VAISALA News

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The CORA Automatic Sounding System – a Brief History

Vaisala delivered the first fully automated sounding system in March 1975. To celebrate the 30-year-old CORA, we look at some significant milestones in its development.

In the early 1970s, Vaisala made the strategic decision to develop a 400 MHz band radiosonde. This was primarily in response to the growing threat of interference in the 28 MHz frequency band. There was also a need to find a windfinding solution for the new radiosonde system.

An attractive new method was to use the long range navigation system Omega, which was under construction by the U.S. Coast Guard. The Omega system operated in the Very Low Frequency (VLF) band, which made it particularly suitable for global use as the signal range was over 10,000 km. The whole globe could be covered with eight Omega transmitting stations, and there would be at least four transmitters within reception range everywhere.

From three possible navigation frequencies, the 13.6 kHz was chosen. The VLF signal did not need to be detected by the radiosonde, but instead could simply be relayed to the ground station where all processing could then take place. This kept the radiosonde design fairly simple, and consequently its manufacturing cost relatively low, making it an attractive new product. The new radiosonde family carried the name Vaisala Radiosonde RS21. The pressure, temperature and humidity (PTU) transducer and sensors were taken from the Vaisala Radiosonde RS18.

Utilizing Omega signals

The new sounding system needed a method to utilize the Omega signals. Fast developing digital electronics and new minicomputers made it possible to apply a revolutionary new approach to the task. Instead of using a conventional phase lock to detect the Omega signals, a correlating receiver, or a correlator, was developed. In the correlator, the Omega signal was first sampled, and then digitized. The digital Omega signal was then correlated with a locally formed similar signal. The results were then passed to the minicomputer, where the signal phases were detected and the wind finally computed.

The basic correlator solution was at a prototype level in late 1972, when Omega windfinding program development was started. The minicomputer used was a NOVA 1200, which had a 16 bit word length, and the address space only allowed direct pointing up to 32 Kword (16 bit words). The ferrite ring memory allowed a processing speed of just 1 MHz. In addition, the program development environment was primitive compared to what it is today. There was no mass memory, so all programs and test data needed to be stored on paper tapes. The only input and output device was Teletype ASR 33, which was an electromechanical, reliable but noisy device, with a printing speed of 10 characters per second. Later, a C-cassette unit with three drives

Jaegersborg sounding station, Denmark, 1977.

The first fully automated sounding system, MicroCORA®.

was added to the system for program loading and intermediate data storage. The main programming language was BASIC, but a number of special functions needed to be written in Assembler code.

From prototypes to first delivery

Soon it was discovered that PTU could also be digitally sampled and processed. Thus it was, at last, possible to create a fully automatic sounding system. In 1973, Vaisala and the Finnish Meteorological Institute joined forces to develop a program to code the WMO TEMP message in a minicomputer. Dr. Daniel Söderman with his team produced the first TEMP coding program in Assembler language – an outstanding achievement. In those days, telex was the primary method to disseminate TEMP messages for global distribution. In order to print the five bit telex code with an eight bit ASCII teletype, an adapter for the teletype printer was needed.

The first winds were measured using Omega as early as February 1973. Soon afterwards the two first prototypes of CORA systems were delivered to the French National Center for Scientific Research (CNRS), to be used in the international GATE campaign in summer 1974. The first production version of the software and system was ready in early 1975, and was delivered to South-Africa. However, it soon became clear that the system was far from "ready".

Improving the system with customers

The second phase of the development began in late 1976, with the goal being to improve both the windfinding performance and radiosonde signal processing. It was soon evident that powerful methods were needed to extract "true" signals from the noise infested, raw PTU and Omega signals received. In addition, there were many operational aspects to be taken into account.

An early customer of the CORA system was the Danish Meteorological Institute, which installed a system in Jaegersborg sounding station near Copenhagen. Through the cooperation with the Danish team, managed by Erik W. Nielsen, many of the data processing and operational issues were solved. However, it was also found that the 32K Word memory was a limiting factor. Another constrain was BASIC, which produced relatively slow executable code.

The breakthrough

R&D Software Engineer Pentti Karhunen, PhD, found a unique and simple solution to invert an 8x8 matrix, needed to determine the wind from the general windfinding equation, binding the measured phases of the signals from eight Omega stations together with the geographical factor. This opened up the opportunity to convert all the needed code to Assembler language. The real test for the new version came in the form of a delivery to the Swedish Airforce in February 1978. CORA passed the field acceptance test, where both the overall system reliability and windfinding accuracy were tested. A new CORA system was born.

The next major steps were the introduction of the RS80 radiosonde family in the beginning of the 1980s, and the use of the NOVA 4 minicomputer with full solid state program storage to replace the electromechanical C-cassette unit. In this configuration with the new radiosonde, MicroCORA® became world famous and remained a reliable tool in synoptic and research meteorology until the termination of the Omega network in 1997. The new sounding systems DigiCORA®, DigiCORA II® and Marwin® were the replacements, but they were still based on the same principles as their predecessor. ●