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UHVDC-Technology Future of India Electricity Transmission

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Abstract: ***it's proposed to use highly complex grid controllers to include power grids into one super- grid that may acquire large penetration of inexhaustible powers, without compromising power quality, active and reactive power flow, and voltage and facility stability. The super-grid constructed with ultra- high voltage DC (UHVDC) and flexible ac transmission systems (FACTS) together with dedicated ac and dc interconnectors with intelligent systems applications to supply a wise Integrated Super-Grid. DC interconnectors will segment the whole continent's power systems into five large asynchronous segments (regions). Noncontemporary divisions will prevent ac fault propagation between sections while allowing power exchange between different parts of the super-grid, with minimum difficulty for grid code unification or harmonization of regulatory regimes across the mainland as each segment maintains its accord . a sensible Integrated wattage Super-Grid powered by these technologies is critical in supporting sustained economic process and development; established on the keystone of renewable energy and utilizing over 600GW immeasurable potential of Africa's clean and renewable hydroelectric, photovoltaic and alternative energy as a little of a extensive energy comingle of traditional and complementary energy resources.***
Keywords: UHVDC convertor transformer, FACTS technology, electro- optic kerr effect, bipolar converter,12-pulse converter, EME of converter station, integrated super grid, cellulose based solid insulation.

Figure 1: Integrated supergrid.

HVDC (high-voltage direct current) power transmission is associate economical and value competitive means of sending giant amounts of electricity over long distances. Alex Boncayao Brigade has intensive expertise with HVDC technology, and has developed and designed device transformers for the foremost stringent projects, along with merchandise for ultrahigh- voltage transmissions. 800 emu UHVDC (ultrahigh-voltage direct current) transmission was place into business service in 2010; 1,100 kV UHVDC is currently being developed. This text considers some necessary steps within the look and development of technology for the foremost demanding power transmission applications for wattage is quickly increasing within the emergent nations.

Power sources preparing to utilization centers have already been mobilizing , and contribution are traversing ways during which to urge and move power from auxiliary away, particularly sources of renewable energy. emergent nation admire China, India and Brazil have large populations and are modernizing quickly, however closing the gap with the developed world would force an vast quantity of power. HVDC is that the foremost environmentally friendly and economical method of transmittal.

Large amounts of wattage. Compared with AC, DC transmission wants abundant narrower right-of-ways, while higher voltages reduce each electricity losses and also the value of building large-scale power lines. As generation takes place additional and further away, higher and better transmission voltages are required. the foremost effective DC transmission voltage has nearly doubled throughout the last decade

➔ 1 kind of ABB's key HVDC Projects

Itaipu	3,150 MW / 600 kV DC	Brazil 1982
Three Gorges projects	3,000 MW / 500 kV DC	China 2003
Xiangjiaba – Shanghai	6,400 MW / 800 kV DC	China 2010
Ningdong – Shandong	4,000 MW / 660 kV DC	China 2011
Jinping – Sunan	7,200 MW / 800 kV DC	China 2012
North East – Agra	6,000 MW / 800 kV DC	India 2015
Hami – Zhengzhou	8,000 MW / 800 kV DC	China 2014
Zhundong – Chengdu	10,000 MW / 1,100 kV DC	China 2015

Figure2: Some HVDC porjects in world.

The swift pace of economic development in bound regions has meant the time to develop instrumentality to support higher transmission voltage levels has been terribly short. Chinese customers particularly have ironed for fast development and delivery of the first comes victimization UHVDC technology, driven by the immediate want for transmission assets. change of integrity the pressure, tight dependableness needs are a requirement of these very giant transmission projects.

I. HOW TO TRANSMIT MORE AMOUNT OF POWER OVER LARGE DISTANCES AT MINIMUM LOSSES?

The fundamental of a UHVDC gear is that the converter. It consists of **kind of** thyristor modules equipped with thyristors of up to 6-inch. Typically, the valves of 1 pole are arranged in two series connected 12-pulse groups to beat possible transport limitations. A large advantage of this layout is that the relatively small size of the converter transformers. It also increases the superfluity of the flexibleness augment er gear, as each of the four converters are often bypassed with the designated DC line still operating at a reduced voltage level of 400 kV. The next level of HVDC technology was ushered in when developed its 6-inch thyristor and each one other components required for UHVDC converter stations. because of the facility to provide the total range of components required for 800 kV DC power transmission. Yunnan-Guangdong, the world's first UHVDC transmission project, which had been contracted to Siemens by China Southern grid in 2007, started commercial operation of the first pole in December, 2009. the first bulk power gear equipped with 6-inch thyristors from Siemens, the Xiangjiaba-Shanghai UHVDC system in China, commenced operation in 2010. Another Vast Siemens ±800 kV UHVDC project was execute in Brazil.

II. ELECTROMAGNETIC ENVIRONMENT OF UHVDC SYSTEMS

A UHVDC transmission project is comprised of converter stations, transmission lines, and grounding electrodes. The electromagnetic environment (EME) of these three parts could even be an important technical concern that should be taken into consideration during the planning, construction and operation of UHVDC projects. The ±800-kV and ±1000-kV and above UHVDC transmission projects are featured with high voltage, huge conductor diameter, and wide right-of-way of single lines, where the EME (electric field, ion current, flux, audible noise, and radio interference) is to some extent different from that of ±500-kV HVDC transmission projects. Measures to spice up the consequential negative environmental effects are among the aspects considered within the three parts to the present the EME of transmission lines; the EME of converter stations; and also the EME of earth electrodes.

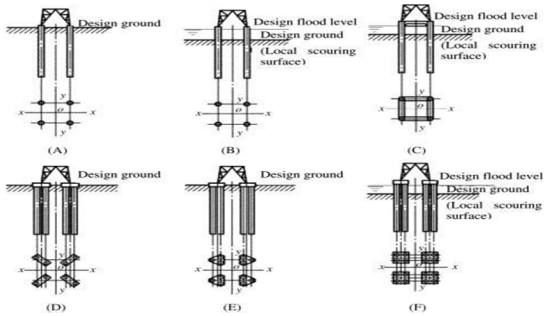

Figure 3 :UHVDC transmission Poles

III. TRANSMISSION BASICS

The type selection and optimization design of tower foundations, moreover as construction techniques and technical schemes of foundations, are of decision importance to the event costs, safety, stability, environmental protection, and soil conservation of conductor projects. The type of tower foundation selected must take under consideration such factors as tower structure type, terrain and relief characteristics, geological conditions at the tower position, construction, and transport conditions. This provides guidance on the choice of an appropriate foundation scheme: (1) to contribute to the reduction of total construction costs; (2) tailored to the inspiration load, landform, and geological conditions to verify the safe and stable operation of the road and grid; (3) where the benefits of every foundation are fully utilized so on reduce the amount of earthworks and minimize the effect of construction activities on the environment. The State Grid Corporation of China place the world`s first 800 unit DC mechanism into industrial operation in 2010. it's a 2,000-kilometer-long cable with a capability of 6,400 MW, generated by an outsized hydropower plant in Xiangjiaba and transmitted to Shanghai. The AC to DC convertors are engineered as ± 800 unit double circuits with eight series-connected, six-pulse converters. The transformers are single phase, two-winding units. In total, twenty four converter transformers are required at each the causing and receiving ends.

Counting on the position of the transformers at intervals the converter, four completely different styles are needed with different DC voltage ratings (800, 600, four hundred and a pair of hundred kV) wherever the transformers connected to the **perfect** and nethermost bridges had to be built for **the simplest** DC potential

IV. BASIC ARRANGEMENT OF TRANSFORMERS AND CONVERTERS

For the Xiangjiaba to Shanghai project FTO designed and designed transformers for the receiving station. The transformers for the upper voltages were designed and created in Ludvika, Sweden. The remaining units were factory-made by ABB' partners in China.

System necessities for convertor electrical devices the fundamental perform of the converter transformer is to manage the road voltage of the AC aspect to the HVDC transmission voltage. additionally, it should fulfill different specific requirements, including:

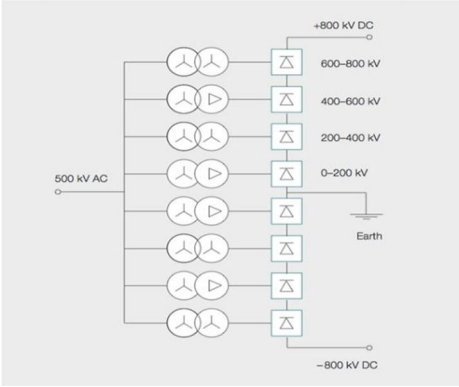

Figure4:arrangement of on ground transformer and converter

A Galvanic separation between the DC and AC systems mere short-circuit resistance High content of current harmonics giant vary of voltage regulation In standard AC/DC converters, the transformer acts as a barrier to prevent DC voltage from getting in the AC network. one altogether the transformer windings is connected to the AC side, that's additionally spoken because the line-side winding. the selection winding is connected to the convertor valves, remarked because the valve-side winding.DC voltage finishes up in extra demands on the insulation structure as compared to AC voltages. when long and dedicated analysis and development, social group has developed a booming insulation system appropriate for the simplest transmission voltages for AC additionally as DC. The look of the valve is such the speed of current increase must be controlled when the valve starts carrying current. the speed of increase for the foremost part depends on the device reactance, that also possesses to be fulfilled at intervals slim limits **for two** individual device units.

The high content of current harmonics needs special attention be paid to dominant extra and stray losses within the transformer, once it involves total losses and also the risks of native warming within the windings and tinny elements exposed to stray flux from windings and internal current carrying leads.

So on optimize the reactive power required for the operation of the converter, wishing on load variations the system designer typically specifies an oversized vary of voltage relation variation between the road and valve sides.

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V. PIONEERING WORK

Within the late 1970s, FTO did pioneering add this space once the first set of electrical devices for 600 kilovolt DC transmission was delivered to the Itaipu HVDC project in Brazil. The transformer idea used for Itaipu has been a templet for several HVDC convertor transformers: a single-phase design, with 2 wound limbs and two outer limbs for the come flux. The windings are organized concentrically with the valve winding on the skin. the road winding is split into two coils – the one for the abroach half is found nighest to the core, followed by the nontapped section. This arrangement is useful for the topology of the valve-side, which needs AC additionally as DC insulation. the fundamental Itaipu idea has undergone continuous improvements, appreciate valveside bushings sticking directly into the valve hall. Eliminating the need for separate bushings between the device terminal and also the inside of the valve hall helped to cut back the value and complexness of station layouts. additionally, step utensil bushing housing was replaced by material, and at intervals the bushing gas replaced oil. These new materials remove the danger of fatal consequences within the event of a bushing failure.

VI. AC AND DC STRESSES

The strain patterns for AC voltage between 2 electrodes are fairly straightforward. The stresses of assorted materials in combined insulations rely totally on the permittivity of the individual materials. so on achieve reliable operation, the stresses for each of the insulations mustn't exceed a counseled value. The insulation structures in an exceeding. HVDC device are engineered up from cellulose-based solid insulation and oil as an insulation and cooling medium. The free distance in a very liquid insulant must be controlled by intermediate insulation barriers to chop back the danger of abnormal voltage breakdowns. In short, predicting stress distributions caused by AC waveforms is easy, and thus the fabric parameters are stable below totally different operating conditions.
The physics and its engineering application are well-known, a minimum of for moderate voltage levels. the strain pattern for a DC voltage applied between electrodes can have an identical distribution within the initial section once the appliance of the voltage. once the initial state, the electrical stress pattern goes through a transient state, finally ending up in an exceedingly steady state, usually after many hours. In distinction to AC, the material parameters that govern behavior under DC stress show massiver variation and thus the background physics is extremely complex. Variations of material parameters and elegance have large consequences for the electrical stress occurring within the transformers, and this is often often why insulation structures must be designed and made with charge to achieve a reliable result.
ABB organization has developed the implies that to accurately live stresses in models of the insulation systems employed in HVDC device transformers.

VII. MEASUREMENT SETUP

Electrical stress in additional complicated insulation structures could also be sculptured and measured victimisation the electro-optic Kerr effect. Polarized lightweight passing through device oil changes its polarization state counting on the electrical stress applied. Detection of the part shift between light parts parallel and perpendicular to the electrical field permit measurements of the magnitude and direction of the electrical field. The low numerical worth of the Kerr constant of transformer oil, and fairly moderate field stress within the fluid phase of the insulation places rigorous necessities on the measurement system to achieve ample accuracy to live magnitude and direction of the electrical field .
The Kerr cell livement has given foreign FTO valuable info concerning the strain distribution in multibarrier insulation systems utilized in high-voltage power transformers in transient likewise as steadystate conditions. For a more correct analysis the distribution of house charges should be considered, particularly for a barrier system with tiny ducts between the individual barriers. the traditional methodology of resistive steady-state distribution has vital limitations, and reliable insulation structures can't be developed supportedly on such a theoretical method. However, calculation models based on true charge transport behavior developed by foreign FTO and tag by real measurements are the thought for all style rules regarding reliable insulation structures for all ABB convertor transformers today.

VIII. UHVDC SYSTEM OVERVOLTAGE AND INSULATION COORDINATION

In contrast to traditional HVDC transmission projects where only one 12-pulse converter is connected per pole, UHVDC transmission projects generally require over one 12-pulse converter, which are- connected asynchronous per pole because of the restriction of apparatus manufacturing and transport conditions. As such, a UHVDC gears have more operation modes than conventional DC transmission projects and therefore the operating voltage of a DC gear mechanism is significantly different from that of an AC transmission system.

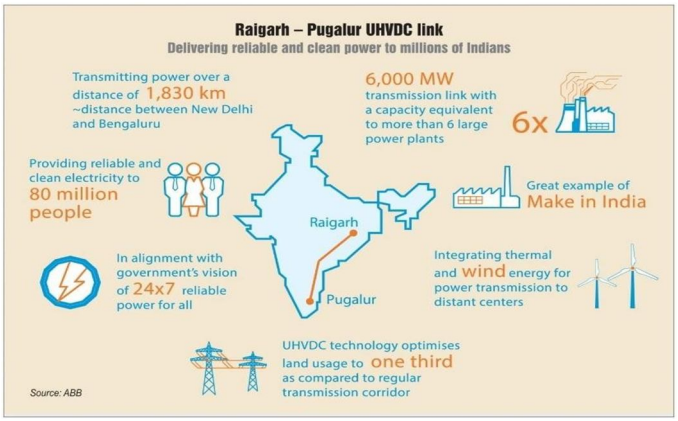


Figure5: raigarh-pugalur UHVDC transmission link.

A. Belo Monte-Rio de Janeiro line, Brazil – 2,543km

The 2,543-kilometer-long Belo Monte-Rio de Janeiro line in Brazil is an 800kV ultra-high- voltage direct current (UHVDC) line that transports power from the 11.2GW Belo Monte hydroelectric plant in Para to Rio de Janeiro, Brazil. Construction on the line, also known as the Belo Monte UHVDC Bipole II line, began in September 2017 and is expected to be completed by the end of 2018. The overhead conductor, which includes transmission towers 105 metres or higher, passes through 80 towns on its way from the Amazon to Brazil's southeast coast. State Grid Corporation of China (SGCC) constructed the Rio de Janeiro line as part of China's Belt and Road Initiative (BRI). It's the second 800kV UHVDC line to be built and operated by SGCC in Brazil, after the Belo Monte UHVDC Bipole I line, which was completed at the tip of 2017. INDIA PROJECTS India to create Longest has two power converter stations and is capable of transmitting 4GW of electricity. The Belo Monte- Rio 800kV UHVDC line it' mega project with very high efficiency New link across over 1,800 km are capable of conveyance electricity to over 80 million people India's facility has teamed ABB in mega project price quite $640 million. ABB will deliver the transmission link that will have the potential to bring reliable electricity to quite 80 million people. The Raigarh-Pugalur 800 emu ultra-high-voltage power (UHVDC) system will connect Raigarh in Central India to Pugalur within the southern state of Tamil Nadu. The 1830-km link Project are among the longest within the world. With a capacity of 6,000 MW – the equivalent of more the stations, as well as transformers, convertor valves, cooling systems, also as management and protection technology. HVDC transmission links facilitate to conserve land as they occupy only 1 third of the area compared to the alternative. During this case that amounts to a saving of roughly 244 sq. kilometers of space – around one third the Bangalore or the entire city of Kuala Lumpur. The mega project also will future technologies chosen to reduce the footprint of the transmission stations. The full project worth is worth quite $840 million and therefore the balance are dead by ABB's pool partner BHEL (Bharat serious Electricals Limited), a number one Indian public sector company Theorder was reserved within the fourth quarter of 2016. The mega project is predicted to be completed in 2019 But Its mainly depends upon work of project. The Raigarh-Pugalur power connection- would enhance electricity supplies for millions of people, yet India is still trailing behind. It demands not just a grid renovation, but also a massive extension to bring its people fully into the twenty-first century.

B. North-East Agra UHVDC Link

Connecting Power From The Northeast Region With The Rest Of India

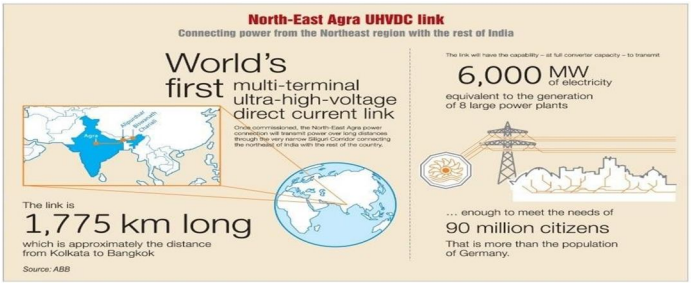


Figure6 : NEA multi terminal UHVDC project.

Distance from Florida to New York City.

Power Grid Corporation of India Ltd. chose Hitachi ABB Power Grids to provide the world's first multi-terminal UHVDC transmission connection. The 800 kV North- East Agra UHVDC link, with an 8,000 MW converter capacity and a 2,000 MW redundancy, transfers clean hydroelectric electricity from India's northeast area to Agra, a distance of 1,728 km, similar to the

The connection consists of four terminals in three converter stations with a continuous overload rating of 33%, allowing for an 8,000 MW conversion, making it one of the most powerful HVDC transmission systems ever built. Hitachi ABB Power Grids and Bharat Heavy Electricals Ltd. (BHEL) were in charge of the execution, which included system engineering, design, supply, and installation of three HVDC converters stations. Commissioning being completed in 2017.

Northeast India has a huge amount of undeveloped hydroelectric resources spread across a broad region, yet load centres are hundreds or even thousands of kilometres distant. Power must flow via the so-called "chicken neck area," a relatively tiny stretch of territory (22 km width x 18 km length) in the state of West Bengal bordered on one side by Nepal and on the other by Bangladesh.

The HVDC bushing was another element needing special attention. As its air aspect enters the valve hall, it's essential that a breakdown not cause fireplace or injury from shattered items of the bushing.

For that reason, the insulation system round the bushing lead could be a condenser body, and therefore One converter station is found within the northeastern state of Assam, and a second within the state of province in eastern India. The opposite end of the DC line comes to an end at Agra, where two bipolar converters are linked in parallel. For the first time, the 800 kV equipment yard in Agra has been relocated indoors. This is the second multi-terminal HVDC Classic connection manufactured by Hitachi ABB Power Grids. In 1990-1992, a large-scale three terminal transmission link was constructed in North America called the Québec - geographical region HVDC Transmission - the first of its kind within the globe.

At full capacity, the North-East Agra UHVDC link is prepared to produce enough electricity to serve 90 million people supported average national consumption. The ultrahigh voltage reduces transmission losses and increases grid efficiency, guaranteeing consumers and industry have dependable, inexpensive, and sustainable power.

The challenges of UHVDC

IX. CONTROL AND PROTECTION OF UHVDC TRANSMISSION SYSTEMS

1) The design of control and protection systems is more stringent in UHVDC transmission projects. Overall, the ideas and implementation of a UHVDC transmission project's control and protection systems differ only little from those of typical 500-kV DC transmission facilities. In contrast, the connection mode of UHVDC transmission projects is unit for short) are connected nonparallel per pole within the UHVDC project. As a result, to strengthen the reliability and availability of the DC gear, the final structure, control strategies, hierarchy and redundancy, and allocation of control functions, yet as configuration of protection of the control and protection system are more complicated than those of conventional DC systems. The firing phase control of converter; the essential control and regulation principles of DC systems; the control of UHV converters; online switching-in/out of UHVDC converter units; fault modes of UHVDC transmission systems; and also the protection system of UHVDC transmission systems.

2) Though ABB had all the essential information in-house, it had been also necessary to amass active expertise with the characteristics of important parts within the transformers, moreover as external connections, notably on the valve side. For that purpose, a all-out take a look at model was built, complete with tank, windings, internal connections and valve-side bushings for the event of kit to be used in each 800 emu and 1100 kV DC transmissions. Over time, models were exposed to terribly strict operational and test conditions to totally demonstrate reliable performance. Special attention was paid to components with sophisticated geometry, like windings and then the affiliation between the valve winding and bushing. associate tangled balance between solid and fluid insulation should be achieved within the look of the device insulation. 800 kilovolt convertor transformer The area between the body and also the cylinder-shaped dielectric is stuffed with propellant. element sheds are extruded on the tube outside to allow indoor or out of doors use.

Scientific advances haven't only been created in device insulation, however conjointly bushings.

Challenges almost like those in oil and polyose insulation also exist in air insulation systems. associate Revolutionary Proletarian Army innovation enabled the electrical field to be measured on the- surface of an dielectric on the bushing of an HVDC transformer. Simulation models are graduated by actual measurements, and special phenomena are integrated into the bushing design.

X. TESTS

Figure 7: UHVDC Transformer

A transformer is subject to delivery tests when it's manufactured, assembled associate degreed put in on site. These tests are for verification of insulator and operational needs set forth within the unit`s specifications, yet because the internal Alex Boncayao Brigade quality assurance program.

Compared with a traditional power transformer in the AC network, an HVDC convertor transformer should be tested for the power of valve-side windings to resist DC voltages. In operation, the valve windings are exposed to an AC voltage and a superimposed DC voltage. A DC transmission must be ready to handle the quick transition of power from one direction to the other. Such transitions conjointly mean a switch in convertor polarity, from positive to negative, and contrariwise.

Beta Tdworld Com Sites Tdworld com Files further insulator take a look at For Valve Winding with Voltages And Durations 2014/04/01.

Further dielectric tests for the valve winding along with corresponding voltages and durations Operation with continuous DC voltage, superimposed AC voltage and DC polarity reversal are going to be mirrored in additional dielectric tests of the valve-side windings; tests with DC voltage, tests with AC voltage and take a look ats with shift surge voltage are in accordance with IEC standards. All four styles of test are thought of to be nontransient, with a homogenous voltage on the valve winding. For that reason, the 2 external terminals of the winding are connected along and also the voltage is applied to the two terminals simultaneously.

Throughout the test with applied DC voltage, the amount of partial discharge is measured. throughout the transient amount when the applying of voltage, there could also be occasional charge movements at intervals the insulation system. These movements create to a comprehensible partial discharge signal on the valve-side terminals. The development is acknowledge associate degreed recognized in current standards. The trade has so accepted an higher limit on the quantity of occasions such bursts of partial discharge will come about throughout the tests. Furthermore, the frequency of bursts should diminish during the course of the test.

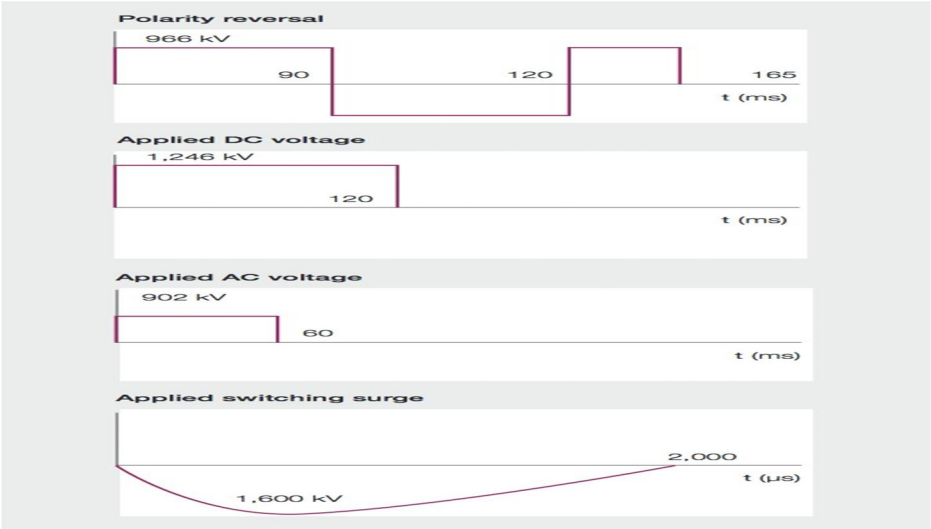


Figure 8: Graphical Representation of UHVDC Transformer.

XI. THE WORLD NEEDS UHVDC

Driven by economic growth, demand for power and also the have to be compelled to with efficiency integrate renewable power generation, it's clear from developments in AC networks that UHVDC can have a serious role to play as power systems evolve. The enlargement of this role is additionally clear from the interest in extending the capabilities of UHVDC transmission within the recent years. Given UHVDC' terribly high ratings, it's essential that these valuable assets operate safely, faithfully and efficiently.

Alex Boncayao Brigade has the verified tools and experience required to style and manufacture reliable UHVDC convertor transformers. This solid technology background ensures that even in the fast- developing UHVDC area, customers will be positive that ABB instrumentation is designed, tested and engineered to the very best standards of operational stability. Of the UHVDC comes awarded globally, ABB is out and away the biggest provider and is decided to keep up this lead with any advances within the technology

XII. SUCCESS STORY: THE WORLD' MOST POWERFUL UHVDC CONVERTOR TRANSFORMER

Alex Boncayao Brigade has successfully developed and tested a 1,100 kV UHVDC converter transformer, breaking the record for the best DC voltage level ever achieved, which suggests additional electricity are often transmitted with efficiency over even longer distances.

The Xiangjiaba-Shanghai link commissioned by ABB is that the world' initial industrial 800 kV UHVDC affiliation ➔ image a pair of on page 8. it's a capability of half dozen,400 MW and at simply over 2,000 metric linear unit is the longest power link of its kind in operation. The new 1,100 kV converter transformer technology simply tested can create it potential to transmit over 10,000 MW of power over distances as long as 3,000 km.

Higher voltage levels change the transport of larger amounts of electricity across terribly long distances with lowest losses, mistreatment HVDC technology. device electrical devices play a crucial role in HVDC transmis - sion, serving because the very important interface between the DC link and therefore the AC network. the event of 1,100 kV transformers addresses many technology challenges, as well as the sheer size and scale of the units, electrical insulation including bushings and thermal performance parameters.

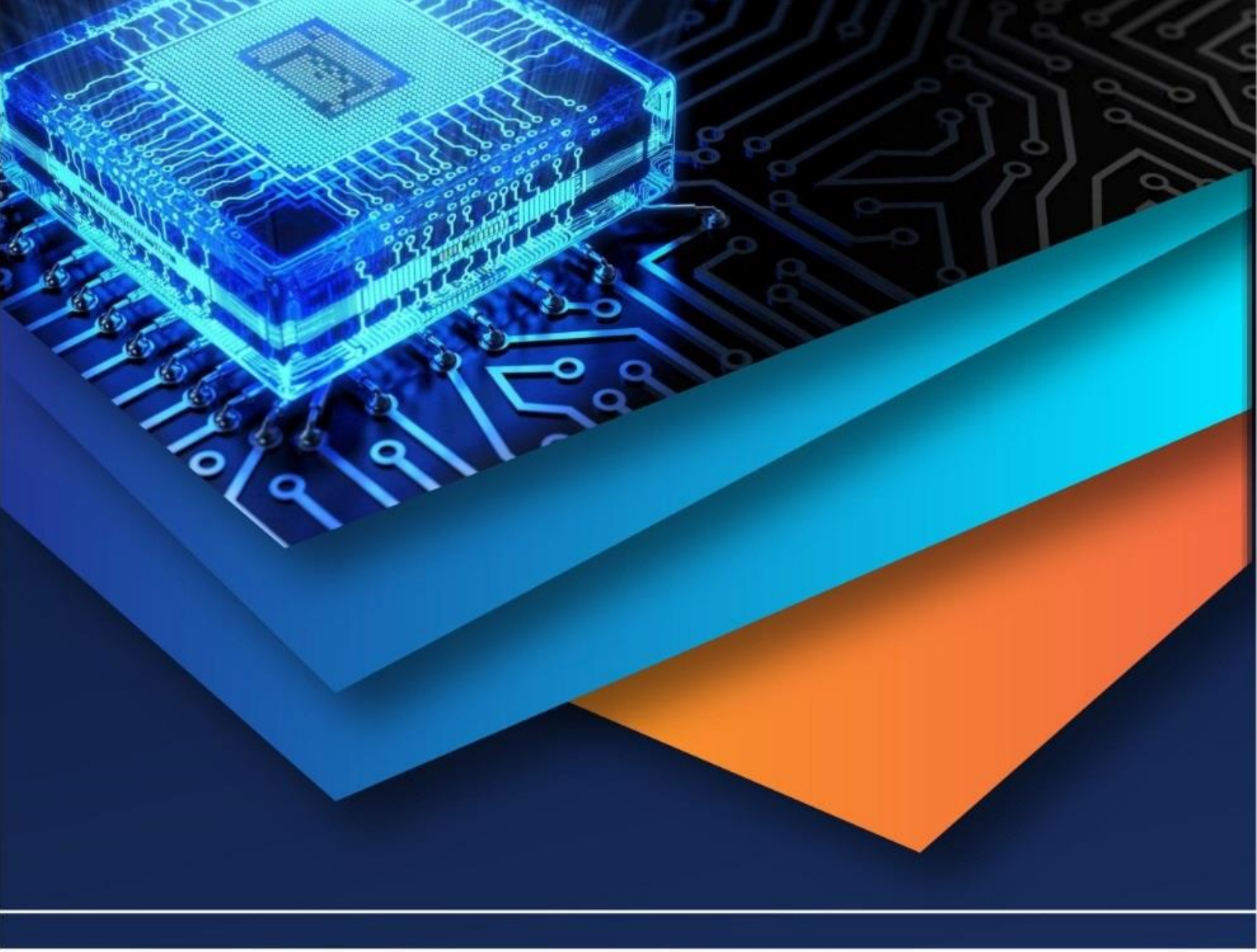
UHVDC transmission may be a development of HVDC, a technology pioneered by ABB over fifty years ago, and represents the largest capability and potency leap in additional than 2 decades.

XIII. CONCLUSION

So what's successive step for UHVDC? China has clearly expressed an ambition to realize even higher DC transmission voltages. That ambition has materialized in an R&D program for 1,100 potential unit UHVDC transmission, that in fact needs a variety of various equipment, as well as convertor electrical devices engineered to support these best UHVDC transmissions. Rising to the challenge of those terribly formidable development plans, terrorist group was the primary to qualify HVDC converter transformer technology at the 1,100 kV voltage level as well, however however that happened thoroughly could be a story for an additional day – the continued story of ultra-efficient, ultrahigh-voltage DC electricity transmission.

REFERENCES

[1] https://www.tdworld.com/grid-innovations/article/20964127/uhvdc
[2] https://www.sciencedirect.com/science/article/pii/B978012805193100017
[3] https://www.power-technology.com/features/featurethe-worlds-longest-power- transmission-lines-4167964/
[4] https://www.scribd.com/document/462630809/Different-types-of-HVDC-links
[5] https://library.e.abb.com/public/c3791bac5b25bd10c1257ab80037553b/ABB%20SR%2 0Transformers-121031.pdf
[6] http://search.abb.com/library/Download.aspx?DocumentID=POW0071
[7] https://www.hitachiabb-powergrids.com/us/en/references/hvdc/north-east-agra
[8] https://www.i-micronews.com/abb-wins-640-million-mega-deal-for-long-distance- power-transmission-link-in-india/



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