The Pearl Harbor Attack:
VLF by Japan in World War Two

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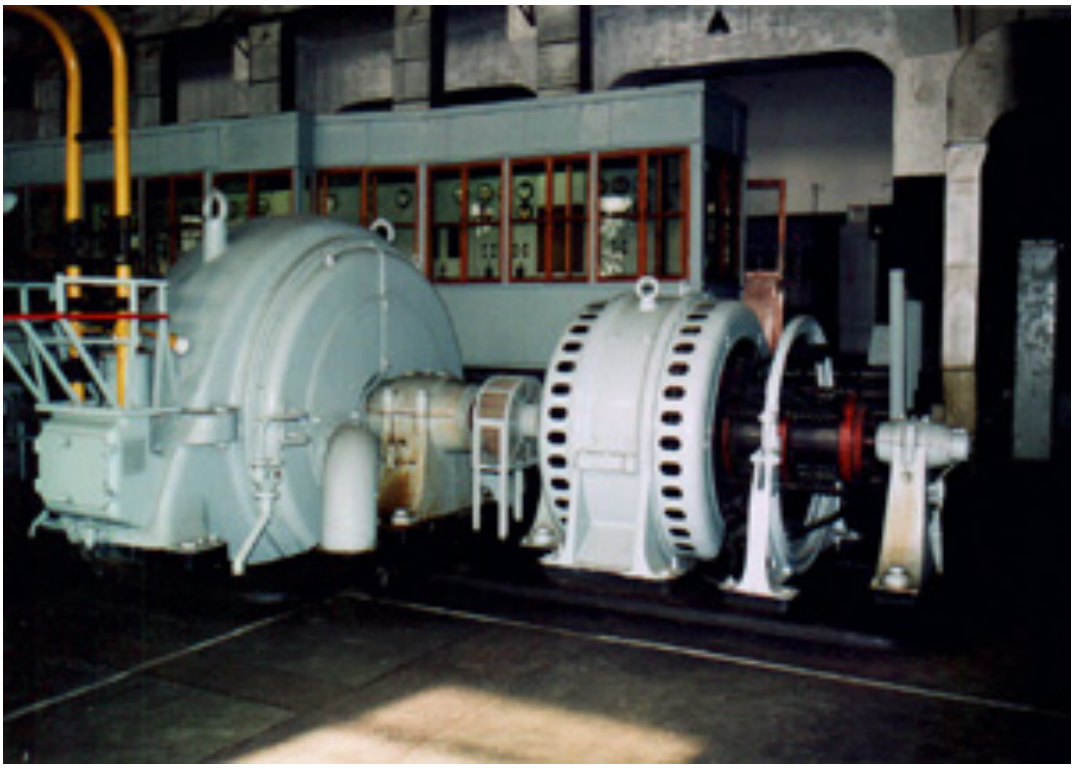
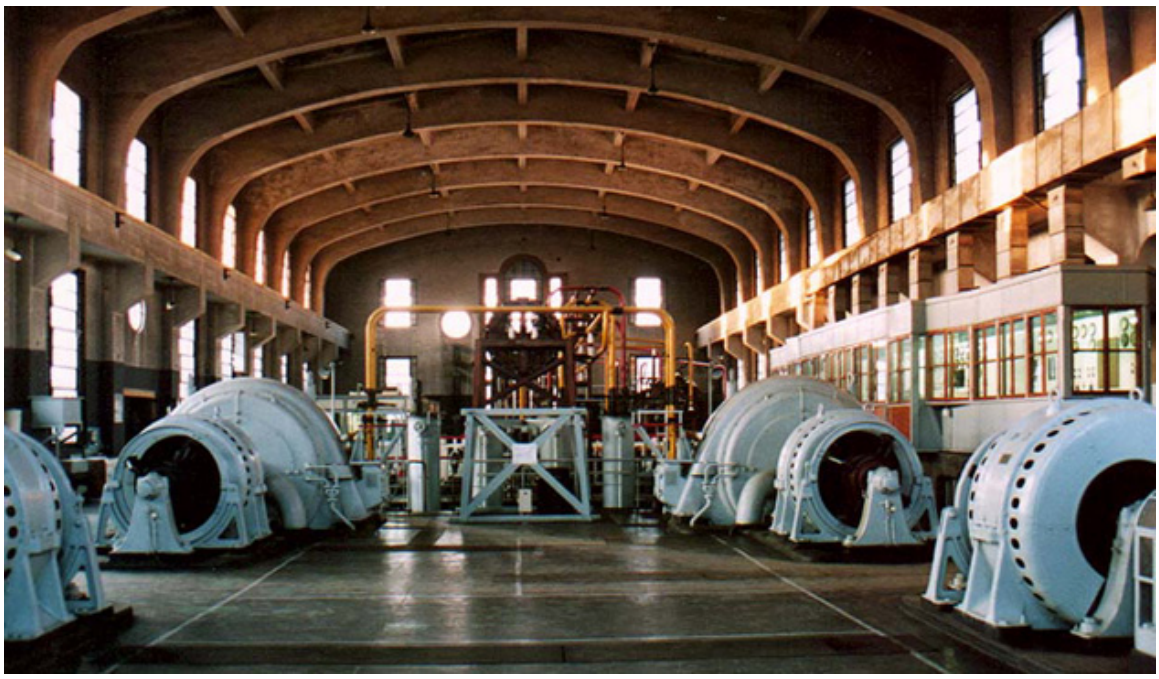
Very low frequencies (VLF) played a role in the Pearl Harbor attack by Japan. (VLF is defined as 3 KHz to 30 KHz, by the ITU). The U.S. Navy knew of the ability of the Imperial Japanese Navy to make use of the unique characteristics of VLF for communications to submarines. Navy Signals Intelligence officers knew of the exact frequency in use.

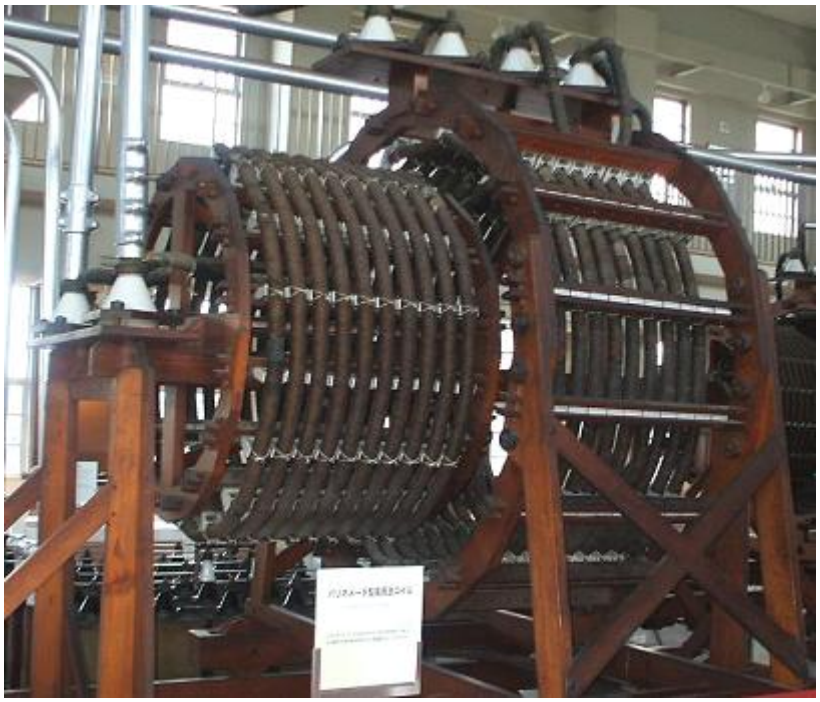


A Telefunken VLF Alternator at its World War Two Site in Japan (now a museum, see below for its website)*

* https://yosami-radio-ts.sakura.ne.jp/english/contents/truth.html



Telefunken Alternators in the Japanese Museum, likely the only ones still extant.



A Tuning Variometer for the Alternators.

A U.S. Navy SigInt historian writes:

"All messages sent to the Strike Force were broadcast by the Tokyo Fleet Broadcast many times and on multiple high frequencies that were received with strong signals all over the Pacific Ocean area. The broadcast also used Tokyo's half million watt very low frequency transmitter on 17.44 kHz that submarines could copy reliably even while submerged at moderate depths. Tokyo's signals were copied 100 percent by the Strike Force and U. S. naval intercept stations. *** [fn] 66[:] *** The information on Tokyo's 17.44 kHz transmitter is from author's recollections of the Station H Supervisor's Manual, WW II experiences and post-war experiences in Japan." †

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The increasing high frequencies used by Tokyo, reported by Robert Stinnett in DAY OF DECEIT, implied that the attacking fleet was increasingly far away from Japan. The Japanese submarines, however, relied on long-range VLF, because it penetrated seawater, so they did not have to take the risks of surfacing to receive messages. They played a significant part in protecting the Japanese fleet. The Telefunken VLF alternator transmitter, with a power of 600 KW, enjoyed a worldwide reach.

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The website of the museum of the Japanese VLF station notes, with respect to the Pearl Harbor attack:

"An Imperial Japanese Navy submarine daily journal records 'received the VLF message of 17.44kc of the Tokyo

† Philip H. Jacobsen (2005) PEARL HARBOR: RADIO OFFICER LESLIE GROGAN OF THE SS LURLINE AND HIS MISIDENTIFIED SIGNALS, Cryptologia, 29:2, 97-120, DOI: 10.1080/0161-110591893825 [---] To link to this article: http://dx.doi.org/10.1080/0161-110591893825

Transmitting Station at 17 meter deep.' " [kc = kilocycles = KHz]

The museum website provides the history of the station:

"April 15 [1929] Yosami Radio Transmitting Station is completed and begins telecommunication, by 17,442 Hz and the wavelength of 17,200 meters with the antenna power 500kW"

"Taken over by the Imperial Japanese Navy [in 1941], for communication to its submarines, and on December 2 reportedly relays the war attack message code of 'Climb Mount Niitake 1208'"

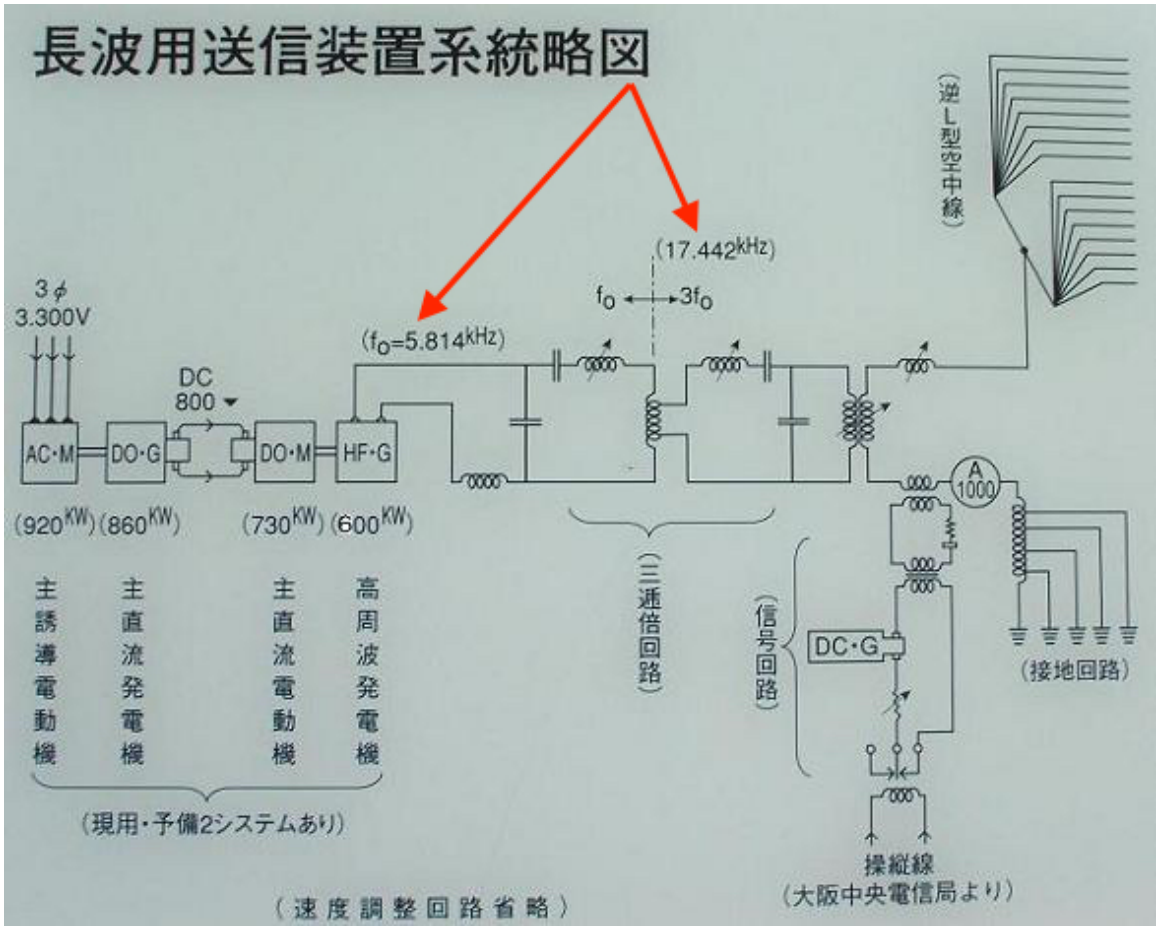
" *** the German High Frequency Generators, designed by Telefunken, and manufactured by AEG, met the requirements of Yosami and [were] then installed.
The Telefunken's High Frequency Generators do not directly generate the frequency of 17.442 kHz; [they] are capable of the high power output of 600kW, and have less frequency change. The initial frequency of 5.814 kHz is multiplied three times by the Tripler to obtain the target frequency of 17.442 kHz."

The term "tripler" implies a Goldschmidt Alternator‡ but Telefunken may have installed a similar Joly-Arco alternator. (The Joly-Arco circuitry, however, usually quadrupled the initial alternator frequency).

The following Japanese schematic diagram shows the tripling transition from the initial mechanical alternator frequency of 5.8

‡ See the wiki: https://en.wikipedia.org/wiki/Goldschmidt_alternator

KHz to the final frequency of 17.4 KHz, also by means of inductive circuitry.



From the Japanese website

Eight tall towers effected the transmission of these VLF signals.

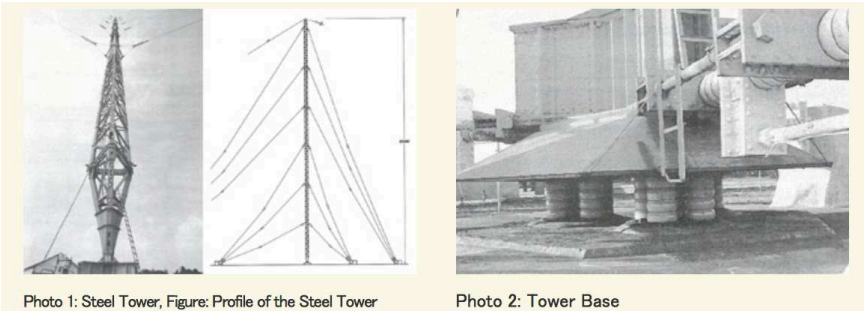


Photo 1: Steel Tower, Figure: Profile of the Steel Tower

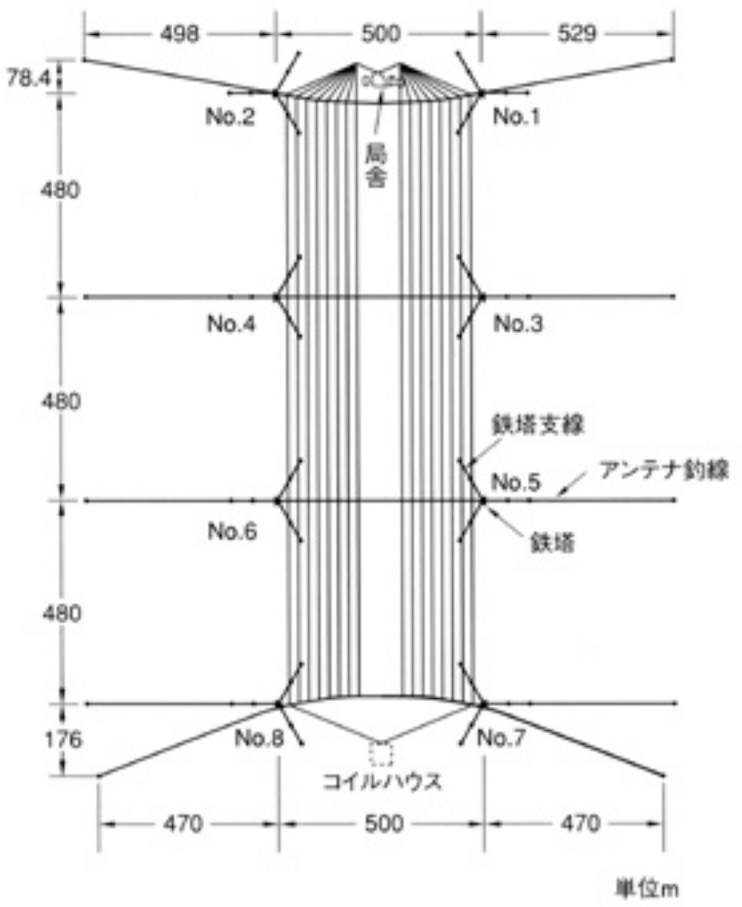
Photo 2: Tower Base

The website describes the antennas:

"Antenna System [-] The eight steel towers of 250 meter high stood in two lines of a distance of 500 meters with a distance of 480 meters between towers in line. The 16 lines of antenna wires of 1,760 meters each were stretched over the eight steel towers in the sky along the two lines of the towers. The 16 lines of antenna wires were hung over the four wire lines connecting the tips of two towers each, and extended in the reverse L shape, while the earth wires were stretched like a mesh under the ground of 1,760m × 880m of the steel towers."

The VLF Towers

Almost all of this installation is long gone, except for the equipment in the museum.



A Schematic Diagram of the Antenna System (from the website)

The transmitter building is at the center top. The guy wires (horizontal in the diagram) between the several towers support the antennas, 16 in number (and vertical in the diagram). The antenna configuration seems to be a tuned multi-wire Marconi "L" over an extensive ground. (The diagram shows tuned grounds). It is hard to know if the horizontal wires radiated or simply acted as a capacity hat for the vertical lead-ins (or both). In any event, they would have made for some directivity towards Europe, being aligned roughly great-circle North from Japan.

The similar Alexanderson alternator system employed vertical radiators from its towers under a long and multi-wire capacity hat, also over a ground mesh. It too featured directivity in its alignment. The World War Two German Goliath VLF transmitter also employed vertical radiators and three umbrella capacity hats. Presumably Telefunken alternators, usually running at 800 KW, powered it.

After the War, in about 1950, the United States, as the occupying power of the late Japanese Empire, put the Japanese station to use for naval communications in the Pacific. It was, however, later decommissioned. The museum retains much of the equipment.

Today, the naval powers of the world continue to rely on VLF transmissions to communicate with their submarines.

(20 X ’22, v2, de K6VK) ##