that the purpose of an LPS is not to attract lightning but to intercept with any stepped leader that would have reached the structure in the absence of the LPS. In other words, a properly designed LPS would not increase the number of lightning strikes that reach the building during a given period.

Due to the potential gradient of the current passage due to the path inductance and current derivative, it is prescribed in the standards to have several down conductors in a given LPS design. The number of down conductors increases with the perimeter of the building and the level of protection (which takes the height of the building into account).

The SANS 62305-3 (2011) describes how to implement the earthing system to minimise surface arcing or step potential hazards. Typically, each down conductor should end up at an earthing component. Interconnection of all earthing components is strongly recommended, although it is not essential. Alternatively, all down conductors could be connected to a ring earth which should satisfy certain compulsory conditions.

EARLY STREAMER EMISSION (ESE) TECHNOLOGY

In the early 70s, due to the rapid increase in copper price prompted several scientists to look for an alternative method of protecting structures that could reduce the amount of metal used in the LPS. By that time several industries produced an air-termination with a piece of radioactive material such as Americium (Am-241), Caesium (Cs-137), Polonium (Po-210) etc., placed in a small container located at the air terminal which claimed to be enhancing the emission of the upward streamer that intercept with the stepped leader. As the streamer inception from these radioactive air-termination occurs earlier than that from an ordinary metal

rod of similar dimensions placed at the same location, this system is termed Early Streamer Emission (ESE) air-terminations.

The concept of the ESE is explained by its manufacturers and inventors as follows.

Consider a Franklin rod of a certain length is placed below a metal plate and grounded. Then a high voltage impulse that is typically having a rise time of 250 µs and a half-peak width of 2500 µs (250/2500 µs waveform) is applied to the upper metal plate. This arrangement is shown in figure-1.

Figure-2 shows the observation of the breakdown mechanism as a function of time. A corona (space charge) burst is generated from the tip of the rod and get disappeared. It appears again after a few microseconds and elongate further but disappears again. This process repeats several times before a self-propagating continuous streamer extends to bridge the gap. Let's call the time from the initiation to the time at which this continuous propagation starts as T_{FR}. The same experiment is repeated for the ESE rod, as its inventors claim the continuous

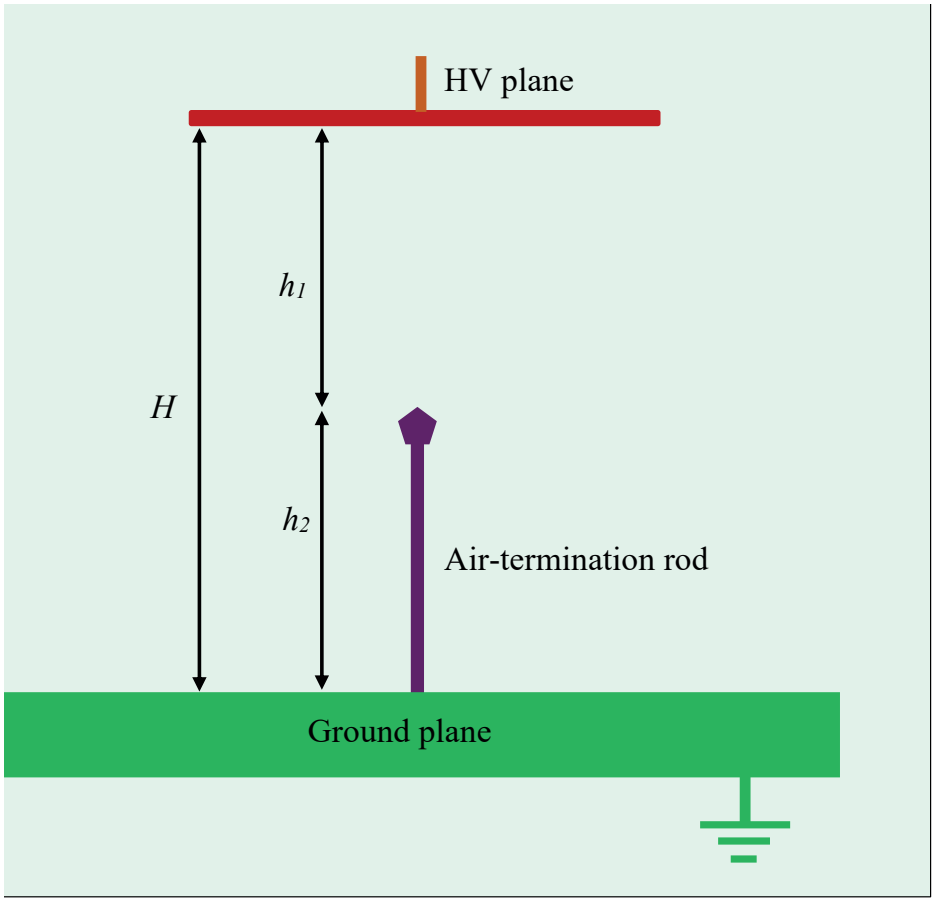


Figure 1

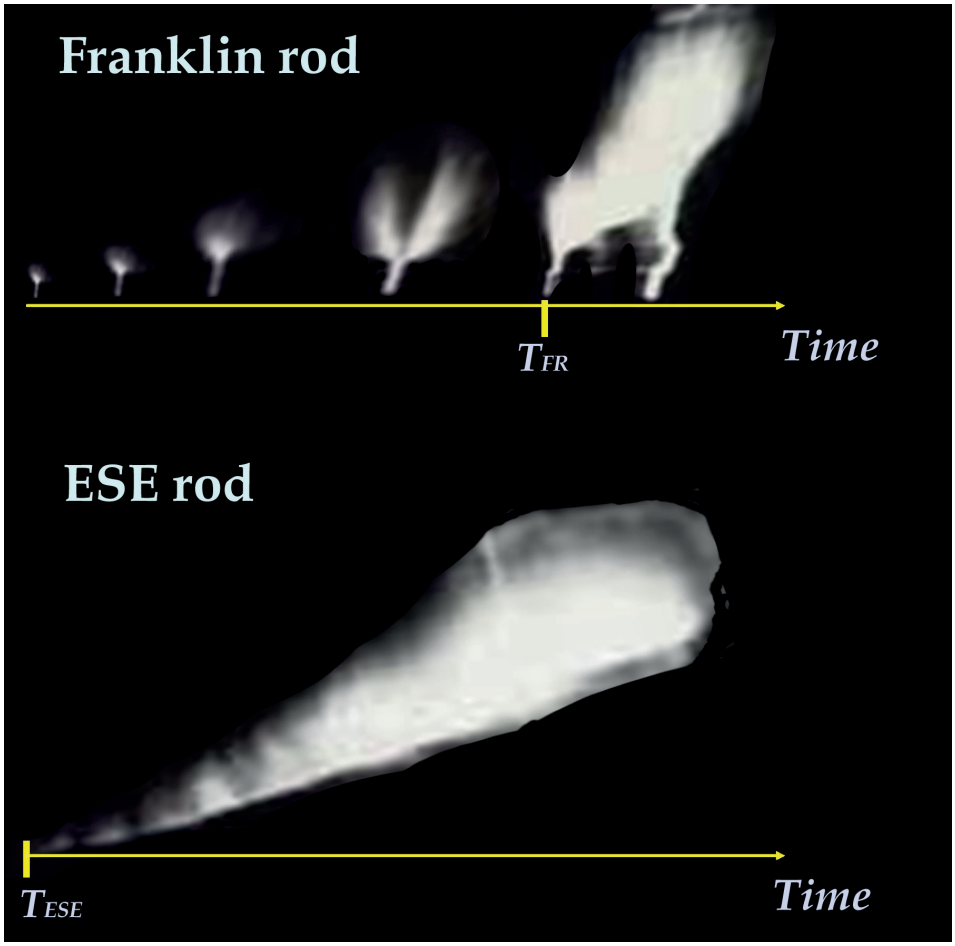


Figure 2

propagation begins at a much earlier time. The difference in the two times is called the time advantage (ΔT) of the ESE rod.

$$\Delta T = T_{FR} - T_{ESE}$$

Then this time advantage is multiplied by the speed of the upward streamer (U) to find the height advantage (ΔH).

$$\Delta H = \Delta T \times U$$

The ESE vendors arbitrarily assumed that $U = 1 \times 10^6$ m/s.

Whereas many national and international standards refused to recommend this so-called new technology, citing that there is no theoretical, experimental or statistical proof to justify the claimed height advantage, in 1995 French Standard NF C 17-102 was established. Spain followed soon setting a standard for ESE technology coded UNE21186. Both standards were updated in 2011.

The testing method and consequent computational guidelines specified in the above French and Spanish standards enables the ESE manufacturers to claim a large protective volume due to the effective height which may be 100-200 times greater than the physical height of the ESE rod.

As a result, the number of air terminations that are required for a building as per the IEC 62305-3 (2010) could be drastically reduced to a minimal value.

There are few key reasons for the committees of IEC and other significant standards to reject the acceptance of ESE technology.

1. As per the NF C 17-102 (2011), the threshold requirements for H, h_1 and h_2 in figure-1 is 2 m 1 m, 1 m respectively. Thus, although the laboratory experiments show the time advantage of the ESE rod, the extrapolation of the results to the natural lightning phenomena which occurs in many magnitudes larger scale is highly questionable.
2. There is no scientific evidence to prove that the upward streamer speed is 106 m/s. In reality, it may be a couple of magnitudes less. The recent experiments done with fast video camcorders will soon reveal the validity of this assumption.
3. The NF C 17-102 states that "In case of an isolated ESE System, at least one down-conductor is needed for each ESE air-terminal". It is undeniable that vendors always follow the minimum requirements outlined in the standards to maximise the profit. Thus, the above clause enables them to install only a single down conductor for buildings with single ESE terminal, if the system is not connected to the steel reinforcement (which is the case in a vast majority of ESE installations). One can show with a simple calculation that at 20 m height a negative subsequent stroke with average parameters could generate 1.6 MV in a single copper conductor of cross-section 75 mm2. Such high voltages need several meters long gaps to avoid possible arcing.
4. In many countries with a high density of lightning ground flash occurrence, statistical data shows that there are many failures of ESE systems, although they are installed according to the French or Spanish standards. It is a well-known fact

that lightning mostly hit corners, edges and ridges at rooftop level. Installation of ESE does not change this natural tendency.

Apart from a large number of failures in ESE installations in many countries with a high lightning density that can be found in the literature, we would like to figure out several other concerns related to ESE device scenario as well.

FALSE CLAIM OF OUTDOOR SAFETY

It is a well-accepted that so far, as per the scientific information we have, there is no reliable technology that could guarantee the safety of people that stay outdoor during thunderstorms. This inability of available technology demands all outdoor activities to be stopped in the vicinity of a thunderstorm and seek shelter in a sturdily built structure.

However, due to its immensely large claimed volume of protection, ESE rods are installed, convincing the customers that it can protect people involved with outdoor activities even under thunderstorm conditions.

Figure-3 shows a school ground in Malaysia which is installed with an ESE terminal on a tall pole which is said to protect the students that play during thunderstorms. Similarly, Figure-4 shows an ESE terminal installed on a rooftop terrace of a large hotel in South Asia.

The terrace is the walkway between the main restaurant and the spa. Therefore a large number of people move on the terrace at any given the time of day. The visitors and staff were given the assurance of safety to use the terrace even during the thunderstorms.

Figure 3

UNNECESSARY COST FOR THE PROTECTION SEEKER

The author has observed numerous cases where ESE air-terminations are installed despite the buildings have a very low-risk index (no protection or only a few protective components are required) according to the risk assessment specified in IEC 62305-2 (2010).

These buildings include;

- Low rise buildings in areas of low lightning occurrence density
- Metallic structures
- Buildings protected by high rise buildings in the near vicinity (e.g. base stations underneath tall and well-grounded metallic towers)
- Buildings which are already protected according to IEC standards

The most common causes of installing ESE devices for buildings that do not need additional protection are the metal-roofed factories, as shown in figure-5. The IEC 62305-3 (2010) allows the metal roof to be used as the air-termination of buildings where puncturing of the material is not an issue (no inflammable or explosive materials are housed) if the thickness of the sheets is 0.5 mm or more and the continuity of the sheets is assured. Most of these factory buildings satisfy this condition. However, ESE vendors install their products even in such cases, concealing the real facts. Most often such installation of ESE air-terminals and copper tapes as down conductors stretched along the roof gives rise to severe corrosion of the roofing material.

Figure-6 shows an example from China, where a building with archaeological value has been installed with two ESE devices despite the building is well protected according to the IEC standards at the highest level of protection.

As these installations are not having any significant probability of strike damage even without the ESE system, the vendors who provided LP is at a zero risk of failure. Such cases also contribute immensely to the no-

Figure 4

Figure 5

accident statistics of installations with ESE devices; which is a false indication of the success of the technology.

LESSONS LEARNED FROM THE SUCCESS OF ESE TECHNOLOGY MARKETING IN ASIA

A majority of the engineering community has rejected ESE technology due to various scientific reasons. A majority of the internationally reputed standards have not recommended the technology; it is of interest to explore the reasons for the success of ESE technology in many countries where the author has conducted several investigations. The facts found are listed below.

- Inclusion of ESE technology in French and Spanish Standards: Being well-developed influential European countries, France and Spain make a considerable psychological impact on developing nations. Once said that such countries had included ESE technology in their standards, the product gets an automatic endorsement to convince the general public regarding its efficiency. Even under a legal framework, the vendor is safe as his product complies with a European Standard.

- Non-rejection of ESE technology by any standard: Although many standards have not included ESE technology in their recommendations, none of the standards has a vehement rejection of the ESE technology. Under such circumstances, there are simply no grounds to persuade an ordinary engineer to reject a product based on ESE technology. One cannot expect a field engineer to read research papers or scientific documents as they are burdened with routinely work. The situation becomes even more challenging for an anti-ESE campaigner when it comes to the convincing of decision-makers who are most often non-technical personnel.

- Introduction as a new technology: The ESE technology surfaced in the late 70s but became a market force in the 90s. Thus, compared to the 300-year-old conventional protection system ESE concept is modern technology. Naturally, the general public loves modern technology. The ESE proponents use this human thinking pattern much to their advantage.

- The "handsome" look: An ESE device is a much more attractive object to the human eye than a copper rod, which is either dull plated or pale-looking due to natural oxidisation of the surface. In contrast, ESE air-terminations come with various shapes and chrome-plated surfaces. In many areas of South Asia, for example, the existence of such a fancy looking device on the roof is a symbol of prestige. To compete with such advantage of ESE devices, several vendors who promote conventional systems in South Asia has started manufacturing Franklin rods with various attractive shapes. None of these are sold as ESE devices, but the beautiful look attracts customers, according to their sales records.

- Convenience for both the client

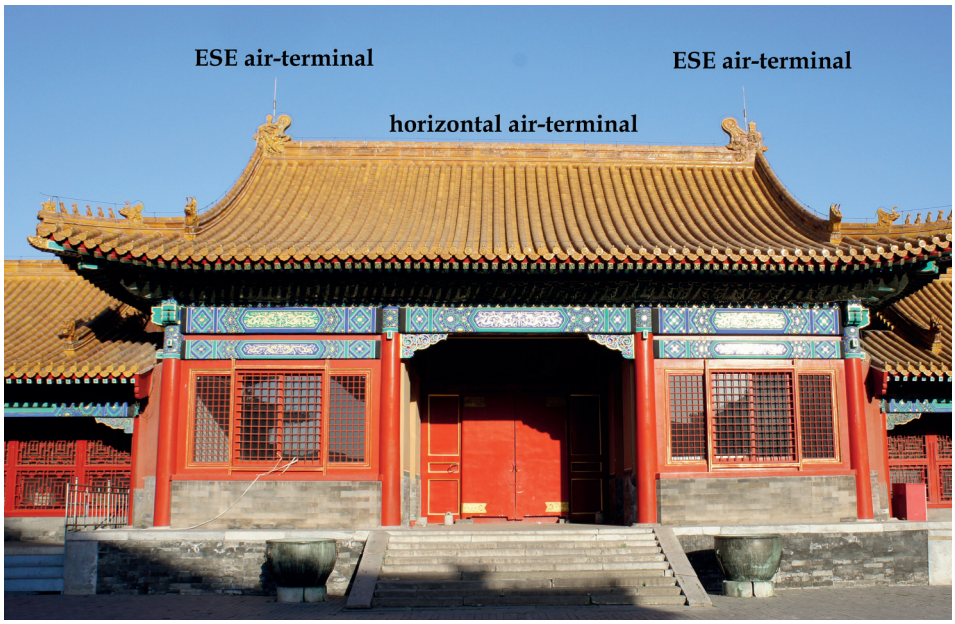


Figure 6

and the vendor: In contrast to an LP system designed according to IEC 62305-3 (2010) or similar, an ESE technology-based LP system, designed according to a standard such as NFC-17-102 (2011) is less laborious and more convenient to be installed. Especially in the case of buildings that have decorated and complex shaped roofing, ESE technology is a big attraction. The single air-termination and single down conductor (in most of the buildings) cause much less disturbance to the aesthetic appearance of the building than the conventional systems do. One of the countermeasures that can be taken by the conventional LP system proponents is to promote the usage of reinforcement steel structure for the purpose served by the down conductors. However, the conditions outlined in IEC 62305-3 (2010) for using the steel reinforcement structure for such purpose, highly restrict the adoption of this technique in practice.

- Powerful marketing strategies: The promotional marketing campaigns of vendors that sell ESE devices are much more rigorous and aggressive than those of other companies. The primary reason for such affordability is the large profit margins that have been enjoyed by the ESE device vendors.

- Lavish rewards to the admirers: Another, unchallengeable strategy adopted by the vendors is to reward heavily the consultants that recommend and promote ESE technology. The enormous profits gained by the vendors make it permissible for them to offer lavish rewards to the consultants; thus, in turn, they get more business; hence more profits. This positive feedback loop gradually adds more consultants into the circle and destroys the companies that are reluctant to stay away from the loop. During the last five years of this investigation, most of the companies that were previously reluctant to market ESE technology were sucked into the loop as they could not survive in the business outside the loop.

- Client's demand for ESE technology: In parallel with point f., the ESE vendors have created an atmosphere in many countries that the total solution of LP relies on the efficiency of ESE technology. Hence, most often, clients demand ESE based LP systems irrespective of the awareness offered by non-ESE technology-based companies. Most often, the contract in line consists of the installation of both SPD system and structural protection system together. Thus, the refusal to offer ESE devices will cost the vendor the total contract. As we have observed, several LP companies in South Asia, whose primary concern is SPDs, started importing ESE devices as they have lost large scale projects due to the above reason.

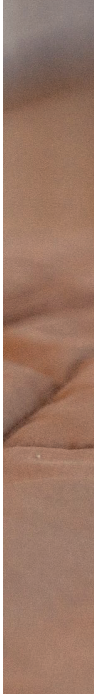
CONCLUSIONS

The above analysis indicates that Africa, being a continent of having a too high lightning ground flash density, and people with a low level of awareness on the international trends are potential victims for fraudulent lightning protection systems, which are not accepted by either national or international standards. Therefore it is the right time for the technical, scientific, academic and federal administrative entities of South Africa to get together and develop a firm policy, guidelines and regulatory codes to monitor and control the lightning protection systems designed within the country and imported to the country.

Such measures could save not only the human life and properties from adverse lightning effects but to have financial gains of not importing unnecessary devices as most of such fraudulent devices are imported rather than locally manufactured. wn

Can't see the educational wood for the technical trees?

Seeking out the right ed-tech partner in South Africa's competitive digital learning space



The global education-technology (ed-tech) market has grown rapidly in the last ten years, morphing from R8,6 billion in venture-capital funding in 2010 to R121 billion last year. And, according to market-intelligence platform HolonIQ, the industry is expected to boom to over R173 trillion by 2030, as more governments, corporates and individuals take heed of the United Nation's sustainable development goal of inclusive and equitable quality education for all.

South Africa's ed-tech market is dominated by corporate education demand and the government's many Sector Education and Training Authority (SETA) needs. The highly competitive local industry's compound annual growth grew at double-digit rates between 2013 and 2018, with an increasing number of schools opting for eLearning courses and students adapting to new ways of learning, such as via videos, animation and Massive Open Online Courses (MOOCs).

When choosing the right ed-tech partner, references and track records matter, says Dr. Kershen Pillay, CEO of the Graduate Institute of Financial Sciences (GIFS), a financial services education provider of accredited and non-accredited programmes. *"The global pandemic has accelerated demand for online learning, and there's been a mushrooming of low-cost eLearning systems and technology, all professing to offer something attractive. The onus is on organisations to really do a solid job when it comes to due diligence and choosing the right partner,"* he says.

Forgoing a thorough assessment can have negative impacts on any business, including unnecessary costs, delayed time to going to market, higher-than-normal client churn, a struggle to attract new customers, and substantial reputation risk. "Aside from the functional nature of an ed-tech partner's software, or its level of innovation, what many people take for granted is how important ongoing customer support is once the initial transaction has been finalised," says Michael Hanly, managing director of New Leaf Technologies, a Joburg-headquartered learning software and solutions company.

Statista, a German online portal for statistics, revealed in January this year that the global customer-care business process outsourcing (BPO) market will reach an astonishing R529 billion in market cap size by 2027. Similarly, FinancesOnline, a Poland-based online-review platform which features reviews posted about businesses, products or services, says that 88% of customers prefer doing business with a company that offers quality customer service over one that has the latest and most innovative products. And 89% of companies in 2018 competed primarily on the basis of customer service, up from just 36% in 2010.

"The main reason we chose New Leaf Technologies as our ed-tech supplier/partner is that they're owner-managed, and understand the value of client-centricity and quick turnaround time," says Pillay. GIFS wanted to align its online learner journey to global standards. *"We benchmarked several systems offered around the world, identified what the legislated educational requirements were, mapped out what our business needs were, and then issued an RFP [request for proposal] to find a partner that could cater for all our requisites."*

Aside from needing a flexible partner that was solution oriented and innovative, GIFS wanted an organisation that was as excited and passionate about its online solutions as they were. This often plays a part in defining the level of customer service and support an organisation provides.

"It's crucial that ed-tech companies really listen to and understand the changing needs and wants of their customers, but also become familiar with external market factors like available spend, industry-specific needs, or to what extent a customer would want software that's more content or technology oriented," says Hanly. *"These factors play a vital role in shaping how companies search for and find ed-tech businesses to meet their needs."*

Among the most important customer expectations, regardless of industry, 76% was for companies to understand their needs, and 75% to get help within five minutes, according to surveys by global professional services firm Accenture, American cloud-based software company Salesforce, global management consulting firm McKinsey, multinational technology company Microsoft, and e-commerce news site Bizreport.

"An excellent degree of customer support is so necessary, and not just at the onset," says Hanly. *"We often forget that the material effects a solid degree of customer service can have on the viability of an ed-tech company, or any business for that matter, can be invaluable."*

Assessing how customers react to good customer support, Salesforce says that 72% share good experiences with others, while 67% are willing to pay more for a great experience. *"Especially in an ed-tech business-to-business market context, new business for an ed-tech supplier often comes through client referrals or word of mouth,"* says Hanly. *"If a supplier has a solid track record with excellent client results, a potential customer may be willing to pay more for their software, which in turn means increased earnings for the supplier."*

Using New Leaf Technologies' cloud-based aNewSpring learning management system (LMS) as a bedrock for how GIFS' online course content is shared, Pillay believes that GIFS has achieved the goals it initially set out to accomplish through the ed-tech partnerships. "The objective to enhance efficiencies right across our business has definitely had an indirect impact on an improved bottom line – our tech has certainly contributed to our maintaining a market-leading and award-winning position."

Looking ahead, Hanly believes that the local ed-tech market is on the edge of a renaissance. *"The profound effect the pandemic has had on safe, credible online learning, coupled with bandwidth increases and dropping data costs, means that the industry, both in South Africa and across the continent, will flourish."* wn

Carbon Tax vs Carbon Trading

- TWO SIDES OF THE SAME COIN -

In pursuit of reducing greenhouse gas emissions, various countries have adopted the practice of carbon trading while others like South Africa have implemented a carbon tax as a corrective means to make carbon-intensive industries more environmentally conscious.

BY ECKART ZOLLNER
HEAD OF BUSINESS DEVELOPMENT
EDS SYSTEMS

These two frameworks are intended to compel enterprises to acknowledge their effect on the environment and encourage change; but does one system work better than the other? It is important to acknowledge that while both have their advantages and disadvantages, they're both sides of the same coin. As such, it is imperative to focus on how organisations can ensure that they're realistically transforming their operations to lower their emissions instead of getting distracted by which is the best theoretical way to do so.

DEFINING THE DIFFERENCES

Carbon trading works by setting a blanket limit or cap on the quantity of emissions allowable from significant carbon sources. Once this overall limit has been determined, governments then issue permits for the limit that acts as credits. These credits can be traded with other companies in the sector and by reducing its own carbon output significantly, a company can then trade the excess on their permits. However, where a company is unable to cut down their emissions, it may have to purchase additional permits to account for the difference. Part of the appeal of this framework is that as the limit is gradually reduced the number of credits is reduced, which will compel companies to adjust their operations to pollute less. On the other hand, carbon tax is a form of carbon pricing that sees a tax applied to carbon fuels or the output of carbon-intensive processes, placing a financial burden on entities that pollute. In this framework, companies have a choice: pollute and pay the tax or reduce emissions to avoid tax.

SOUTH AFRICA'S CARBON TAX ACT

To meet our obligations in terms of the Paris Accord, the South African government has begun implementing the Carbon Tax Act which makes provision for a phased roll out of tax liability for carbon-intensive industries. One of the advantages of using carbon tax is that it represents a quantifiable source of revenue generation that can be controlled by government,

along with providing an incentive to avoid the tax by reducing emissions. Furthermore, by making businesses and consumers alike aware of the environmental costs of production, consumption and investment decisions as they relate to emission initiatives, enterprises can be encouraged to adopt cleaner technologies and consumers can make more sustainable choices in how they spend their money.

The Carbon Tax envisages an incremental approach to imposing carbon tax liability, which is divided into three phases. In the first phase (which runs until the end of 2022), scope 1 emitters will be liable to pay carbon tax for direct emissions from an owned or controlled source, such as emissions produced during the burning of fossil fuels. Whilst the Act imposes a tax liability it also provides relief in the form of emission allowances that range from 60 - 95% in the first phase. For example, there is a permissible basic tax-free allowance of 60% for all activities. For companies that use carbon offsets, it is possible to reduce their tax liability by up to 10%, and a further 5% budget allowance is given simply for meeting the Act's reporting requirements. A further 10% allowance makes provision for trade-exposed sectors that might be liable to pay a carbon levy on import/export transactions.

QUANTIFIABLE THANKS TO TECHNOLOGY

When it comes to quantifying carbon output, it is no longer a guessing game. Thanks to locally developed carbon tax analytics software, it is possible for organisations to accurately calculate and visualise their carbon footprint. In order to evidence compliance with the Carbon Tax Act, a carbon analytics tool can be used to generate an automated, accurate report that details emissions by source. All it takes is for someone to input the process or emissions data into the software, in order to obtain an exact tax liability amount and a clear picture of the carbon footprint of the entire organisation. Once enterprises have a clear understanding of where their major carbon tax liabilities lie, they'll be able to strategise on implementing carbon reduction frameworks across the value chain in a manner that properly acknowledges the urgency in reducing the carbon footprint of everything manufactured, traded, transported and consumed around the world. wn

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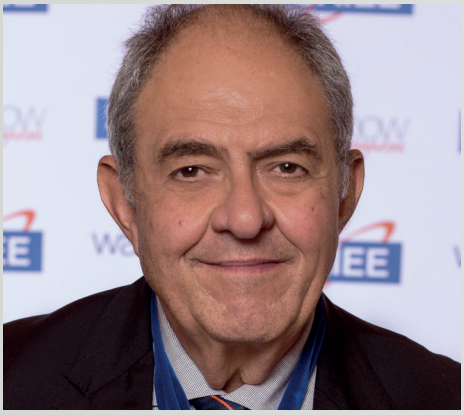

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	Rotating Machines - Webinar
11	**SAIEE Training Academy - Online CPD Course:** Design of Economical Earthing Systems for Utility Electrical Installations - Day 2
15	**Power & Energy Section - Webinar** The case for Solar Power in residential homes within South Africa
16	**KZN Centre - Webinar** Green Economy - by Richard Ahlschlager
16	**SAIEE/IEEE SA - Webinar** Managing uncertainties of the Future Grid
17	**Bernard Price Memorial Lecture - Webinar** Presenter: Roger Price - "Leaving a Legacy"
	SAIEE Training Academy - Online CPD Course: LV/MV & HV Switchgear Operation, Safety, Maintenance and Management - Day 1
18	**SAIEE Training Academy - Online CPD Course:** LV/MV & HV Switchgear Operation, Safety, Maintenance and Management - Day 2
21	**SAIEE Training Academy - Online CPD Course:** Transformer construction, operation, maintenance, testing and protection - Day 1
22	**SAIEE Training Academy - Online CPD Course:** Transformer construction, operation, maintenance, testing and protection - Day 2

SEPTEMBER 2020 (CONT)

23	**SAIEE Training Academy - Online CPD Course:** Transformer construction, operation, maintenance, testing and protection - Day 3
24	**SAIEE Training Academy - Online CPD Course:** Transformer construction, operation, maintenance, testing and protection - Day 4

OCTOBER 2020

08	**SAIEE Training Academy - Online CPD Course:** SANS 10142 - PART 1 & OHS ACT - Day 1
09	**SAIEE Training Academy - Online CPD Course:** SANS 10142 - PART 1 & OHS ACT - Day 2
12	**SAIEE Training Academy - Online CPD Course:** Planning Strategic Feasibility Studies - Day 1
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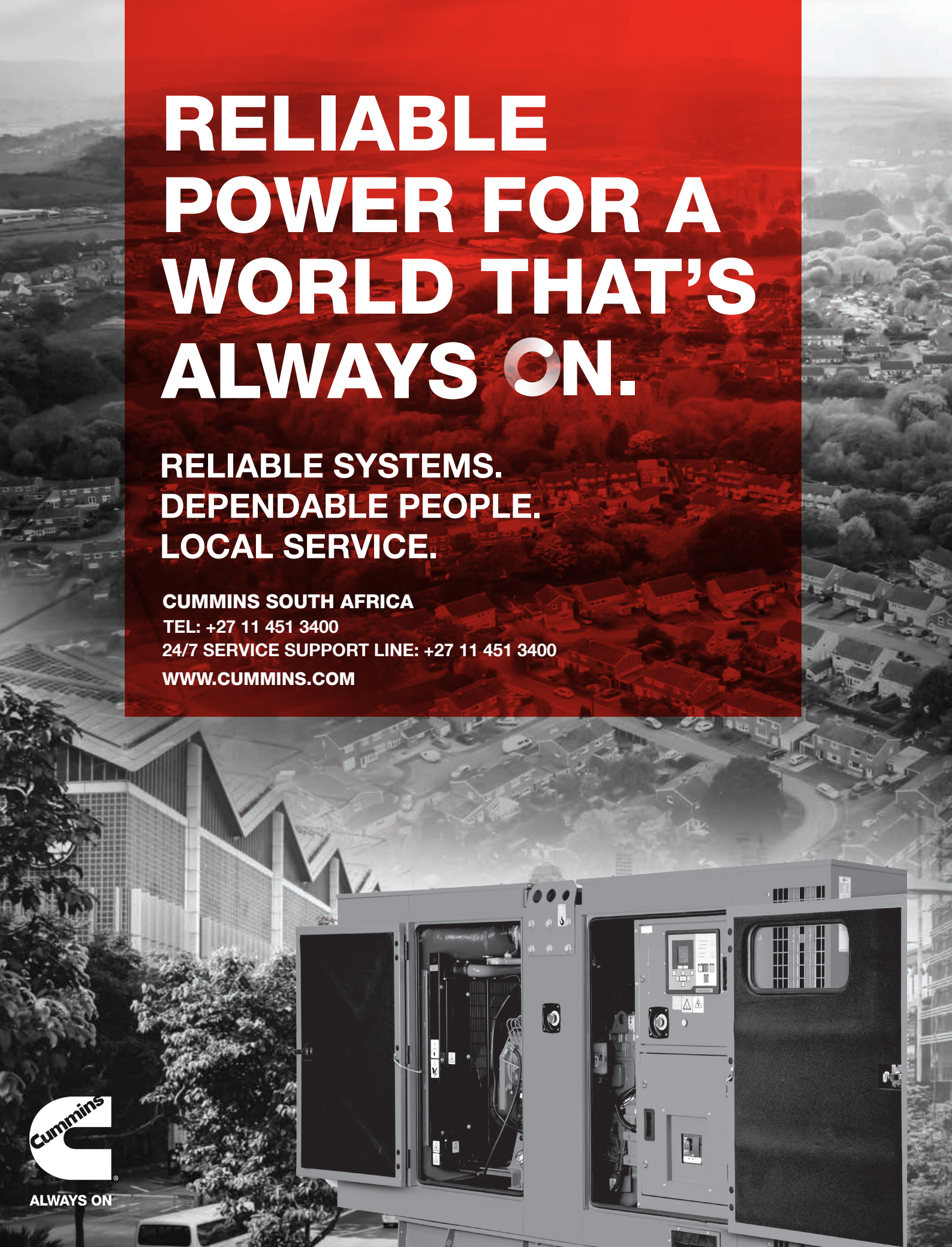
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