ACCURACY IN ORBIT: MORE VOSTOK DETAILS

The launch time and instrument settings for Vostok 4 were scheduled to produce a separation of five kilometres between this satellite and Vostok 3. A study of the refined orbital data has indicated that the achieved minimum distance after injection was 6.5 km.

Both Vostok 3 and Vostok 4 were launched from one particular launch complex of the authorities—Vostok 3 at 11.18 Moscow time on August 11 and Vostok 4 at 11.02 a.m. on August 12—with deviations from the scheduled time of less than one second.

Refined orbital data are as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>Max height (km)</th>
<th>Min height (km)</th>
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<tbody>
<tr>
<td>V3</td>
<td>V4</td>
<td>V3</td>
</tr>
<tr>
<td>1st orbit August 11</td>
<td>88.330</td>
<td>234.6</td>
</tr>
<tr>
<td>17th orbit August 12</td>
<td>88.260</td>
<td>229.9</td>
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<tr>
<td>33rd orbit August 13</td>
<td>88.180</td>
<td>224.4</td>
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<tr>
<td>49th orbit August 14</td>
<td>88.084</td>
<td>221.7</td>
</tr>
<tr>
<td>64th orbit August 15</td>
<td>87.972</td>
<td>220.3</td>
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The distance separating the two spacecraft increased from the initial 6.5 km value because of the different orbits. At the beginning of the 33rd orbit of Vostok 3 the separation was 850km and at the beginning of the 64th orbit it was 2,850km.

No air leakage was experienced, and cabin pressures in both craft remained between 755 and 775mm throughout the flight. The temperature ranges were 13-26°C for Vostok 3 and 12-28°C for Vostok 4. The highest temperatures relating to the pre-launch period. The percentage of oxygen in the cabin atmospheres varied from 21 to 25, and that of carbon dioxide did not exceed 0.5%

The programme envisaged 50- to 60-minute free-floating periods each cosmonaut during their space flight are “absolutely safe.” The doses received by each cosmonaut in one day of flight amounted to 11 milliard. The full does incurred by Nikolayev was 43 milliard, and that by Popovich was 32 milliard. The orbits of the two spacecraft were chosen to ensure that the radiations of the radiation belts of the Earth accounted for a small part of the total dose incurred.

The artificial radiation belt formed as a result of the US high-altitude nuclear explosion had become acceptable.

One of the problems of ensuring safety against radiation is that of predicting and registering onset of a solar flare. Radiation on the surface of the Sun about which large chromosphere flares occur are characterized by very powerful magnetic fields, more than a thousand times stronger than those of the neighbouring quiet areas. The appearance of flares which are accompanied by the ejection of high-energy particles is connected with certain definite forms of these fields. These active areas of the solar surface are the source of powerful impulses of electromagnetic waves in the centimetre and decimetre range. This radiation is also registered and enables the beginning of solar flares to be accurately specified.

In addition to optical and radio-astronomical observations of the Sun immediately before and during the flight, the intensity of radiation was directly measured in the upper layers of the atmosphere by balloon sondes flown several times a day in various places in the USSR, including the polar regions.

For running control of radiation conditions in outer space, the spacecraft had special dosimetric equipment and the cosmonauts were supplied with different kinds of individual dosimeters. The spacecraft possessed the required shielding and, as a precaution against possible worsening of radiation conditions, the cosmonauts were supplied with special protective anti-radiation chemical preparations. Special biological specimens were carried.

Medical factors

Much new information was desired, particularly regarding the central nervous system and the vestibular apparatus, and so the biomedical measurements were much more extensive than with Vostok 1 and 2. The telemetry system registered:

1. electrocardiogram (state of the heart and circulatory system)
2. pneumogram (breathing movements)
3. electroencephalogram (reflecting the condition of the central nervous system, and enabling the condition of sleep and alertness, fatigue and excitement to be followed)
4. skin-galvanic reactions (ohmic resistance of the skin, for the purpose of studying the central nervous system. Changes in the skin resistance are connected with non-specific reactions of the organism and arise in varying conditions, e.g. under pathological irritations, emotional tensions, etc)
5. electro-oculogram (movements of the eyes; to give objective information about vestibular disorders)

plus pulse frequency, breathing frequency, etc. The cosmonauts were also observed by television, and their condition assessed through conversation, the volume and quality of the work they did.

Nikolayev’s pulse and breathing frequencies four hours before the launch were 72 and 11 per minute; those of Popovich were 80 and 15.

Emotional tension was reflected in the figures for one hour before launch, Nikolayev’s pulse being 88 and that of Popovich 100. For two hours before launch the figures were: Nikolayev, 115; Popovich, 110.

During injection (the active part of the trajectory) Nikolayev’s pulse was 120 and that of Popovich 130.

Nikolayev returned to a normal pulse rate after 10-12 hours of flight, and Popovich after six hours. During the course of the entire flight the pulse of both cosmonauts fell to within 50-80.

Pulse and breathing of both cosmonauts became more frequent before re-entry; an hour after landing Nikolayev’s pulse rate was 96-104 and that of Popovich was 85, with breathing frequencies 14 and 16. Post-flight examination revealed no disorders.

As a result of all the medical observations, including the experiences of free-floating in the cabins, it may be supposed that space flights lasting several hundred hours may be undertaken by cosmonauts who have received the necessary training. This has certainly been established for a flight of the order of 100 hours, with preservation of working capabilities at the necessary level.

Radiation protection

The radiation doses incurred by the cosmonauts during their space flight are “absolutely safe.” The doses received by each cosmonaut in one day of flight amounted to 11 milliard. The full doses incurred by Nikolayev was 43 milliard, and that by Popovich was 32 milliard. The orbits of the two spacecraft were chosen so that the radiations of the radiation belts of the Earth accounted for a small part of the total dose incurred.

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Radio Communication

Radio communications between the two spacecraft were stable and clear at all distances. The radio equipment aboard the spacecraft included three two-way radio-telephone lines, two in the shortwave band and one in the ultra-shortwave band. There was also a tape recorder and a medium wave and shortwave broadcasting radio receiver.

The cosmonauts had four reception channels; ultra-shortwave, long-distance shortwave, inter-ship and broadcasting band. In the main they were used for long-distance shortwave and inter-ship communications, each cosmonaut using only one earphone.

Conversations with the cosmonauts over the ultra-shortwave were conducted at a distance of several thousand kilometres. Nikolayev, Khrushchev talked from Yalta with the cosmonauts while they were flying over Leningrad, Sverdlovsk and other cities, as far as the border of Mongolia—a distance of 5,500km.

Communications in the shortwave band were quite successful both along the main earth-ship-earth radio channel and in listening on the Earth to the ship-to-ship radio channel. The maximum distance was 12,000-20,000km.

The programme envisaged 50- to 60-minute free-floating periods on the fourth orbit of the first day of flight and on the second orbits of each subsequent day. In these conditions the cosmonauts could not use the microphones and earphones of the spacesuits, which were disconnected, and they had to maintain radio communications by means of a special system of cabin loudspeakers and microphones.