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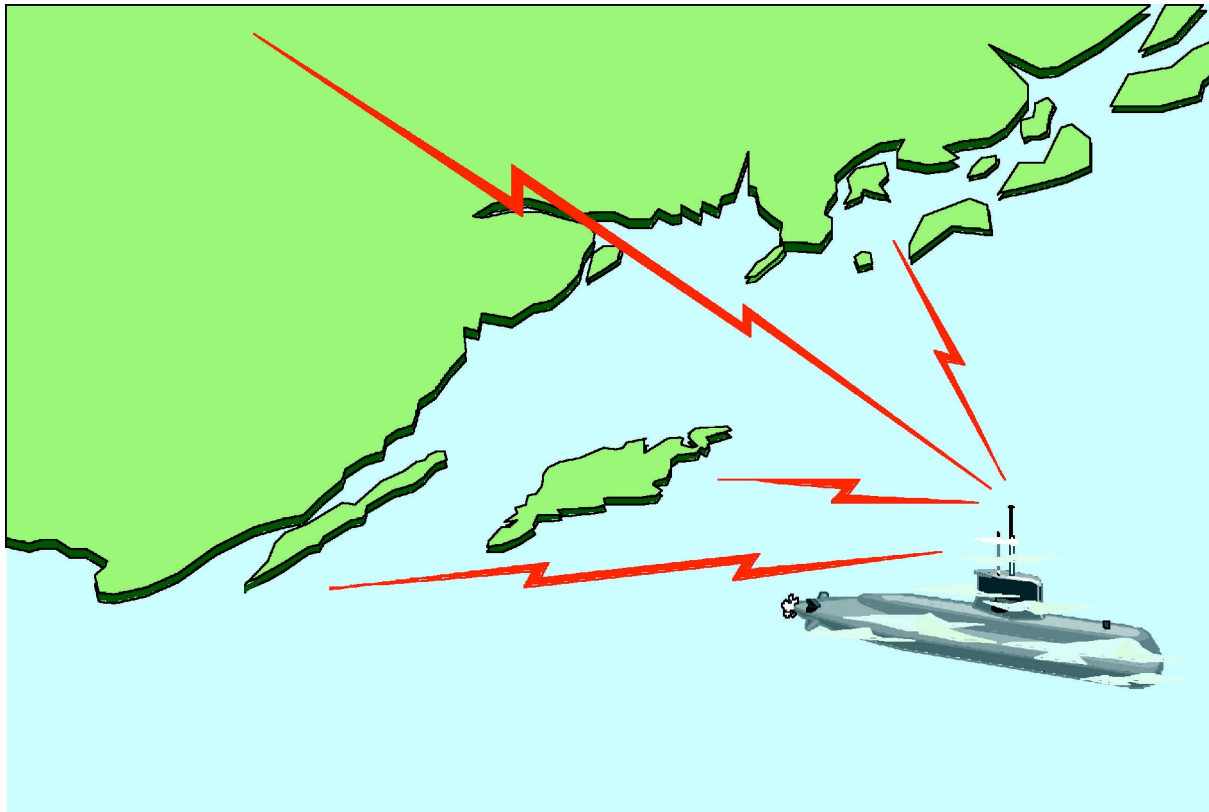


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# Submarine communication Ernst F W Alexanderson World heritage SAQ Grimeton

*Carl-Henrik Walde*

M07/17



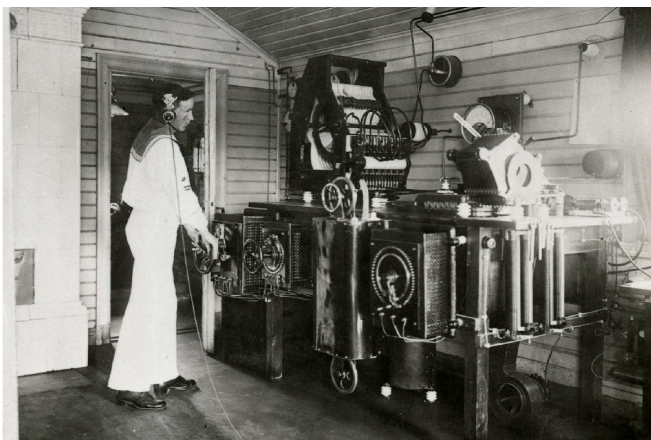
## **”Radio” arrives in Sweden**

In the 1860s, James Clerk Maxwell published his theory of electromagnetic waves which was confirmed experimentally by Heinrich Hertz ten years later; they were seen by physicists as an interesting scientific phenomenon, no more. Guglielmo Marconi, an engineer and entrepreneur of Italian-Irish descent, the ”father of radio”, was the first to utilize the technology for wireless communication. He shared the Nobel Prize in Physics in 1909 with Professor Karl Ferdinand Braun.

In the beginning, radio signals were generated by the energy of electric sparks that produced ”damped” radio waves; the power decreased until the next spark came after roughly one millisecond, a technique that gave a wide frequency spectrum. From the turn of the century, it was possible to use ”continuous” waves (CW) with Poulsen's arc transmitter or highspeed generators of several makes. In the 1920s, transmitting tubes had come and were used in the famous Rugby station.

Already in 1899 the navy tested spark transmitters and a couple of years later the first stations were built in Karlskrona, Oscar-Fredriksborg and Fårösund. In the early 1900s, the Royal Swedish Navy dominated the wireless traffic; the Swedish merchant fleet began to use spark in 1911.

*Svärdfisken* (the *Swordfish*) was the first Swedish sub with longwave telegraphy. For many years, this did not differ significantly from surface ship technology.



*Karlskrona radio SAA (Naval museum)*



*Svärdfisken 1915*

## **Ernst Alexanderson and Varberg Radio (SAQ) in Grimeton**

Ernst Fredrik Werner Alexanderson (1878-1975) graduated at the Royal Institute of Technology in Stockholm and then spent some time at the Technical University of Berlin-Charlottenburg where he received basic knowledge of ”radio”. He moved to USA in 1901 and worked at General Electric (GE) in Schenectady, N. Y., where ”Alex's lab” became well-known. He was there during all his long and creative life.

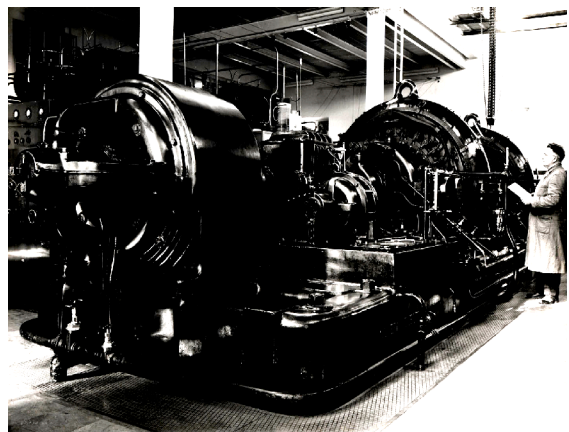
Shortly after the turn of the century, Alexanderson developed alternators for ”long longwave” based on an idea of Reginald A Fessenden who made the world's first broadcast experiment on Christmas Eve 1906 when speech, singing and music fascinated radio officers on ships off the United States east coast.

Alexanderson designed more powerful transmitters and in 1918 had succeeded in designing an alternator with an output of 200 kilowatts and a "multituned" antenna with better, though low, efficiency.

Telecommunication between Sweden and America went over cable or by spark from Karlsborg radio (SAJ) via the UK. However, direct communication with America was sought, and the Swedish Parliament decided to build a radio station for traffic to the United States. Swedish Telecom chose Alexanderson's system which was part of a worldwide radio network for telegraphy.

The Swedish station, built at Grimeton, was put into operation in October 1924. The two 200 kW alternators on 17.2 kHz could go alone or in parallel. The six 127 meter high antenna towers carried twelve 2,200 m long wires that went to the six downward vertical wires that constituted the antenna. For reception from the United States, Kungsbacka radio (SAK) was built with a 13 km long directive antenna. Telegrams were handled at the radio center at Göteborg Telegraph Station. The author's father worked there at the end of the 1920s and used a typewriter to receive morse at 35 wpm, often difficult because of longwave atmospheric noise.

SAQ was used for some years after World War II, but there were no real chance for the alternator and the antenna system to survive when shortwave took over long distance international radio communication. One alternator was scrapped in 1960.



SAQ (Gustaf Björkström, County Museum Varberg, Technical Museum Stockholm)

### **Submarine communication**

For submarine communications, longwave (VLF, Very Low Frequencies and LF, Low Frequencies) is used to submarines and shortwave (HF, High Frequencies) from submarines under the water surface over which the antenna is raised.

In the summer of 1925, Erik Anderberg, a young naval officer interested in radio and later admiral, was in Varberg on the torpedo boat *Rigel*, his first command. There was also the submarine *Illern* (the *Polecat*). Anderberg put a longwave receiver on the sub and asked SAQ to send. *Illern* dived, confirmed by the logbook. Possibly this is the first time one realized that longwave signals penetrated into the water. If any navy prior to World War II used longwave for traffic to submerged submarines is not documented and continues to be an important research area.

Longwave signals are attenuated along the ground and along the water. At the water surface, the signals refract and go down almost vertically where most of the attenuation occurs, more for higher salinity and more for higher frequencies.

During the war, the great powers used VLF, the Royal Navy from Rugby and the Kriegsmarine from Nauen and later in Kalbe an der Milde where "Goliath" was the world's strongest radio station that provided underwater coverage over the globe. Sweden had SAQ with low frequency, high power and state-of-the-art antenna.

The Swedish navy wanted a longwave resource of its own, optimized for the Baltic Sea. Ruda radio (SHR) was built with a 40 kW longwave transmitter and a 200 meter high vertical umbrella antenna with top lines that increased the efficiency. Ruda radio opened on December 1, 1959 and was intended for telegraphy, an excellent communication method, especially in difficult situations. Today, Ruda has a transistorized transmitter with MSK (Minimum Shift Keying) modulation.

FOA, the Defence Research Institute, investigated how to cover the brackish Baltic Sea with another longwave transmitter. Without computer support FOA worked manually with one map with circles for the transmitter field strength and one with transparent curves for needed field strength. The result was amazing: the optimal location was in the area of Ruda. Later, two supplementary transmitters were added. The high salinity western waters could be covered only by Grimeton.



*Ruda radio with icy umbrella wires (Christmas card)*



*Sjöormen – the shortwave antenna has a horizontal disc (Bengt Rasin)*

### **Submarine communications improved with the Sjöormen series**

In the 1940s the transistor was invented. Beside the electron tube it was the most important technology step in radio history, rewarded with a Nobel Prize in 1956.

In the 1950s, with *Sjöormen* (the *Sea Serpent*), communication was radically improved: better longwave reception in the sub and shortwave bursts or "squashes" from the sub. Two systems could be designed with semiconductor technology: the longwave antenna amplifier and the burst system. Most of the equipment was installed in 19-inch racks, a rational way to facilitate maintenance and upgrades.

For longwave reception, Philips Teleindustri AB had previously delivered ferrite antennas with amplifiers in tube technology. Now, Philips made a transistorized

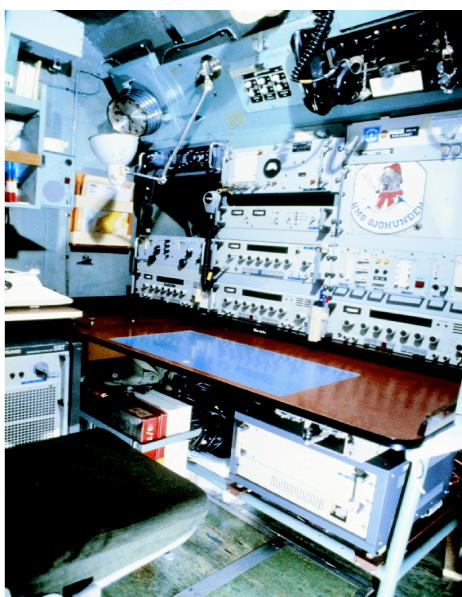
antenna amplifier that was easy to specify: the only overall requirement was "best sensitivity to weak signals". It became an excellent product that was also installed on other submarines and several times moved to new buildings.

In the 1950s and under high secrecy, the naval telecom laboratory developed a burst transmission system under the code name "Snaggen" which was industrialized by AB Transistor with discrete transistors and core memories. Then, signal processing had not come far and the author chose a well-known and for shortwave suitable code that indicated errors by writing a "Z" on the teleprinter. Initially, a simple one time pad ciphering was used. The system has been updated; no details given.

The radio transmitter had electron tubes and could be momentarily overloaded. Over time, its performance was not sufficient, and in the 1970s, the then current standard was introduced with a fully transistorized extremely good shortwave transmitter from Standard Radio, acquired with the Danish Navy according to the "Swedish model", where staffs, agencies, research institutes, universities, schools, industry, consultants, users and sometimes also other nations work together in confidence.

The telecom lab also studied shortwave antennas and did model trials for future industrial development. Fortunately, it was possible to find a miniversion of an American nuclear submarine antenna that, although expensive, was a formidable success and was also put on other submarines and, just as the longwave antenna amplifier, was later moved to new buildings.

For the reception of bursts, many remotely controlled diversity receivers were installed near the coast as well as inland giving an enormous redundancy with pseudorandomly controlled frequency changes, which the coast radio station and the submarine's radioman chose for the time and location. In the beginning, we used the Swedish defense receiver from Standard Radio. Unfortunately, its ledex switches took a lot of battering by the frequent frequency changes. The receivers were later changed to one of Thrane and Thrane's proven equipment from the Dansk radio (Danish radio). The structure of the receiver chain has withstood all reorganizations.



*Sjöhundens radio office*



*Receivers somewhere in Sweden (Arne Ahlström)*

## Sweden's submarines save Grimeton's radio station

The naval interest in Grimeton decreased over time, and at the beginning of 1995, Swedish Telecom decided to close SAQ, still there thanks to its submarine use.

A resistance movement was formed where the County of the Halland, Varberg Town and many others, supported by very hard pressure from radio engineers, radio officers, radio amateurs and other radio enthusiasts, and not least the non-profit association Alexander with many former Grimeton employees.

As a first step, we managed to postpone the end to September 1995 so that SAQ could be heard at a London conference celebrating the 100th anniversary of radio. Then it took only one year until the county declared SAQ an industrial monument.

At that time, we began to think of Grimeton as a UNESCO world heritage site. The work against this goal was begun with great enthusiasm and we were helped on the "royal tour" to Halland by King Carl XVI Gustaf who sent a message to the people of the world. The author had the honor to sit by the telegraph key, the royal couple, the marshal of the realm (royal court CEO) and the county governor standing.

Swedish Telecom has generously donated the station to a foundation adding a considerable sum of money for continued operation and maintenance. Our thanks should also go to the Swedish Navy, that previously contributed, albeit indirectly and then unknowingly, by paying for the maintenance of the antenna system.

In Grimeton you will find both old technology and modern equipment with antenna systems for maritime radio, broadcasting, television and base stations for mobile services. It is living industrial monument, ranked as one of Sweden's foremost.



*The "Royal message" is sent (Telia)*



*Ernst F W Alexanderson  
doctor h c (Tech. Museum)*

On "Alexanderson's Day", a Sunday at the June/July turn of the month, many visitors come. The antennas, the water fountains, the fluid resistors, the clattering relays and the noisy 50-tonne heavy alternator reflect the atmosphere of the 1920s. Then, please remember Ernst Alexanderson, the "complete chief engineer".

## **World heritage at last - it took its time!**

For 60 years, UNESCO has worked against its ambitious goal: "to build peace in the minds of men", which includes the preservation of irreplaceable natural and cultural monuments.

After intensive eight-year work, SAQ was put on World Heritage List on July 2, 2004. UNESCO's decision was felt as very great by all radio enthusiasts and as a manifestation in a country where IT and radio technology are core areas. Two days later, on Alexanderson Day, 1600 people gathered to see and hear SAQ send out the message over the earth. The return channels were amateur radio, email and fax!

The spark era lasted from 1900 to 1920, the tube era from 1920 to 1960. In the transistorized electronic era, we may remember wireless communication over millenniums with its acoustic and optical digital methods such as smoke signals, jungle drums, bonfires, signal trumpets, signal flags, semaphore flags, optical telegraph networks to spark transmitters and signal processing systems of today.

We are happy to have an 80-year radio station in Grimeton. The antenna towers are a characteristic sight of the landscape, well visible from cars on the E6, from trains on the west coast railway and through submarine periscopes off the Halland coast.



*Towers in 1930 (Mårten Sjöbeck, ATA)*



*The reception building (Elsa Dagås)*

## **Grimeton is worth a trip**

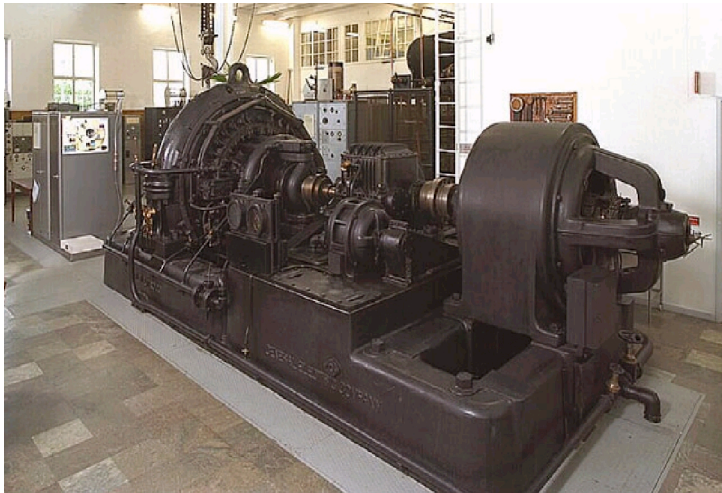
The Visitor's Center, sponsored by the City of Varberg and Varberg's Savings Bank Foundation, opened on July 2, 2005, 80 days after Gustaf V inaugurated SAQ.

At [www.grimeton.org](http://www.grimeton.org) you can see where, when and how to find SAQ.

The association Alexander is responsible for the SAQ transmissions. It goes on air on Alexanderson Day, UN Day 24 October and Christmas Eve. In the summer, the alternator is run once a week. It is sometimes televised and on the Internet.

Varberg radio in Grimeton is a unique world heritage: SAQ, the only preelectronic powerful radio transmitter of the world, has global reach – you may visit it by DX reception if you have a suitable radio receiver.

**”Wireless communication” has changed with time:**



*Then, the transmitter to subs was SAQ Grimeton, today it is SHR Ruda.*



*100 years ago, reception on top of the bunker of SAE Tingstäde radio.*



*Today, at the NAVCOMMEN SWE: silence and no telegraph keys used.*

The author graduated from KTH Teknisk Fysik (Engineering Physics) in 1958 and was in the Swedish defense for more than 40 years, including being chief engineer and manager of the the marine telecom and the joint radio divisions, both with submarine communication on the agenda. Today he is a telehistorian. He has been secretary of the Swedish National Committee for Radio Science (the expert body of the Royal Academy of Sciences, URSI member committee) for over 20 years and of the Nordic Radio Society Foundation for more than 30 years. As SM5BF Calle he is honorary member of SSA, the Swedish League of Radio Amateurs.

The illustration on the front page was made by Christer Ardell. On this page, the Ruda photo is by the author and ”Mara” by its commander Niclas Lyngstam.

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