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The Influence of Two Different High Voltages on the Performance of VSD

Wadah Aljasim[1], Abdulhadi Alhassani[2], Saif Alwazzan[3], Waleed Noori Hussain[4]

[1]*Head of Research's Department & IUC, Sydney, Australia*
[2]*Dean of University & IUC, Basra, Iraq*
[3]*Head of IT Department, & IUC, Basra, Iraq*
[4]*Lecturer & IUC, Basra, Iraq*

Abstract— This paper shows a comparison simulation results for two high voltages 11KV and 10 KV on the downstream equipment of the variable speed drive VSD.

Keywords—**11 and 10 KV Supply, VSD and MATLAB /SIMULINK.**

I. INTRODUCTION

A transmission tower or power tower (electricity pylon in the United Kingdom and parts of Europe) is a tall structure as shown in figure 1, usually a steel lattice tower, used to support an overhead power line. They are used in high-voltage AC and DC systems, and come in a wide variety of shapes and sizes. Typical height ranges from 15 to 55 m (49 to 180 ft), though the tallest are the 370 m (1,214 ft) towers of a 2,700 m (8,858 ft) span of Zhoushan Island Overhead Powerline Tie. In addition to steel, other materials may be used, including concrete and wood. There are four major categories of transmission towers: suspension, terminal, tension, and transposition. Some transmission towers combine these basic functions. Transmission towers and their overhead power lines are often considered to be a form of visual pollution. Methods to reduce the visual effect include undergrounding [1].

Towers may be self-supporting and capable of resisting all forces due to conductor loads, unbalanced conductors, wind and ice in any direction. Such towers often have approximately square bases and usually four points of contact with the ground. A semi-flexible tower is designed so that it can use overhead grounding wires to transfer mechanical load to adjacent structures, if a phase conductor breaks and the structure is subject to unbalanced loads. This type is useful at extra-high voltages, where phase conductors are bundled (two or more wires per phase). It is unlikely for all of them to break at once, barring a catastrophic crash or storm. A guyed tower has a very small footprint and relies on guy wires in tension to support the structure and any unbalanced tension load from the conductors. A guyed tower can be made in a V shape, which saves weight and cost [2].

Figure 1: HV Transmission tower [Yummifruitbat]

As of 2012, 345 kV lines on wood towers are still in use in the US and some are still being constructed on this technology [3-4]. A new type of pylon will be used in the Netherlands starting in 2010. The pylons were designed as a minimalist structure by Dutch architects Zwarts and Jansma. The use of physical laws for the design made a reduction of the magnetic field possible. Also, the visual impact on the surrounding landscape is reduced [5]. A clown-shaped pylon appears in Hungary (GPS coordinates of the location: (47.235548, 19.389177) [6]. The first hydroelectric stations in Québec were built by private entrepreneurs in the late 1800s. In 1903 the first long distance high-voltage transmission line in North America was built, a 50 kV line connecting a Shawinigan power station to Montréal, 135 km away. In the first half of the 1900s, the market was dominated by regional monopolies, whose service was publicly criticized. In response, in 1944 the provincial government created Hydro Quebec from the expropriated Montreal Light, Heat & Power [7].

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In 1963 Hydro-Québec purchased the shares of nearly all remaining privately owned electrical utilities then operating in Québec and undertook construction of the Manicouagan-Outardes hydroelectric complex. To transmit the complex's annual production of about 30 billion kWh over a distance of nearly 700 km, Hydro-Québec had to innovate. Led by Jean-Jacques Archambault, it became the first utility in the world to transmit electricity at 735 kV, rather than 300–400 kV which was the world standard at that time.[2] In 1962, Hydro-Québec proceeded with the construction of the first 735 kV power line in the world. The line, stretching from the Manic-Outardes dam to the Levis substation, was brought into service on 29 November 1965 [8].

Over the next twenty years, from 1965 to 1985, Quebec underwent a massive expansion of its 735 kV power grid and its hydroelectric generating capacity [9]. Hydro-Québec Equipment, another division of Hydro-Québec, and Société d'énergie de la Baie James built these transmission lines, electrical substations, and generating stations. Constructing the transmission system for the La Grande Phase One, part of the James Bay Project, took 12,500 towers, 13 electrical substations, 10,000 kilometres (6,000 mi) of ground wire, and 60,000 kilometres (40,000 mi) of electrical conductor at a cost of C$3.1 billion alone [10]. In less than four decades, Hydro-Québec's generating capacity went from 3,000 MW in 1963 to nearly 33,000 MW in 2002, with 25,000 MW of that power sent to population centers on 735 kV power lines [11]. As shown in Figure 2.1, electricity is produced at lower voltages (10,000 to 25,000 volts) at generators from various fuel sources, such as nuclear, coal, oil, natural gas, hydro power, geothermal, photovoltaic, etc. Some generators are owned by the same electric utilities that serve the end-use customer; some are owned by independent power producers (IPPs); and others are owned by customers themselves—particularly large industrial customers. Electricity from generators is "stepped up" to higher voltages for transportation in bulk over transmission lines. Operating the transmission lines at high voltage (i.e., 230,000 to 765,000 volts) reduces the losses of electricity from conductor heating and allows power to be shipped economically over long distances. Transmission lines are interconnected at switching stations and substations to form a network of lines and stations called a power "grid."

Electricity flows through the interconnected network of transmission lines from the generators to the loads in accordance with the laws of physics—along "paths of least resistance," in much the same way that water flows through a network of canals. When the power arrives near a load center, it is "stepped down" to lower voltages for distribution to customers. The bulk power system is predominantly an alternating current (AC) system, as opposed to a direct current (DC) system, because of the ease and low cost with which voltages in AC systems can be converted from one level to another. Some larger industrial and commercial customers take service at intermediate voltage levels (12,000 to 115,000 volts), but most residential customers take their electrical service at 120 and 240 volts [12].

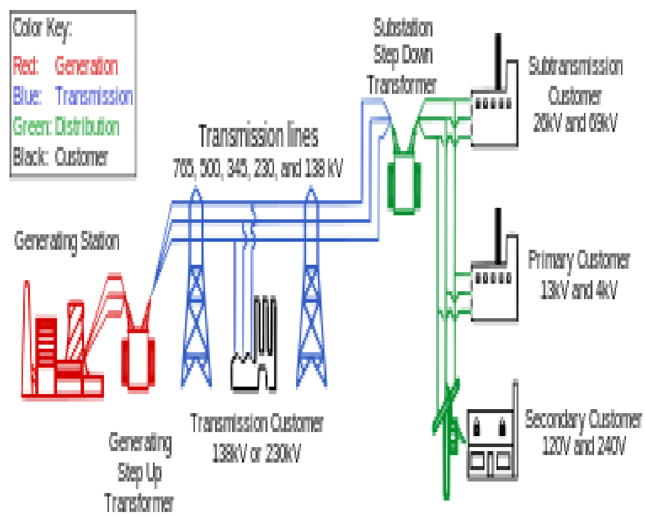

Figure 2: Simplified diagram of AC electricity delivery from generation stations to consumers [12].

II. SIMULATION RESULTS

Figure 3 shows the 10 KV HV input voltage supplies VSD transformer. The secondary part of this transformer consists of four coils each coil having 1030 V; all coils are supplying 24 diodes. The output of these diodes can be calculated as shown below in equation 1:

$$\text{DC bus} = 1030*\sqrt{2}*4=5826/2 = 2913 \text{ VDC} \qquad (1)$$

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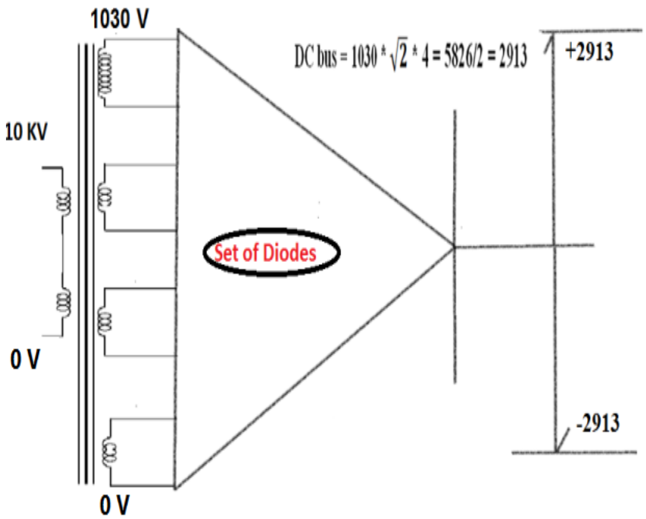

Figure 3: Simplified diagram of 10 KV input supply to the tested VSD.

Figure 4 shows the input high voltage of the tested VSD in KV versus time in millisecond when the input voltage applied to the VSD is 10 KV. Figure 4 shows the fault is happening due to poor quality of the HV transmission lines, as a result of this defect it will affect the client equipment and especially when the HV lines will extend for the long distance between the service provider and the client. As shown the DC bus fluctuate around 6.5 KV and when the fault occurred then DC bus will reduce to less than 5.2 KV and then raise to reach high level more than 7.5 KV to trip the protection circuit breaker, which exceed the maximum permitted value (7.5) KV.

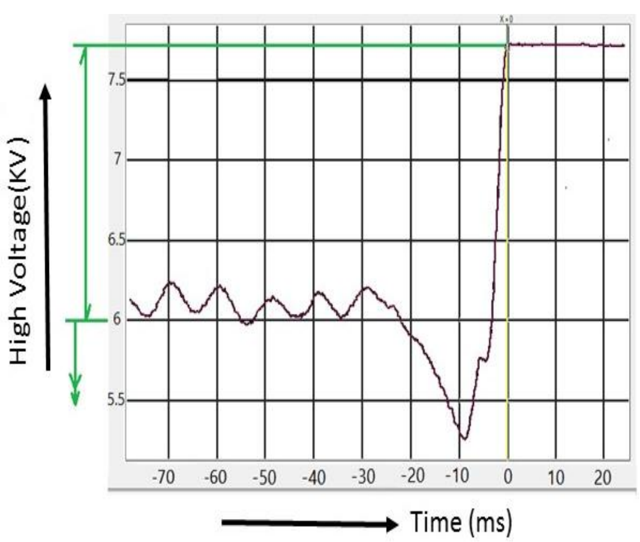

Figure 4: High voltage in KV verses time for 10 KV input for the tested VSD.

Figure 5 shows the 11 KV HV input voltage supplies VSD transformer. The secondary part of this transformer consists of four coils each coil having 1133 V; all coils are supplying 24 diodes. The output of these diodes can be calculated as shown below in equation 2:

$$\text{DC bus} = 1133*\sqrt{2}*4=6409/2 = 3204 \text{ VDC} \qquad (2)$$

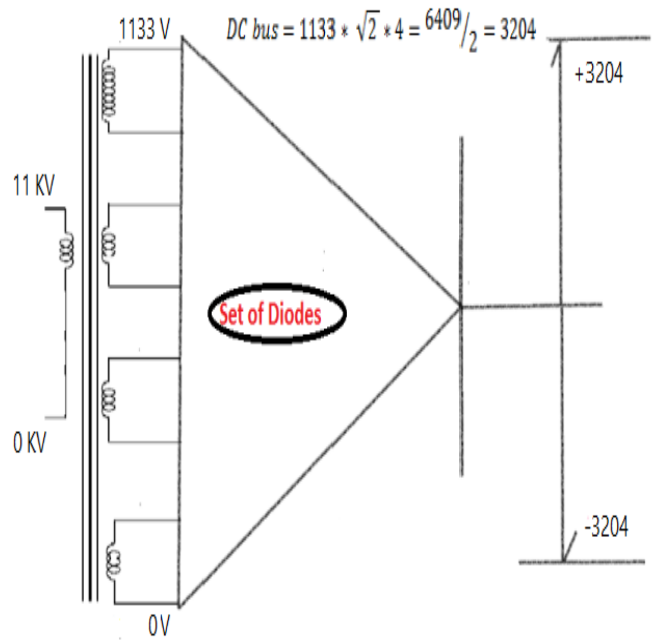

Figure 5: Simplified diagram of 11 KV input supply to the tested VSD.

Figure 6 shows the input high voltage of the tested VSD in KV versus time in millisecond when the input voltage applied to the VSD is 11 KV. Figure 6 shows the fault is happening due to poor quality of the HV transmission lines, as a result of this defect it will affect the client equipment and especially when the HV lines extend for the long distance between the service provider and the client. As shown the input voltage will fluctuate on 6 KV and when the fault occurred then input voltage will be decline to 4.7 KV and then raise to reach 7.8, which is within the normal operating setting of the protection circuit breaker.

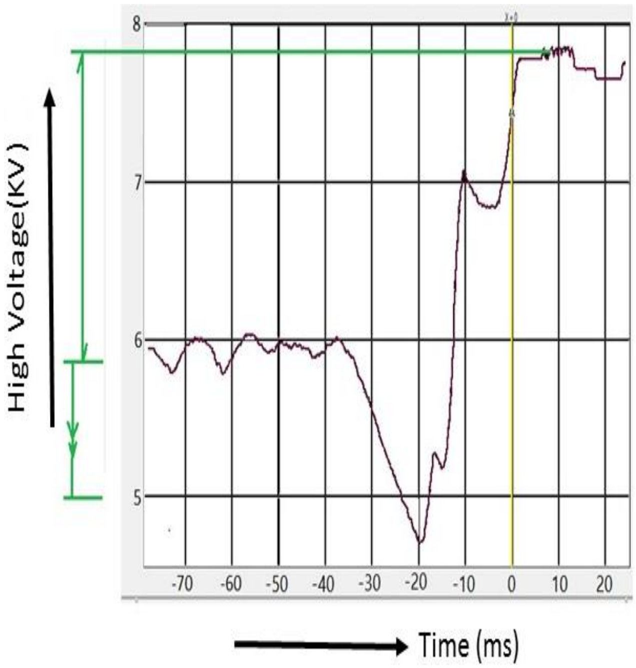

Figure 6: High voltage in KV verses time for 11 KV input for the tested VSD.

III. CONCLUSIONS

When we applied 10 KV as an input voltage to the tested VSD, then in normal condition (no external trouble in the transmission lines) then the input voltage in KV versus time in millisecond will behave normal and no trip will occur, however if any external fault is occurred in the transmission lines or by the service provider due to poor quality for the mentioned time in the experiment as shown in figure 4, then the input voltage will raise above the setting of the protection breaker and then the breaker was tripping.

When we applied 11 KV as an input voltage to the same tested VSD, then in normal condition (no external trouble in the transmission lines) then the input voltage in KV versus time in millisecond will behave normal and no trip will occur, and if any external fault is occurred in the transmission lines or by service provider due to poor quality for the mentioned time in the experiment as shown in figure 6, then the input voltage will stay below the setting of the protection breaker and the breaker was not tripping.

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We Dr. Wadah Aljaism, Dr Abdulhadi Alhassani, Saif Alwazzan, Waleed Noori are acknowledging that the above study achieved by us with the aid of MATLAB/SIMULINK. All the simulation results are performed by the mentioned software.

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