THE RUSSIAN VLF NAVAID SYSTEM, ALPHA, RSDN-20

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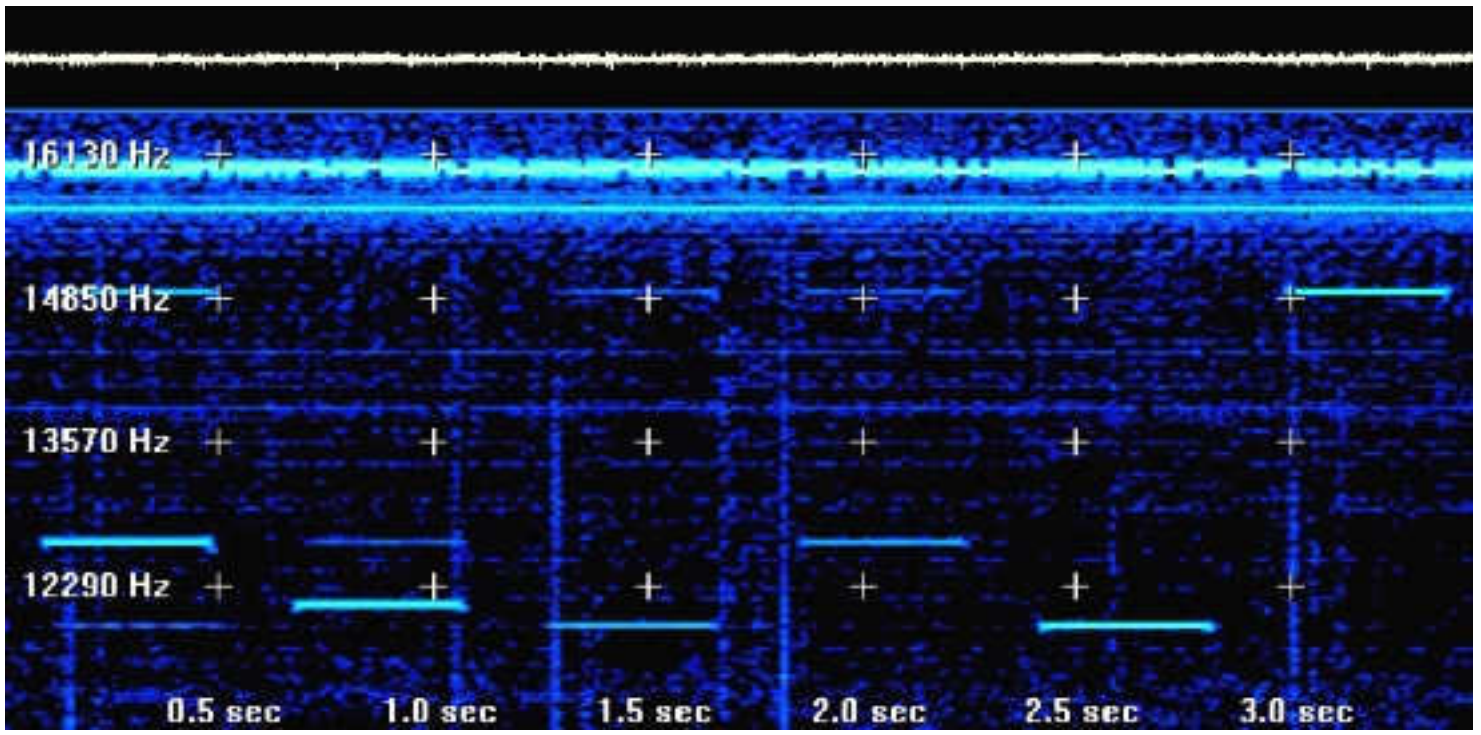
Some historical background on Alpha / RSDN-20

I think nearly everyone interested in the really low radio frequencies, at one time or another, has heard the " *bee-boo"* sound of the Russian radio navigation system Alpha. Or more precisely RSDN-20, as the official Russian acronym for the system is, meaning " *normal long-range navigation system* " where D stands for long-range. Alpha / RSDN-20 is a hyperbolic navaid, the Russian equivalent to the now closed western OMEGA VLF navaid system. Although the former Soviet, now CIS, Alpha / RSDN-20 VLF navigation system has operated in relative obscurity over the past tree decades, there is little information to be found on the web, but it has been studied by several individuals, and it's existence has been publicized at a number of conferences during that period.



The ALPHA / RSDN-20 radionavigation system is transmitting a 3.6 sec long repeating sequence consisting of six 400 ms long frequency combinations with a 200 ms spacing. The Alpha / RSDN-20 signal spectrogram above are made with GRAM 5.0 and received at my QTH at 59°8'12"N 11°23'55"E on the 14 th of May 2000 at 0656 UTC.

Tree of the Alpha / RSDN-20 stations are received, Krasnodar, Revda and Novosibirsk. The far-east station at Khabarovsk and the station at Seyda in Turkmenistan are out of range or QRT.
The original consept for Alpha / RSDN-20 was born in 1957. In 1962 was the start for the implementation of the navigational system and already then was the signals received and monitored at Harvard for a few days. "The quality of the signals was poor" and "the exact frequencies varied like those from rather poor crystals ", one of the monitoring crew recalls. In 1968 was the system operational with 3 stations at Krasnodar, Novosibirsk and Komsomolsk-na-Amur. The RSDN-20 transmitter at Novosibirsk was (and still is) the master station. These tree original transmitters are sometimes called Sigma in literature. The same year was the stations listed in the International Frequency List with six frequencies; 11.905 kHz, 12.500 kHz, 12.649 kHz, 13.281 kHz, 14.881 kHz and 15.625 kHz. The International Frequency List also reported 500 kW ofpower to the antenna at each location and at each frequency.

When representatives from Racal Marine Electronics (formerly Decca Navigator Company) was attending a fishing exhibition in Leningrad 1968, they recall visiting a Russian fishing wessel were they was shown a navaid receiver intended for us in the Arctic waters north of the former Soviet Union. The receiver was designated by the acronym PIRS-1R and the navaid system was at that time officially called RSVT-1.

With the tree original RSDN-20 transmitters located almost on a line from west to east across the Russian continent, the system coverage was obviously not intended for Soviet domestic use. One would assume it was originally intended for submarine as well as aviation use in Polar and North American regions and possibly also for the southern Asia and Indian Ocean regions.

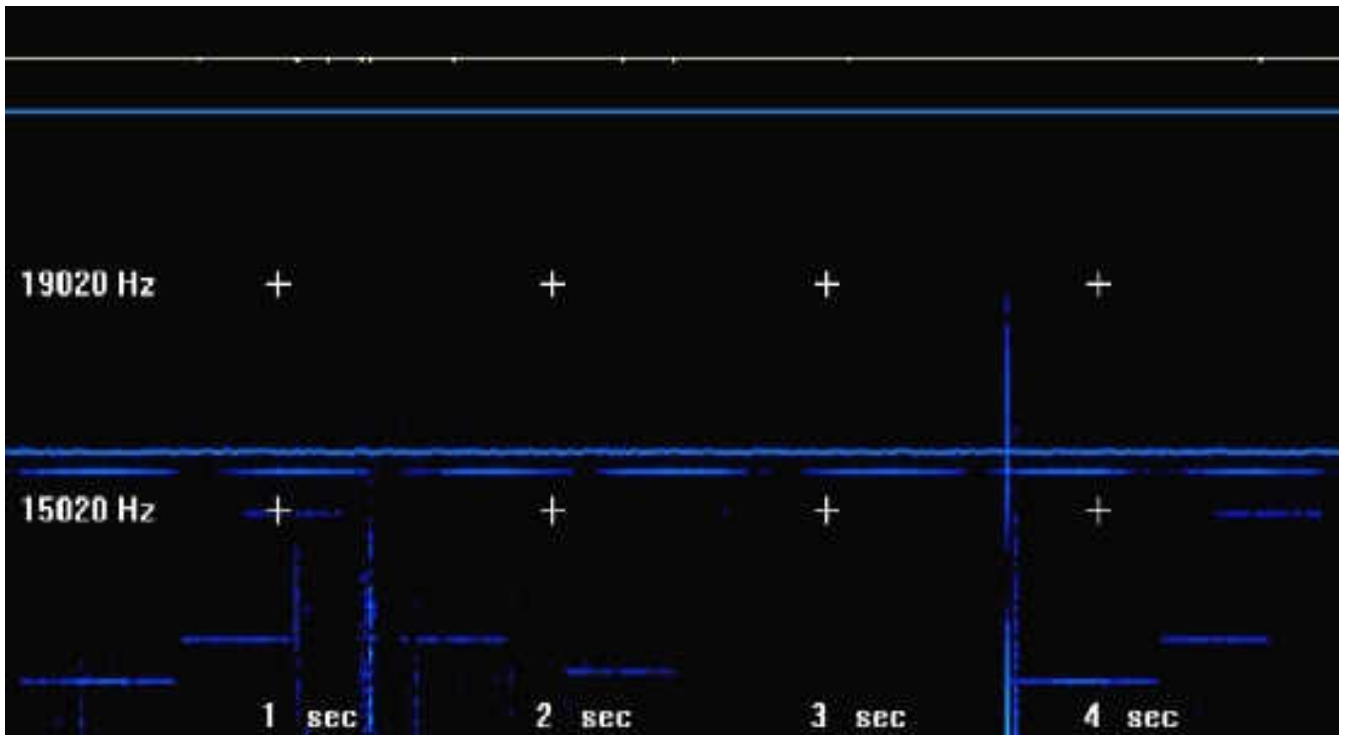
With the prior tree station configuration of RSDN-20, if one station were off air, the remaining two would be virtually useless for navigation and the overall system availability is very limited. In August 1991 a Soviet delegation at the IOA, (International Omega Association), meeting in Vancouver headed by general Anatoliy G. Funtikov announced that two new Alpha / RSDN-20 transmitter sites had been constructed, one on the Kola peninsula near Murmansk in Russia and one near Chardzhou in Turkmenistan. The Murmansk transmitter located near the village of Revda was given an exlusive frequency F4, 12.090773 kHz. The same was done in Turkmenistan with the new transmitter at the village of Seyda (Seidi in Russian) near Chardzou. With two more transmitter sites the navigational system would be more reliable and also more adapted for civilian use within the former Soviet union. With this inclusion oftwo new transmitters followed also a new transmitter sequence. At the same IOA 16 meeting was there also given information of a new uniqe frequency, F3p, from the master station at Novosibirsk. This new frequency was 1/7.2 Hz higher in frequency than the nominal F3. This has also been the observed with the transmission from Revda and reported but not observed with the segment 4 transmission from Seyda in Turkmenistan.

The RSDN-20 transmission sequence

The basic signal epoch consists of six pulse periods in 3.6 sec. Compared to the longer sequence (10 sec) that was used for the Omega navaid,
Alpha / RSDN-20 are more suitable for faster moving vehicles, i.e. aeroplanes.
The phase of each pulse does not start at the same value each 3.6 sec epoch but rather repeats in an overall period of 7 x 3.6 = 25.2 sec.
The pulse durations are 400 msec with 200 msec between pulses. The pulses contain no known modulated or otherwise information. When the system is off air for maintenance or other reasons there are sometimes periods with test transmissions with other phase and sequence patters then the normal one.

OLD RSDN-20 transmission sequence by frequency:

Segment nr. station Frequency kHz	1	2	3	4	5	6
F3 14.880952 kHz	Novosibirsk	Novosibirsk			Krasnodar	Komsomolsk-na-Amur
F2 12.648809 kHz	Komsomolsk-na-Amur	Krasnodar				Novosibirsk
F1 11.904761 kHz	Krasnodar	Komsomolsk-na-Amur	Novosibirsk	Novosibirsk	Novosibirsk	



A different Alpha / RSDN-20 transmitter sequence. This Alpha / RSDN-20 transmission from Krasnodar was received at my QTH on the 9.th of May 200 at 0656 UTC. It consists of a different pulse length sequence then the original one and also making use of a pulsed signal at the 15.625 kHz alternative frequency. Transmitter patters like this are not uncommon in periods when the system are off-air for maintenance.

There has been some speculations that the Alpha / RSDN-20 system use these sequences for *special* navigational purposes, until that is confirmed, such speculations are most likely based on misunderstanding of the basic principles of hyperbolic navigation.

NEW RSDN-20 transmission sequence by frequency

Segment nr. station / Frequency kHz	1	2	3	4	5	6
F3p 14.881091 kHz				Novosibirsk, Revda, Seyda		
F3 14.880952 kHz	Krasnodar	Khabarovsk	Novosibirsk		Seyda	Revda
F2 12.648809 kHz	Revda	Novosibirsk	Khabarovsk	Krasnodar		Seyda
F4 12.090773 kHz		Revda				
F5 12.044270 kHz			Seyda			
F1 11.904761 kHz	Novosibirsk	Seyda	Krasnodar	Khabarovsk	Revda	

NEW RSDN-20 sequence by transmitter site

	1	2	3	4	5	6
Novosibirsk	F1	F2	F3	F3p		
Krasnodar	F3		F1	F2		
Khabarovsk		F3	F2	F1		
Revda	F2	F4		F3p	F1	F3
Seyda		F1	F5	F3p	F3	F2

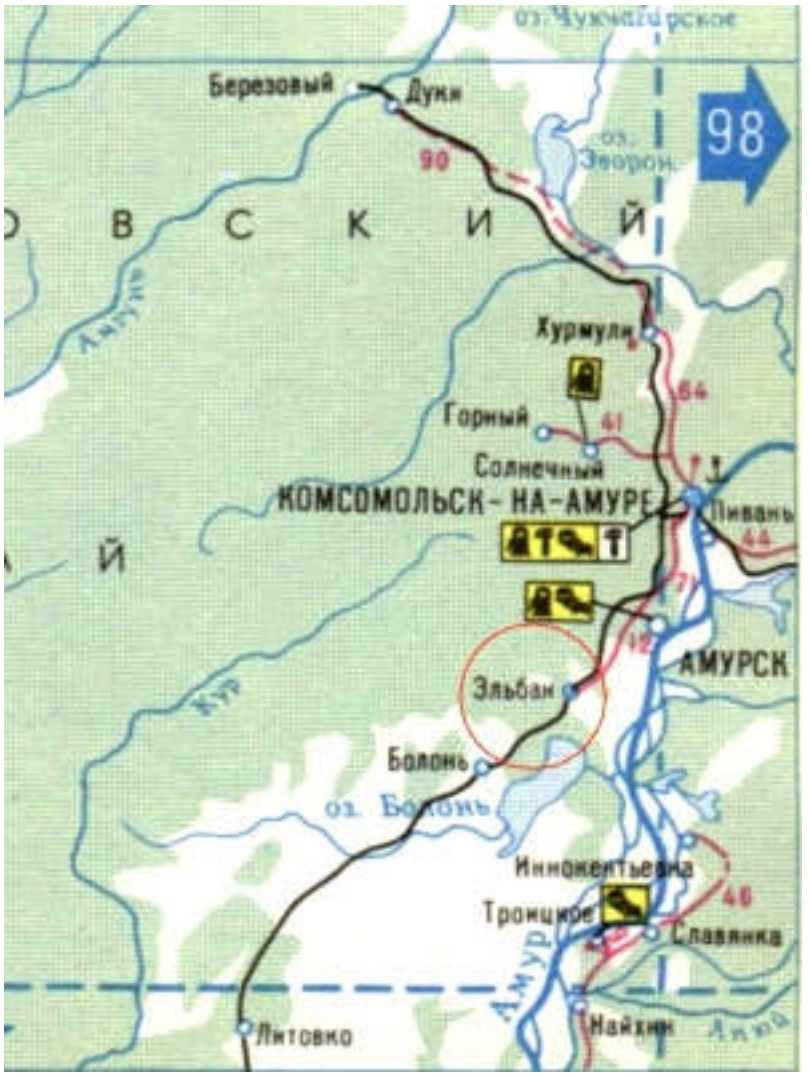
The RSDN-20 transmitter locations

The mysteries that is shrouding the Alpha / RSDN-20 navaid system to most of the VLF amateur community is also valid for the location of the different transmitters in the system. The stations at Novosibirsk in the south-sentral Russia and Krasnodar at the north shore of the Black Sea are close to the two respective towns. The far-east station are north of the town of Khabarovsk, close to the village of
El'ban, and NOT at Komsomolsk-na-Amur.

The station at the Kola peninsula are near the village of Revda, quite a distance from the port of Murmansk. And finally there is the only station outside the Russian border, outside the town of Chardzou, near the village of Seyda (the Russians spell it Seidi) in Turkmenistan. This Alpha / RSDN-20 transmitter is most likely not active as the Russians have problems with it.

But there can be changes of transmitter sites in the future and even today the best way to be certain of the actual positions of the transmitter sites are by Radio Direction Finding. This should be the rule for most of the *interesting* transmitters on the VLF band. Take a look at the RDF PROJECT. Radio Direction Finding is fun, interesting and not at all difficult, join in and see how this really should be done.

A.)	**NOVOSIBIRSK**	**55:45:22.0**	**N**	**84:26:52.4**	**E**
B.)	**KRASNODAR**	**45:24:17.9**	**N**	**38:09:29.0**	**E**
C.)	**KHABAROVSK**	**50:04:23.9**	**N**	**136:36:24.1**	**E**
D.)	**REVDA**	**68:02:07.8**	**N**	**34:41:00.0**	**E**
I.)	**SEYDA**	**39:28:16.0**	**N**	**62:43:07.3**	**E**



The location of the Alpha / RSDN-20 transmitter at the urban-type settlement El'ban, North of Khabarovsk (Far East).

The location of the Alpha / RSDN-20 transmitter at the village of Revda (Kola Pennisula).

The RSDN-20 frequencies

I shall not delve into the details of hyperbolic navigation, but the reason for the mathematical relationship between the transmitter frequencies are bound up in the navigational purpose. The

determination of the exact signal characteristics is an interesting mathematical puzzle. For the mathematical minded of you this is as easy as a piece of cake. There is another way to make out the exlusive Revda F4 frequency with another basenumber ! Can you find it ? The base harmonics that build up each signal are seen to be separated by 1 /(3.6 sec) or 0.27777….. Hz, but are not integer multiples of 0.27777…..Hz. Are there exceptions to this rule ? The operational RSDN-20 system frequencies are mathematical related to a base frequency of 744 1/21 Hz.

```
F0   744 1/21      Hz = 1MHz / 1344
F1   11904.76190   Hz = 16 x F0
F2   12648.80952   Hz = 17 x F0
F3   14880.95238   Hz = 20 x F0
F3p  14881.09127   Hz = F3 + (5/36)
F4   12090.77381   Hz = (260/16) x F0
F5   12044.27083   Hz = (259/16) x F0
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There is also a set of *very rarely* used alternate frequencies wich are multiples of 781.25 Hz

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F6   12500.00000   Hz = 16 x 781.25 Hz
F7   13281.25000   Hz = 17 x 781.25 Hz
F8   15625.00000   Hz = 20 x 781.25 Hz
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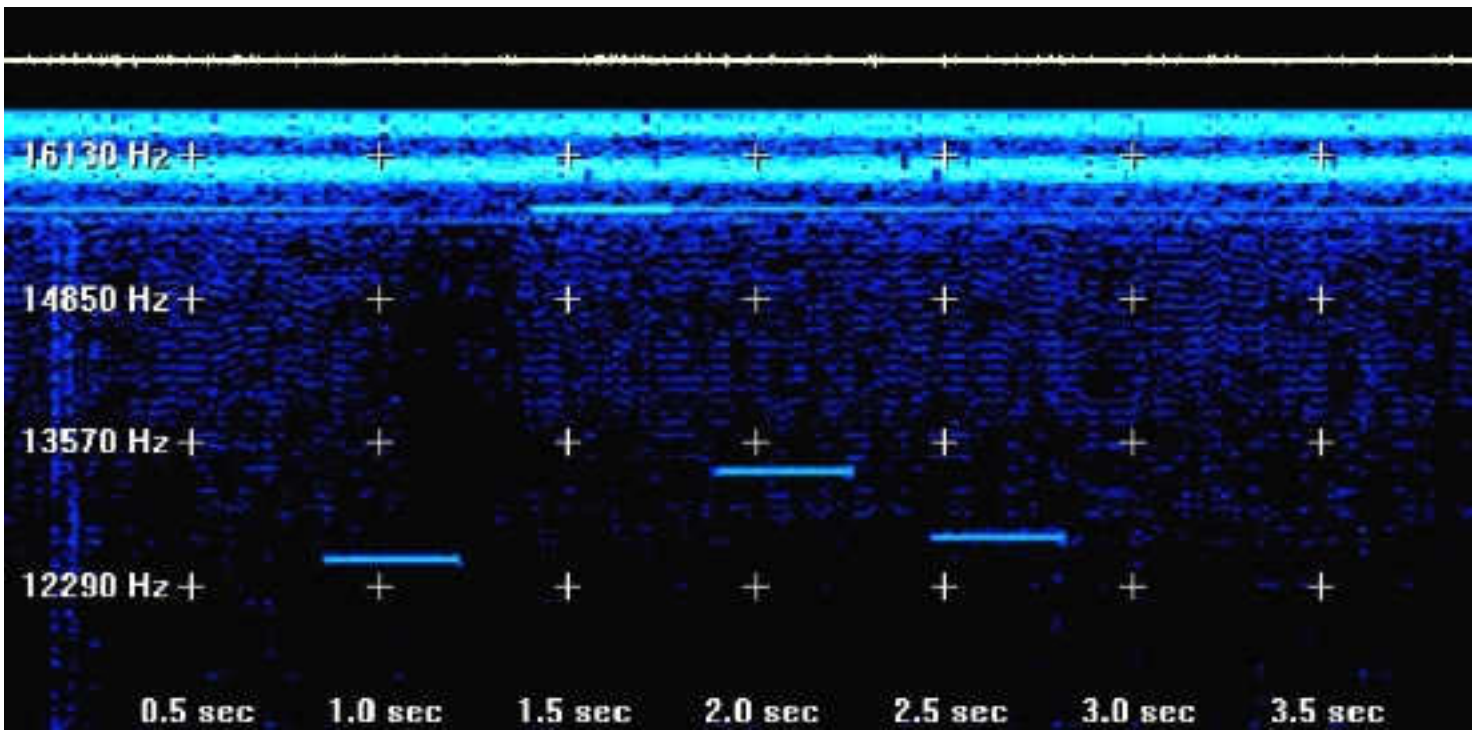

Alpha secondary frequencies.
This is a very exclusive capture of the Alpha / RSDN-20 secondary frequencies. The signal was received at my QTH on the 2.nd of June 2000 at 0947 UTC. Seconds later Alpha went QRT for unknown reasons. The station transmitting is Revda on the Kola peninsula in north-western Russia.

The four different frequencies are the tree known secondary frequencies, 12.500 kHz, 13.281 kHz and 15.625 kHz together with a new, previously unlisted, Fx on 12.700 kHz. Note the weak continuous background signal at 15.625 kHz. This transmission is *very often* received at my QTH. The transmission is unidentified and most likely not a regular part of the Alpha / RSDN-20 system sequence.

Sudden phase shifts at 2100 UTC – 0000 Moscow time
Every day at 2100 UTC there are sudden phase shifts, thes occur simultaneously and with the same

phase-shift on all stations. There is also another phase-shift with the phase of each individual pulse to time the shift relative to 2100 UTC. Since there is not an integer number of cycles of each carrier in a 24 hour day, these phase-shifts appear to be there to reset to zero phase at the beginning of each day.
These shifts are 360°/7=51.4° for F2, 2x360°/7=102.9° for F3 and 3x360°/7=154.3° for F1

Early Soviet RSVT-1 receiver

Not easy to find info on this one, but the receiver PIRS-1R is discussed in detail in a 1974 textbook intended for students in the Soviet maritime academy. The receiver weighed 226.5 kg and consumed 1.3 kW ! In the receiver a synchronized commutation module detected the first pulse of the master station and drove five mechanical drum commutators with positions for each pulse in the epoch. The frequency of a quartz crystal was automatically tuned to the master station via a servo-driven variable capacitor. The phase of the master at one of the common navigation frequencies was measured and stored via a phase discriminator and a motor-driven phase rotator during the appropriate segment. Simirarly, the master phase at the difference of the two navigation frequencies was stored during another segment. Then during the other segments, the slave phases at the common and difference frequencies were measured and stored with identical hardware, wich also drove indicator dials and counters. Phase propagation corrections and fixes were accomplished manually.

The future for Alpha / RSDN-20

No one knows ! For the time being (07072000) are the system only partially operating. But this is not uncommon, there have been very long maintenance periods in the past. The future for this kind of navigational system don't look bright. Even though the operational expenses are low (for comparison : the eight Omega station costed only a total of $ 12M / year) some "evil tongues" in the UK have been speculating in the closure of the Alpha / RSDN-20 system because of unpaid electricity bills. ! There is also a lot more to be written on Alpha, but that will be the issue of an update.

A large thank you to:

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The WEB for being there.

If you have information or questions regarding Alpha / RSDN-20 or related topics, feel free to mail to:
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