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MAJOR TRENDS



The history of gas-insulated substations

06/13/2012 - 2.19 pm

 CLEAN GRID  GIS  HISTORY

The gas-insulated substation (GIS) represents a key element of high voltage electrical transmission networks thanks to its reliability, low maintenance requirements and compact dimensions. Here is a brief history of its development and pioneers.



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[The world's first metal-clad 800 kV GIS, installed at Joshua Falls, USA, 1980.]

The roots of HV encapsulated substations go back to the metal enclosed concept of the 1920s when oil was used as the insulating medium. Compressed air and different gases were the focus of much research work, and the first Freon-based solution at 33 kV appeared in 1936. The following decades brought new versions until developments in industrial processes, chemistry and physics led the switchgear industry towards the end of the 20th century to the use of SF₆ for arc extinguishing and insulation as the main GIS technology.



SF₆ gas was already known during the 1940s. Westinghouse holds the original patent for the use of SF₆ as interrupting medium, and their engineers developed the first applications for switches and circuit breakers in the early 1950s. In the 1960s all major manufacturers such as BBC-Calor Emag, Siemens, Magrini, Merlin-Gerin, NEI-Reyrolle, the Japanese and Delle-Alsthom had started intensive developments on the basis of SF₆. The dual-pressure SF₆ circuit breakers of the early GIS systems were soon replaced by single pressure, while circuit breakers were adopting puffer and combined thermal-puffer arc extinguishing chambers. The GIS focus was on the benefits of a compact indoor solution, protected from the environment and closer to users, whereas some markets preferred outdoor rugged solutions using hybrid GIS solutions.



The GE contribution

Grid Solutions, a business of GE Renewable Energy, has a rich GIS development history through its ancestor companies, Delle-Alsthom, Sprecher & Schuh, GEC and AEG.

Delle-Alsthom France started GIS development in 1958 and in 1966-1967 delivered a world first with its “Fluobloc” at 245 kV in several Paris substations, demonstrating the benefits of underground GIS to supply bulk power close to city users. Achievements in the higher voltage ranges were subsequently marked by the deliveries of the first substations for 420 kV in 1976 and for 550 kV in 1977. Another “world first” was the completion of AEP’s 800 kV GIS in Joshua Falls in 1979.

Sprecher & Schuh studied compact metalclad installations as early as 1954 with oil insulation systems, but soon came to the conclusion that SF₆ gas insulation offered greater advantages. Their first GIS for 220 kV was delivered in 1970 and the 145 kV, 40 kA in 1971. The original circuit breakers with double pressure SF₆ systems (220 kV, 50 kA), developed together with ITE USA, were operated by the well-known Sprecher motor-wound spring operating mechanisms, which contributed to the success of subsequent GIS families. The exclusive third-generation FK mechanism today serves all Grid Solutions’ GIS products on the world market.

AEG in Germany has also long been involved in GIS and SF₆, with its first GIS substation delivered in 1971.

Meanwhile, GEC in England was collaborating with Siemens, and their first GIS was a 145 kV substation in London in 1982. As GIS systems developed and their extensive use in HV networks grew, Grid Solutions became the manufacturer of complete GIS ranges of 72.5-800 kV in which single-phase and three-phase encapsulation is used.

Looking ahead

Clearly, the most significant development factor was the adoption of SF₆ as an insulation medium. This boosted the development of smaller switchgear requiring less operating energy and reduced materials and resources, leading to higher performance. So far 420 kV, 63 kA with a single break is possible with the spring mechanism.

<p>ated substations (ed) using oil as dium</p> <p>nd as insulating kV</p> <p>Electric applies the use of SF₆, gas g medium</p> <p>1950s ications for switches akers</p>	<p>1957-1961 GIS solutions with compressed air</p> <p>1966-67 Delle-Alsthom's "world first" 245 kV "Fluobloc" GIS</p> <p>1967 GIS breakthrough – Siemens, BBC, Magrini, Mitsubishi</p> <p>1970-1971 First spring mechanism-operated GIS by Sprecher & Schuh on the market</p>	<p>1971 First GIS produced by AEG for UW Neukölln Berlin</p> <p>Late 1970s First GIS type GMT I produced by GEC</p> <p>1976 B 212 GIS systems circuit breaker. B 114 for use in the Swiss, German and Austrian railway networks at 110-132-170 kV and 14 2/3 Hz</p>	<p>1977 550 kV GIS in Ontario Hydro's Clairville and Milton S/S by Alsthom</p>  <p>1979 800 kV GIS by Alsthom, another "world first" in AEP's Joshua Falls S/S</p> <p>1995-96 First single break 420 kV GIS CB B142 with hydraulic mechanism</p> <p>2003 550 kV 63 kA T355 GIS Areva (Alstom Grid), the first and only spring-operated solution on the world market at this rating</p>	<p>2003-20 Creation of the the smallest for volume</p> <p>2012 20,000 GIS bay for reliable ene</p>
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After 50 years in the making, GIS development is accelerating thanks to the availability of simulation tools and the capability to integrate environmental needs into the design. Future trends could be influenced by the substitution of SF₆ technology, which, however, is likely to be a very complex task. Other steps have already been taken. Moving HV substations closer to consumers results in reduced transmission losses. Indoor GIS reduce the environmental influences on the switchgear, reducing maintenance needs and increasing lifetime. More and more "intelligence" is integrated into the GIS using electronic devices, forming part of digital substations. Ecological and economic considerations, together with ongoing technological developments have made even further optimisation of GIS conceivable.



Roving ambassador

Endre Mikes was born and bred in Hungary. He studied in

Budapest and Moscow, earning an M.Sc. in electrical engineering in 1968. He came to Switzerland in 1970, where he was hired by Grid Solutions ancestor company Sprecher & Schuh in 1973. “I worked in HV testing and CB development and then moved to GIS design and construction. Later, as consulting engineer, I contributed to industry bodies such as CIGRE, IEEE, etc.” It is thanks to his international contacts, technical know-how and linguistic versatility that he became globetrotting ambassador for the company. “In this capacity, I’ve witnessed the changing market focus over 40 years – first Western Europe, then the Far East, later the Gulf area, and since the fall of the Berlin Wall, Eastern Europe and Russia. “In that time, I also observed major changes in the technology and design, in particular the reduction in size. Every 10 years or so, R&D came up with new designs, increased capabilities, better use of materials, advances in civil works that enable GIS to be installed underground, and now major improvements in the environmental footprint of our equipment. I foresee even greater changes in the not too distant future.”

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