

HARBINGERS OF SPUTNIK: THE AMATEUR RADIO PREPARATIONS IN THE SOVIET UNION

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Abstract: After recapitulating and re-evaluating the principal early signals that the Soviet Union was planning to launch an artificial earth satellite (Sputnik 1) in 1957, which have long been familiar to space historians, this article presents some additional pre-sputnik material from *Radio*, the Soviet government's monthly magazine for radio amateurs, and from other sources, which has not previously been identified by western scholars. The preparations of the Soviet radio amateurs for satellite tracking are also described. The fact that western radio amateurs were no more successful in discovering Soviet intentions, at the time, than the scientists or the intelligence agencies, is documented and discussed. To complete the picture, contemporary assessments of the scientific value of amateur radio observations of the early satellites are surveyed. The article concludes by discussing the surprise aspect of the first sputniks in the light of the fresh information presented, and by noting some still unanswered historical questions.

At the historical symposium which was held in Washington to mark the 40th anniversary of the launching of Sputnik 1 on 4 October 1957,¹ Glenn Hastedt reflected on that event as one of the few in which "technological surprise" had played an important role in modern international relations. After pointing out that: "Surprise is never total... There is always some warning.", he went on to survey the different ways in which scholars seek to explain the occurrence of international surprise, by invoking the mechanisms which obscure available warnings from the awareness of decision-makers whose concerns might seem more likely, on the face of it, to have prompted them to pay scrupulous attention to just such indicators.² New evidence, to be presented here, reveals that a few more pointers to the

Soviet preparations for launching the first sputniks were available in advance, than has previously been thought, despite which not only the western intelligence organizations but also the western radio amateurs remained largely unaware of them until October 1957. Using Russian sources, it is also possible to present a much fuller picture than has previously been available in English, of how the Soviet radio amateurs were organized for their briefly important role in tracking satellites.

THE STORY SO FAR

In the late 1940s and early 1950s, military planners, upper atmosphere scientists, rocket engineers, amateur rocket groups and spaceflight societies outside the Soviet Union were all more or less interested in the question of what steps were being taken by Soviet scientists towards the first phases of space exploration, namely high-altitude vertical rocket soundings and the preparation of unmanned artificial satellites. In 1950, just seven years before Sputnik 1, an early RAND study of political aspects of a possible American satellite project may have played down the possibility of a similar Soviet project, but at least the author felt obliged to consider the idea.³ The revelations of defectors such as Grigory Tokaev were being studied closely at the time.⁴ And by 1954 North American Aviation's George Sutton was taking the Soviet capability quite seriously:

I do not know how far along the Soviets are with a complete satellite vehicle. I know that they were planning to work on one several years ago.... I do know that they have the essential knowledge to develop the rocket engine for a satellite vehicle... From the standpoint of the rocket power plant... they should be qualified to embark on a satellite project.⁵

On 16 April 1955 the Soviet official media announced the formation of an *Interdepartmental Commission on Interplanetary Communications (ICIC)*, to be headed by Academician Leonid I. Sedov.⁶ Once the United States had made an official announcement, on 29 July 1955, that it was going to try to launch an unmanned scientific satellite as a contribution to the 1957–58 International Geophysical Year (IGY), the pressure on both the news media and the intelligence agencies, to determine whether there was about to be an actual Soviet programme, and if so, whether it would also be an IGY

project (the data from which would be shared internationally), became intense.⁷

Two days after the American announcement, Khrushchev remarked informally that "if it is in the interests of humanity, the Soviet Union is always prepared to support it."⁸ On the same day Sedov flew to Copenhagen via Stockholm, as one of the first two Soviet citizens to attend a congress of the International Astronautical Federation (as observers). On their arrival, on 2 August 1955, the Soviet delegates claimed they had not yet heard about the American announcement, which may indeed have been the case. After glancing through the press reports, Sedov responded through an interpreter to questions at a press conference. In these exchanges he tried to handle the sensitive issue of the timing of any Soviet programme by using a technique often deployed by Soviet officials on such occasions, which consisted in simply repeating back to the western press something which had already been announced by a *western* source, without attributing it to any Soviet organization. Sedov stated that there were ongoing studies for a satellite project in the Soviet Union, which was nothing new. He then appears, somewhat rashly, to have agreed in principle with the confused western news reports which were claiming that a satellite could be launched within the next two years, whereas in fact the United States had committed itself to doing so, not by the start of the IGY – within two years, but only by its end – within three years and five months. Satellites larger than the one planned for the U.S. Vanguard project were technically possible, he added. When it came to the timing of a full-scale Soviet satellite project, however, he tried not to be drawn, stating only that it would begin "in the comparatively near future". An official Soviet statement would be issued in due course, when preparations were complete. He gave no indication as to whether a Soviet project, when it came, would be committed to the IGY.⁹ Passed through an interpreter to news-hungry science journalists, however, Sedov's attempted subtleties were sometimes lost, and in some papers the Soviet Union was wrongly reported to be committed from that point to launching an IGY satellite. In fact the Soviet government had made no such announcement, and would not do so for another year.¹⁰ The scientific secretary of the ICIC, Anatoliy G. Karpenko, gave additional details of Soviet thinking in mid-August, but used the same cautious phrase about the project's timing.¹¹

In February 1956, against a background of rumours of an imminent Soviet satellite launch,¹² Sedov had a fairly relaxed and open

exchange with Richard Porter of General Electric, the convenor of the U.S. IGY committee's technical panel on the satellite project. The occasion was an International Convention of the Research Institute of the Physics of Jet Propulsion, held at Freudenstadt in West Germany. Responding to a paper by Porter on "The American Earth Satellite Program", Sedov agreed that the guidance problem for orbital insertion was formidable, such that a fifty percent success rate would be considered good. He stressed the need for simplicity of instrumentation, and suggested that the first on-board measurements would probably be of internal pressure, air resistance, meteor impacts, ultra-violet radiation and cosmic rays. (Karpenko had already added internal temperature to this list.) When Porter pressed him for technical details, however, Sedov pleaded ignorance, probably with some justification.¹³

The first official announcement that the Soviet IGY committee would undertake a satellite project for the IGY was made on 11 September 1956 by its chairman, and vice president of the Soviet Academy of Sciences, Ivan P. Bardin (a metallurgist), at the scientific Assembly convened by the international IGY planning committee (CSAGI) in Barcelona. Bardin stated little more than that there would indeed be a Soviet IGY satellite programme, and that information about the proposed launch schedules and experiments would be supplied in due course.¹⁴ (Two Soviet rocket scientists, Boris A. Mirtov and Sergey M. Poloskov, had originally been included in the proposed Soviet delegation, but there is no record of their having actually been present.¹⁵) However John Simpson, the distinguished cosmic ray physicist at the University of Chicago's Fermi Institute, who was a member both of the U.S. IGY committee and of the CSAGI, recalls a similar meeting with Sedov to Porter's at Freudenstadt, but in private, during the Barcelona Assembly of 1956, at which the ICIC chairman volunteered details of the likely size, orbit and telemetry frequencies of a future Soviet satellite, none of which information had been in Bardin's official statement.¹⁶

A resolution passed by the rockets and satellites working group, and not contested by Bardin, recommended "that for all IGY satellites the radio systems employed for tracking and telemetering be compatible with those which have been announced at the current CSAGI meeting in order that the same ground-based receiving equipment can be used throughout".¹⁷ The "announced" systems were those planned for the U.S. Vanguard programme, using a frequency of 108 megahertz, or megacycles (Mc/s) to use the contemporary term,

which had been described in U.S. documentation distributed before the meeting.¹⁸ Other resolutions at Barcelona called for "countries having satellite programs" [i.e. the Soviet Union] to supply information about their tracking equipment and launch schedules.

In October 1956 a member of the ICIC, Georgiy I. Pokrovskiy, wrote an article in *Moscow News* which described a possible future satellite as having a diameter of 24 (23.6) inches, weight of 100 (180) pounds, perigee of 185 (156) miles and apogee of 810 (560) miles.¹⁹ Although Sergey P. Korolev had not then begun to design the 'simple satellite' which became Sputnik 1, Pokrovskiy's figures approximated the eventual reality (given in brackets).²⁰

Nine months later, on the eve of the opening of the IGY, the Soviet IGY committee finally supplied some sketchy information about their satellite project. On 10 June 1957 Bardin sent a seven-page document to Lloyd Berkner, the vice president of CSAGI and its reporter for rockets and satellites, which gave brief indications of the types of experiment to be carried on sounding rockets and satellites, but no technical information about the measuring instruments or the telemetry. Nor was any indication given about the timing of satellite launch attempts.²¹ In the same month, however, the president of the Soviet Academy of Sciences, Alexander N. Nesmeyanov, was twice reported as having stated that everything was now ready for launching a Soviet satellite, and in one case as having added "within the next few months".²²

Also in June, two articles in the Soviet magazine *Radio* gave detailed explanations of how the satellite's radio telemetry could usefully be observed by amateurs on frequencies close to 20 and 40 Mc/s. *Radio* published three further articles on the subject in July, and two in August.²³ These publications will be discussed in the next section.

In July, and at short notice, a party of four Soviet rocket scientists paid an unprecedented two weeks' visit to their British counterparts. At an international symposium at the Cranfield College of Aeronautics, ICIC member Boris M. Petrov outlined the scientific programme planned for Soviet satellites.²⁴ And at University College, London, Andrey M. Kasatkin gave a detailed description of one of the principal Soviet meteorological sounding rockets, including its telemetering frequency of 22 megahertz.²⁵

Then on 16 August Bardin wrote again to Berkner, in English, this time giving the exact frequencies that were to be used in Soviet satellite telemetry. A note on the copy of this letter forwarded to the

president of CSAGI, Sydney Chapman, states that the U.S. IGY office had sent the original on to Berkner at Boulder, where he would have been attending the Assembly of the International Radio Science Union (URSI).²⁶ However, the original appears to have mis-carried.²⁷ If the staff of the U.S. IGY office had appreciated its importance they might have sent copies directly to Richard Porter, who convened the U.S. IGY satellite panel, or to the scientists at the Naval Research Laboratory and elsewhere who were preparing the radio tracking systems. But they did not, with the result that the latter remained ignorant of the Soviet decision on frequencies until a few days before the launch of Sputnik 1 on 4 October 1957.

The Bardin letter had not been copied to the Brussels office of Marcel Nicolet, the General Secretary of the IGY, where its significance would certainly not have been overlooked. But, either in response to a recent pressing enquiry about the telemetry frequency from the British, or else by accident, the Soviet committee sent a copy to the Royal Society.²⁸ The British, however, did not set the probability of a Soviet satellite high enough to make any advance preparations for tracking it.²⁹

The final source of information on the Soviet satellite programme, prior to Sputnik 1, was the September issue of the Soviet Academy's journal *Advances in the Physical Sciences*, which commemorated the centenary of the birth of the great early Russian theorist of rocketry, Konstantin E. Tsiolkovskiy, on 17 September 1857, with a collection of articles about experiments that might be carried on rockets and satellites.³⁰ Taking their lead from Firmin Krieger in his second RAND report, released in June 1957, (which they seldom acknowledged), some American commentators had by then predicted that the anniversary might be the date chosen to launch the first Soviet satellite.³¹

Copies of the recent *Radio* articles were taken to Washington at the end of September by Soviet delegates attending the CSAGI Conference on Rockets and Satellites, which was the first time that suitably qualified scientists from both the Soviet Union and the United States had ever sat down for a thorough discussion of the requirements and problems of international cooperation in respect of satellite experiments.³² The American scientists were particularly concerned at the Soviet decision to use their own frequencies for telemetry and tracking, not the 108 Mc/s that had been somewhat unilaterally "agreed" at Barcelona. At a working group session on the afternoon of 1 October 1957 Andrey Kasatkin described the Soviet team as being "on the eve of launching the satellite".³³ Then, at a

reception in the Soviet embassy on the last evening of the conference, the news of the successful launching of Sputnik 1 was announced.³⁴ Kasatkin's phrase was later generously interpreted as having given the formal notice of an impending satellite launch that was required by the still incompletely agreed procedures of the IGY.³⁵

In the United States, the space age was launched with a scramble to rebuild and realign the tracking stations of an IGY programme that had never expected to be left in second place at such an early stage of the game. In Brussels, Marcel Nicolet was obliged to deny "the suggestion that the Russians had double-crossed the IGY by operating the signals on other than the agreed (American) wave length and sending the satellite up by stealth".³⁶ The extent to which western analysts had ignored even the modest amount of advance information provided by Soviet sources, only added salt to the wounds in United States' self-esteem that were caused by having been "caught with its antennas down".³⁷

PREPARING THE SOVIET AMATEUR RADIO COMMUNITY

Western space historians, including the present author, have tended to refer to *Radio* as a "Soviet radio amateurs' magazine" with little further thought.³⁸ But its Soviet institutional status meant that there were important differences between *Radio* and amateur radio magazines in western countries, such as *QST* in the United States or the *Bulletin of the Radio Society of Great Britain*. Founded in 1927, by the 1950s *Radio* was an organ, jointly, of the Ministry of Communications and the Voluntary Society for Cooperation with the Army, Air Force and Navy, usually known from its Russian acronym as DOSAAF. There are indications that DOSAAF was the senior member in this partnership. Despite its name, DOSAAF was controlled by the Central Committee of the Communist Party of the Soviet Union, and led by Soviet military officers. It was set up in 1951 by amalgamating a trio of supporting organizations for the principal armed forces, which in their turn had briefly succeeded a similar national body, Osoaviakhim, founded in the 1920s. The first practical, and extensive, studies of rocketry in the Soviet Union had been conducted by the Group for the Study of Reactive Motion, or GIRD, which was established in 1929 as a subordinate entity within Osoaviakhim. Thus there was probably a tradition within DOSAAF of taking space flight

seriously. In any case, early in 1954 it was a DOSAAF institution, the V.P. Chkalov Central Aeroclub in Moscow, that established an Astronautics Section which aimed to continue the work of GIRD and "to facilitate the realization of cosmic flights for peaceful purposes".³⁹

DOSAAF worked through a network of clubs based in schools, workplaces, collective farms and other institutions, and was closely linked with the Komsomol, the youth organization of the CPSU, and the MPVO, the national civil defence force. DOSAAF was responsible for the pre-induction military training of Soviet teenagers, and for much of the training and preparation of the civilian population for nuclear war. Although there is little explicit reference to this subject in the pages of *Radio*, there is no doubt that a strong network of radio amateurs was seen as a highly desirable national asset in the circumstances of the Cold War:

DOSAAF is a voluntary paramilitary mass organization, whose primary purpose is to teach skills and establish or perpetuate traditions that will be of value to the Soviet armed forces. Thus it trains the population, especially the young people, in such skills as marksmanship, skiing, diving, parachute jumping, piloting of planes, *radio operations*, truck driving, and mechanics . . .⁴⁰

DOSAAF had its own semi-weekly national newspaper, *Soviet Patriot*, launched in April 1956, and several magazines. It had its own airfields and aircraft, rifle ranges, fleets of vehicles and maintenance shops, several radio stations, and a network of 'defence houses' containing arsenals of small-arms and other equipment. Between 1952 and 1962 it is estimated to have doubled its membership from 15 to 30 million, approximately. The national Soviet network of hundreds of local amateur radio clubs was entirely controlled by DOSAAF, and the thousands of individual amateurs who operated with their own equipment were also DOSAAF members. Thus not only had the amateurs whose skills were praised in the pages of *Radio* in the 1950s been trained within the DOSAAF system, often whilst still at secondary school, but they were also in many cases operating from its local premises or with its equipment.⁴¹

In 1957 *Radio* had a circulation of approximately 200,000 copies. It featured rather more treatments of the scientific basis and applications of radio than did comparable western magazines. (By contrast, *Wireless World* was still giving space to a correspondence on electrical machines for corporal punishment.) The ratio of ideological content

was fairly low, being largely confined to the monthly editorial. The presentation was appealing, by contemporary Soviet standards, and there was usually plenty of interesting general material alongside the more technical articles. Occasional items from western radio magazines added a cosmopolitan flavour.

The *Radio* articles described below may not at first appear significant to readers familiar only with the western popular literature on astronautics and other scientific matters in the 1950s. During the cold war most western intelligence about Soviet technology was gathered, not from secret documents purloined by spies, but from the careful analysis of open sources. Firmin Krieger's compilations of such material at the RAND Corporation are the obvious case in point.

In September and November 1954, the year in which the Soviet Academy of Sciences announced its intention to join the IGY, *Radio* published articles on the Soviet arctic research stations which should have suggested to any western scientific intelligence agency that it was a publication worth watching. There were also reports on the communist-bloc International Broadcasting Organization (IBO), and the annual meeting of the A.S. Popov Society, or Pan-Soviet Scientific-Technical Society for Radio Technology and Electronic Communications, to give the full title, which must surely have been of interest to Soviet-watchers.

In 1955 *Radio* published further items about the Soviet arctic drift-stations in April, May, June and September. In March it celebrated a 17,000 km. two-way voice link between the North Pole-3 station and the Soviet whaling flotilla in the Southern Ocean, which had actually been achieved in November 1954. An article in November 1955 described the achievements of Soviet amateurs in making contacts with the polar stations.

As for topics more relevant to future space exploration, *Radio* published articles in February and July 1955 on atomic and solar batteries, respectively. In May, Academician Aksel I. Berg contributed an article on "Radio-Electronics" which referred in general terms to radio-based navigation and guidance, alongside descriptions of the applications of radio-electronics to spectroscopy, astronomy, and meteorology. Another short piece in the same issue, by Yuri S. Khlebtsevich, a founder member of the Chkalov Astronautics Section (above), dealt directly with "Remote radio-guidance of space rockets". The article emphasized that rockets carrying people to the Moon, as envisaged by the president of the Soviet Academy of Sciences, Alexander Nesmeyanov, in an address to the World Peace

Council on 27 November 1953, would have to be preceded by automatic, radio-guided rockets. It would also be necessary to explore the lunar surface with miniature, remotely guided, tank-like vehicles, equipped with television, in order to collect the data that would be required before human beings could be sent to the Moon. No reference was made to artificial earth satellites as such.⁴²

In August 1955 a longer article on "Radio-guided Rockets", by I. Kucherov, placed a similar emphasis on lunar exploration, with sketches of the idea, attributed to Tsiolkovskiy, that the optimum trajectory for a lunar rocket would be between two satellites in orbit around the Earth and the Moon.⁴³ The article focused mainly on the technical problems to be resolved in all remote guidance systems, with frequent references to military applications, and had little to say about astronautics as such. The earth satellite was not explicitly described as housing human personnel, but the guidance tasks attributed to it, and the use of the word "station" to describe it, while not conclusive, suggest that this was being assumed. This article was possibly the first in *Radio* to use the expression "artificial earth satellite".

In January 1956 *Radio* made its first reference to the International Geophysical Year, in the first of what became an irregular series of pieces dealing with the Soviet IGY Antarctic Expedition, with either transcriptions of expedition broadcasts or two-way radio interviews, such as the one published in the issue for September 1956. As with the Soviet arctic stations, the magazine gave publicity to Soviet amateurs who succeeded in making links with the "Mirny" station in Antarctica.

In June 1956 *Radio* published a major article on "The Television of the Future", by V. Petrov, which explained the imminent feasibility of global television broadcasts mediated by a network of three geostationary satellites, one of which was illustrated on its cover. At the beginning of the article Petrov repeated the careful vagueness which had been used by Sedov and Karpenko in 1955 (above), when stating that:

It will be necessary to resolve some enormous and incredibly diverse technical difficulties, before the first flying apparatus, launched from the planetary surface, will overcome the force of terrestrial gravity. At the present time we are already in possession of all the complex scientific and technical information that will enable us to construct such a vehicle within the next two years.⁴⁴

After attributing the idea of the geostationary satellite to Tsiolkovskiy, Petrov gave a brief description of Fred Singer's proposal for a miniature unmanned satellite (MOUSE).⁴⁵ He then gave a slightly fuller account of Wernher von Braun's current proposal for a large geostationary space station.⁴⁶ After listing some of the station's potential scientific uses, Petrov added that, according to von Braun, it could also be adapted for military purposes, such as reconnaissance, or as a launch platform for guided atomic missiles. There followed a general discussion of the accelerations needed to place a satellite in orbit at different altitudes, and then a sketch of a possible system of three geostationary satellites for global television relays. The satellites were described as being "above"⁴⁷ the Soviet Union, the Chinese People's Republic, and the United States, with the unstated implication that each might have been launched by, and belong to, one of the three powers.

Whilst making the obvious point that the first small satellites, due to be launched over the next two or three years to altitudes of between 300 and 2,000 km, would be dedicated to the study of the near-space environment, Petrov refrained from actually mentioning the International Geophysical Year. A simple explanation for this omission could be that he was writing about four months before the first official announcement that the Soviet Union would try to launch satellites for the IGY, which was made in September 1956.⁴⁸

On 1 July 1956, during the "thaw" which preceded the visits of Khrushchev and Bulganin to India and Britain, the Soviet government may have been responding to representations from some of its less conformable amateurs, when it lifted the ban on all communications with western radio amateurs, which had been administered by DOSAAF, with the backing of the security organs, since its establishment in 1951.⁴⁹ To reinforce this policy switch, an editorial in the October 1956 issue of *Radio* called for "Broadening the international links of Soviet radio amateurs". In its issues for May, July and December 1956 *Radio* carefully instructed its readers on how to adapt the popular, ex-military A7A and A7B shortwave radio sets so as to be able to work frequencies between 37.8 and 40.2 Mc/s. (Soviet radio amateurs were already routinely adapting their sets, if necessary, to handle 20 Mc/s.⁵⁰) Both moves appear, with hindsight, to have been anticipating the need for Soviet and foreign radio amateurs to participate in tracking Soviet satellites, and several articles about building or adapting receivers were referred back to in 1957, when the call went out for amateurs to become involved.⁵¹

Towards the end of 1956 the editors of *Radio* invited several prominent officials and scientists to give their views about the most important issues in the development of radio-electronics, that should be addressed by radio amateurs. One reply, published in January 1957 but editorially prepared before the end of October 1956, is especially significant here. In three short sentences, before going on to discuss his special field, the development of colour television, Honoured Scientist Professor Pyotr V. Shmakov suggested that, since some twenty [sic] satellites were due to be launched during the eighteen months of the International Geophysical Year, radio amateurs should be mobilized to monitor their radio signals and report their observations to the scientists. The proposal was probably inspired by the example of the United States (below), where a similar scheme had already been announced.

According to the then president of the Soviet Amateur Radio Federation, Nikolay V. Kazanskiy, DOSAAF officials responsible for amateur radio, himself amongst them, were called in by the Central Committee of the CPSU at the very end of 1956, and asked about the capabilities of Soviet amateur radio. No explanation was given for the questions, which included such "strange ones" as "Are the basic clubs equipped with tape recorders?". At the time the DOSAAF officials failed to see a connection between this interrogation and the IGY satellite programme.⁵² On the other hand, Rudolph A. Svoren, then on the staff of *Radio*, has recalled that the radio amateurs themselves promoted the idea of an amateur satellite tracking project with the Central Committee of DOSAAF, through the medium of their occasional consultant, the radio scientist Anatoliy M. Shakhovskoy, whom they knew to be somehow connected with the Soviet satellite project.⁵³ The sequence of events cannot now be fully reconstructed, but perhaps this phase came in the first weeks of 1957.

At some point in the early spring of 1957, the director of the Institute of Radio Technology and Electronics of the Academy of Sciences, Academician Vladimir A. Kotel'nikov, called on the chairman of the DOSAAF Central Radio Club, Colonel-General Pavel A. Belov, with a formal request for the assistance of radio amateurs with tracking future sputniks. Members of the Institute, including Shakhovskoy, Vladimir M. Dubrovin, and O.N. Rzhiga, were assigned to liaise with the radio amateurs.⁵⁴ By April, or possibly May if the June issue was 'held' for them, as it may have been, they had prepared the articles on satellite tracking which were published in *Radio* in the summer of 1957.

In May 1957 the chairman of the Radio Council of the Academy of Sciences, N. Dzhigit, contributed an article on "Scientific Research in the Field of Radio". Although he mentioned some of the scientific topics that would be addressed in the IGY, and several of the Soviet scientific institutions that would take part in the Year, Dzhigit did not refer to the Year as such. The same issue, however, also carried an unsigned piece entitled "International Geophysical Year". On the subject of satellites, it stated only that:

One exciting aspect of the International Geophysical Year will be the launching of man-made, artificial satellites. The first satellite will probably not be equipped with any apparatus. But later ones will carry instruments for the measurement of temperature, atmospheric resistance, the incidence of cosmic rays, solar ultraviolet radiation, etc.⁵⁵

No reference was made to Shmakov's earlier suggestion that radio amateurs should participate in observing the satellites. However, they were very much to be encouraged to help with other aspects of the Year, according to remarks by the Deputy Director of the Institute of Terrestrial Magnetism and Radio Diffusion (NIZMIR), A.N. Popov, with which the unsigned piece concluded. Stating that the scientists had been thinking about such arrangements for some time, Popov referred the editors of *Radio* to a lecture on the significance of the IGY for scientific research into problems of radio-communications and the diffusion of radio-waves, which had been given to the Moscow Central Radio Club some time previously by his colleague Natalia P. Ben'kova. Popov picked out the problem of "whistling atmospherics" as one that particularly lent itself to useful contributions from amateurs. And the article concluded with his general exhortation for radio amateurs to respond to the call to join in the International Geophysical Year, and to make a strong contribution to the collective enterprise of planetary geophysics.

Ben'kova was a young scientist at the beginning of a distinguished career in ionospheric physics, and during the IGY she was chosen to coordinate the entire Soviet effort for the Ionosphere discipline of the programme. But if her lecture on radio science in the IGY, given at the end of 1956 or early in 1957, contained ideas that Soviet radio amateurs outside Moscow needed to hear about before the IGY began on 1 July 1957, it was far from clear how they were supposed to do so, since *Radio* never published a digest of it.⁵⁶ A version of the lecture, probably only slightly altered from the original, was

eventually published in an edition of 11,600 copies by the Ministry of Communications in February 1958. It included brief references to Sputniks 1 and 2, and to the American Explorer 1, launched on 31 January 1958, which appear to have been pasted in while it waited to go to press. But it contained no suggestions that radio amateurs could contribute observations of satellites, or whistlers, or anything else.⁵⁷ During the interview featured in the May 1957 article, therefore, Popov was probably speaking for himself, rather than summarizing Ben'kova, when he expressed the idea that the amateurs should cooperate with the scientists, though still not on satellite tracking.

In June, July and August *Radio* published the series of articles on the required equipment and methods for observing future Soviet satellites, which have long been familiar to historians. But since the failure of western observers to notice this information prior to Sputnik 1 has often been attributed to the relative obscurity of its publication, it is worth adding the hitherto unnoticed fact that the material in question was also re-published at the time in a second official source. On 30 June 1957 *Soviet Patriot*, the semi-weekly DOSAAF newspaper, carried a slightly abridged version of the first article in the *Radio* series; it also published another of the *Radio* articles a few weeks later.⁵⁸ The circulation of *Soviet Patriot* was at least 100,000, or half that of *Radio*, and may have been more.⁵⁹ Like *Radio*, it was perfectly accessible to foreign diplomats and journalists in Moscow.

A network of satellite observation points was established in 28 DOSAAF radio clubs, mainly in large cities along the 55th parallel of latitude or near the southern borders of the USSR.⁶⁰ The Academy of Sciences and Ministry of Defence arranged for sets of equipment to be delivered by air. These included the MAG-8 tape recorder and the GSS-6 standard signal generator, for checking the unstable characteristics of the valve receivers of the day. The club chairmen were brought to Moscow for lectures about satellite observation and the construction of apparatus. Leaders for the observation teams were supplied from Moscow, and some of the country's most highly skilled amateurs were sent to the key observation posts in Magadan, Kamchatka, and Sakhalin. At each post club members were organized to maintain a round-the-clock radio watch. Meanwhile scientists from the Institute of Radio Technology took a duplicate of the 20 Mc/s transmitter designed for Sputnik 1 to a small rural aerodrome, and flew it on a plane in order to practice receiving the signals on the ground.⁶¹

Then, in August and September:

...through the Central Amateur Shortwave Radio Station [UA3KAA], specimen radio signals from the transmitters of the first artificial earth satellites, recorded on magnetic tape, were broadcast several times a week. This made it possible for a large number of radio amateurs in the Soviet Union to study thoroughly the signal forms and to adjust their equipment.⁶²

This was not announced in *Radio* beforehand; but the DOSAAF radio clubs always had other, more direct, means of communication at their disposal. Despite the new NATO listening stations which became operational in Turkey and elsewhere from 1955 on, the broadcasts went just as unnoticed by the outside world as the articles in *Radio* and in *Soviet Patriot*.

Exactly how these test signals were relayed remains unclear. The actual future sputnik frequencies would not have been used, for several reasons. Both were outside the amateur wavebands. The 40 Mc/s frequency was physically unsuitable. 20 Mc/s could have been used, in daytime at least, but only at the cost of drawing immediate worldwide attention, because it would have been right next to the most public object in the spectrum, the WWV time-signal broadcast continuously by the U.S. National Bureau of Standards.⁶³ While that location would later have technical and political advantages for the actual sputniks, once they were launched, something more familiar and more discreet was probably used for the sample signals. In addition to standard frequency signals, the DOSAAF Central Radio Stations (UA3KAA and UA3KAB) regularly broadcast three one-hour training programmes a week on 7.5 and 14.1 Mc/s. These were normally used for things like teaching morse code, but the sample sputnik signals may just possibly have been included in them.⁶⁴

Nikolay Kazanskiy has recalled attending a meeting of the State Commission responsible for the satellite project in July or August, at which Korolev was also present. The chairman raised the question of who should be responsible for confirming that the satellite was established in orbit, and how fast this could be communicated. After indefinite responses from other officials, Kazanskiy promised that once the signals had been detected at a DOSAAF observation post the information would reach the Central DOSAAF Radio Station within fifteen minutes. A mobile radio-relay station was then installed at Rastorguyevovo to pass on the confirmation of orbit to various authorities.⁶⁵

At the eleventh hour, Colonel-General Pavel Belov put out a rallying call in the October issue of *Radio*, in which he praised the preparations at some of the DOSAAF radio clubs around the country, and called for a maximum effort to be made by all the clubs as well as by individual amateurs.⁶⁶ In a box on the same page the magazine announced that three prizes would be awarded to the clubs which made the best job of organizing this work, and ten further prizes to individual amateurs whose observations were judged to have particular scientific value.

The earliest public suggestions that Soviet radio amateurs should assist their country's IGY programme, in satellite tracking or in other ways, were made in the January and May 1957 issues of *Radio*.⁶⁷ Together with other material in the magazine, such as its antarctic coverage, they should have alerted foreign intelligence and scientific organizations with an interest in the Soviet IGY programme, in time for them to have been waiting expectantly for the June, July and August issues of the magazine, packed as they were to be with important information about the tracking systems planned for Soviet satellites. The June issue came out late, nearer the middle than the (more usual) beginning of the month, perhaps because of the inclusion of the satellite articles. But copies of *Radio* were hardly difficult to obtain. Apart from the kiosks and technical bookshops of Moscow, accessible to any passing military attaché, they were delivered promptly each month to western institutions such as the British Patent Office library and Imperial College, London.

And in fact one western intelligence agency had already drawn attention to one of the earlier space articles in *Radio*, when preparing a digest of information circulated in July 1956. The Department of Scientific Intelligence of the Canadian Department of Defence quoted a passage from Kucherov's article in the August 1955 issue, in which he discussed the difficulties of achieving the regular orbital rendezvous between supply rockets and an orbiting space station that would be needed for the construction of the latter.⁶⁸ The timing of the DSI report may simply have been unlucky. The next space article in *Radio* after Kucherov's was Petrov's in June 1956, which included a forecast that the first satellites would be launched within two years. It is unlikely that such a prediction, banal though it was in the context of the ongoing American Vanguard programme, would have been overlooked by the compilers of the DSI report, so presumably their work was completed before that issue of *Radio* reached them.⁶⁹

The timing of Firmin Krieger's June 1956 RAND report, *A Casebook on Soviet Astronautics*, was also wrong for catching the Petrov article. The Khlebtsevich article, in the May 1955 issue of *Radio*, was listed without any reference in the commentary; the more explicit Kucherov piece, which appeared two months later, was overlooked.⁷⁰ In Krieger's follow-up report, in June 1957, the Kucherov article was the only piece retrieved from 1955, and translated in full, before material from 1956 and 1957 was presented. The Petrov article was also translated. No other articles from *Radio* were listed.

Until the end of September 1957, when Soviet scientists brought the information to Washington themselves on the eve of the IGY Conference on Rockets and Satellites, the at first hinted and then publicly announced preparations of the Soviet radio amateurs for tracking the first sputniks were almost completely missed by the western scientific and intelligence organizations with a major interest in and responsibility for acquiring such information.⁷¹ But what about those western radio amateurs, with whom their Soviet counterparts had been officially encouraged to increase their contacts as recently as October 1956?

THE WESTERN RADIO AMATEURS

In August 1956 the IGY committee of the International Radio Science Union (URSI) noted that the cooperation of all radio amateurs was being sought for the Year, particularly for the transmission of scientific data from remote stations. They passed this suggestion to the International Radio Consultative Committee which was meeting at the same time in Warsaw.⁷² In January 1957 R.L. Smith-Rose, director of radio research at the Department of Scientific and Industrial Research and acting director of the National Physical Laboratory, explained to radio amateurs in Britain the scientific significance of the IGY and the part which they could play in it. The projects which he suggested, however, were almost solely concerned with the nature of radio propagation in the higher frequencies, including the meteorological, auroral and solar conditions by which it might be affected. No reference was made to monitoring the signals from future satellites.⁷³

The VHF committee of the Radio Society of Great Britain duly considered Smith-Rose's ideas, and appointed two IGY coordinators, D.W. Furby (G3EOH) and G.M. Stone (G3FZL), to promote

experiments along the lines suggested. In their first report, in April 1957, it was proposed to cooperate with a group of Danish amateurs on trans-auroral radio propagation. Further reports in 1957 gave basic information about the IGY and about the use of amateur beacon stations, to be established in Britain, Denmark, Poland and Yugoslavia, for propagation measurements.⁷⁴ The coordinators reported handling a large amount of IGY correspondence.

One British publication, *The Short Wave Magazine*, reported in January 1957 that the American satellite frequency would be 108 Mc/s. In March this statement was revised, to the effect that this was the "agreed" frequency for all IGY earth satellites:

Naturally, nothing is known about the Russian plans, except that the frequency is the same as that for the American spheres. Yet it is the Russian one that we are more likely to hear (or see) in this country.⁷⁵

In December 1957, after two Soviet and no American satellites had been launched, *Short Wave Magazine* was still referring, somewhat peevishly, to 108 Mc/s as "the official IGY channel".⁷⁶

In the same month, *Wireless World* was only slightly exaggerating when it stated that:

Nobody in this country was prepared for the use of 20 Mc/s and 40 Mc/s as the transmission frequencies because it was expected that the American satellite, using 108 Mc/s, would be the first to be launched. This state of unpreparedness should never have existed, however, for the frequencies were published in the June, 1957, issue of the Russian journal *Radio*, which is available in this country, and were officially notified to the Royal Society in the following August.⁷⁷

Radio amateurs in the United States were also briefed on the contribution they could make to the IGY. But in that country considerable emphasis was placed on their role in tracking future American satellites. Preparations began as early as January 1956, when the U.S. IGY committee's satellite panel approved the formation of Project Moonbeam for this purpose.⁷⁸ In July 1956 a detailed account of the Minitrack-2 apparatus for construction and operation by amateurs was published in *QST*, the magazine of the American Radio Relay League.⁷⁹ Although this was not re-published in *Radio* until a year later, it seems probable that Shmakov's suggestion that Soviet amateurs should help with satellite tracking, made in the January 1957

issue of *Radio*, had been inspired by information about what was already being done in this regard in the United States.⁸⁰

Further accounts of the Minitrack-2 system appeared in *QST* in April and September 1957, as well as in other American journals before the launching of Sputnik 1.⁸¹ These preparations themselves make it all the more remarkable that no one seems to have wondered whether the Soviet IGY organizers might not be taking a similar approach, that of mobilizing radio amateurs, and then gone on to examine the obvious and readily available source of such information.

As for direct radio contacts between Soviet and western amateurs, several factors may have prevented the passage of information about Soviet preparations. Two-way voice connections over many thousands of miles were occasionally achieved even before the official Soviet ban on them was lifted in mid-1956. The first QSL cards, confirmations of radio contact, were sent to western amateurs at the end of the year. But even where contact was established, other difficulties arose, as the veteran British amateur, Pat Gowen (G3IOR), recalls:

The links from the UK to radio-amateurs in the USSR were very few and far between in those days, and further, both language and political barriers hampered the discussion of complex issues.

Officially the Soviet radio amateurs were not permitted contacts outside their own bloc before the second half of 1956. They never called 'CQ' (the invitation to be called by any listening station) but 'WSEM', which was similar but directed only to stations affiliated with the communist-bloc IBO. I often called such WSEM stations in the hope of a contact, but other than the occasional acknowledgement that I was being heard, no real dialogue resulted. Some of us including myself did of course have the odd sporadic longer contact, but these were *very* limited in content, normally restricted to the names of the operators, their locations and often some details of the apparatus and antennas they were using thrown in.

My first *official* contact with a USSR radio amateur was on 8 December 1956, with no more logged until 5 May 1957. From then on many hundreds of contacts ensued, but never a mention of SPUTNIK ever came about. I now wonder whether, if they had told us what was going on, we would in fact have believed them.⁸²

From the other side, in addition to similar language and political barriers, the paramilitary nature of the DOSAAF radio clubs network doubtless played a part. The blanket ban on amateur radio contacts with the West was lifted 15 months before the launching of Sputnik 1, but such things leave their mark. The communal setting and militaristic atmosphere of the radio clubs can hardly have been conducive to openness on such a sensitive issue as the Soviet satellite programme.

It is also relevant to recall the formal barriers which continued to separate the radio amateurs of the Communist bloc from their colleagues in other countries. Although a Soviet delegate had attended the founding conference of the International Amateur Radio Union in 1925, the Radio Sport Federation of the USSR would not be admitted to membership until 1963.⁸³

USING THE AMATEUR DATA

Western observers visiting the Soviet Union soon after October 1957 were sometimes surprised by the technological backwardness of its satellite-tracking equipment, by comparison with the state-of-the-art Baker-Nunn cameras and the Minitrack radio signal analysers of the United States.⁸⁴ At the Washington Conference Kasatkin had responded to criticism of the Soviet choice of satellite frequencies by arguing that although a higher frequency, such as the 108 Mc/s for which the Americans had opted, made for greater tracking precision, comparable accuracy in orbital calculations might also be attainable through statistical treatment of a large number of observations of a lower frequency beacon.⁸⁵ The network of DOSAAF radio tracking-stations appears to have been an attempt to build what amounted to a single, geographically-dispersed tracking instrument for the purpose explained by Kasatkin. It was of course supplemented by a large number of other observations by IGY scientists and by amateur observers within and beyond the Soviet Union.

According to the fairly detailed accounts contained in the bumper, celebration issue of *Radio* for December 1957, most stations in the DOSAAF network performed little better than some of the luckier individual amateurs, in respect of their response time to Sputnik 1, which was launched at 22.28 on Friday, 4 October, Moscow time (MSK). The first newflash was probably put out by Radio Moscow at about half an hour after midnight, followed by a full TASS bulletin

broadcast an hour or more after that, on 5 October.⁸⁶ Most radio amateurs learned about the launch only from such bulletins, or else from *Pravda*, and pointed out that they had then been unable to start monitoring the ether until they got back from work, which many Soviet citizens were obliged to attend on Saturdays at that time. DOSAAF stations featured in that issue reported their first acquisitions as 09.59 and even 22.27 MSK on 5 October. The Novosibirsk radio club managed 08.30 and one or two individuals did likewise. By contrast, the DOSAAF station at Khabarovsk acquired the satellite signal at 00.20 MSK, and the Magadan DOSAAF station very shortly after that. The times were early in the satellite's second orbit, as it passed northwards above the Siberian steppes. These two provincial stations, at least, must almost certainly have been placed on alert before the launch. Perhaps they were considered so remote and secure, in the generally militarized Soviet Far East, that any leakage of the information was unlikely.

Most accounts of Sputnik 1, by both western and Soviet historians, have stated that its orbit was first confirmed at the Baykonur launch site.⁸⁷ The tradition of the Russian radio amateurs, however, maintains that the first confirmation given to the Soviet government, at least, came directly from one of their tracking stations. Because it includes the launch trajectory, the first circuit of a satellite, until it recrosses the latitude of its launch point, takes appreciably longer than subsequent orbits, thus causing greater easting in the ground-track. Another factor in the case of Sputnik 1 is that, for reasons of caution, small delays may have been built in, either to the release of the satellite from the carrier rocket, or to the switch which turned on the beacon signal.⁸⁸ It is therefore possible that the signals were in fact detected at DOSAAF stations in the Soviet Far East before they were heard directly at Baykonur. Indeed the special allocation of expert radio amateurs to stations in that region (above) suggests that this contingency was allowed for. Another possible explanation is that Baykonur, or other Soviet military installations, may have picked up the signals at the end of the first orbit, but waited for additional confirmation from the DOSAAF stations before informing the authorities in Moscow.⁸⁹

Radio amateurs who sent observations of the first sputniks to the Soviet IGY committee received a special QSL card, which informed them that "Your observations are scientifically valuable, and we shall make use of them when working up our results in accordance with the programme of the International Geophysical Year." The utility

of observations supplied by radio amateurs was also acknowledged in other ways.

Thus on 9 October *Pravda* stated that both radio amateurs and amateur astronomers had materially assisted the scientists with tracking Sputnik 1. If the radio amateur observations included readings taken with direction-finders, it pointed out, they could in themselves provide a rough determination of the orbital elements. And the strength of the transmitters on the satellite had been deliberately chosen so that radio amateurs all over the world could join in the observation programme. The article was reprinted in the November issue of *Radio*, which also included a graphic description of the way in which "a large army of Soviet radio amateurs took an extremely active role in this absorbing scientific experiment".⁹⁰

On 13 November, in a major article on Sputnik 2, *Pravda* once again acknowledged the work of the DOSAAF clubs and thousands of amateurs. There was so much of this material that only a preliminary survey of it had yet been made. But it was certain to yield valuable information about the properties of ionospheric layers and the dispersion of radiowaves.⁹¹

Starting with its editorial "Radio Amateurs Assist the Scientists", the December issue of *Radio* was largely given over to celebratory descriptions of the first two Soviet satellites and the role which had been played by Soviet radio amateurs, including those at the DOSAAF tracking stations. The Academy of Sciences, it reported, had already concluded that the reports of radio amateurs had furnished valuable data, which was still being processed. The magazine continued the practice, begun in November, of praising individual amateurs for their achievements, and awarded the prizes announced in October to the DOSAAF clubs in Khabarovsk, Magadan and Leningrad. Further prizes and diplomas, it was announced, would be awarded for work done on Sputnik 2. Once again the recent *Pravda* article was reprinted.

Superficially, this pattern appeared to continue in 1958. An article on radio-electronics by Academician Berg, in the January issue, and three celebrating the launch of Sputnik 3, in June and July, paid the usual tributes to the work of the radio amateurs. But the wording was increasingly perfunctory, and these were the only space-related items, a total of eight pages, for the entire year. The emphasis in them shifted noticeably towards the exaltation of Soviet science and engineering, together with their contribution to the political and strategic might of the motherland. Tracking by radio amateurs was

still appreciated, but clearly it was no longer seen as essential. The point was made explicit by one of the June articles, entitled "What Sort of Programme Are The Radio Amateurs Following?". The answer, or recommendation, was one of making very precisely timed measurements of the onset and loss of satellite signals, together with minor variations in the intensity of the signal, as a contribution to scientific studies of the ionosphere. This work, it was acknowledged, was far more complex than the observations that had been made on the first two sputniks: "However, there can be no doubt that Soviet radio enthusiasts will turn successfully to this new challenge, and will provide our scientists with valuable material on which to base their findings."⁹² Plainly there *was* just such a doubt. Even if enough amateurs had possessed the interest and skills for such work, it is doubtful whether many of them, or their clubs, could obtain equipment with the necessary levels of calibration and sensitivity. The lack of follow-up articles describing such work by amateurs suggests that it was in fact impossible to impose this "turn" on their community. Nor was there ever any report about them making observations on whistlers, or any other geophysical phenomena, as a contribution to the national IGY programme. No separate prizes were awarded for amateur observations of Sputnik 2, but the individual prizes announced in October 1957 seem eventually to have been awarded for work on both the first two satellites.⁹³ No prizes were even proposed in respect of Sputnik 3.

The trend was not all downhill, however. The launching of the first lunar probe, *Mechta* or *Lunik 1*, on 2 January 1959, was naturally hailed as a "Tremendous Victory for Soviet Man", and an article in July drew attention to the contribution made by Soviet amateurs in tracking it, just as they had the early sputniks. It is indeed likely that the specific tracking problems posed by lunar probes, which needed data for rapid three-dimensional fixes in an environment with, at the time, several physical unknowns, would have restored the value of amateur observations for a while. But the title of the July article, "Strengthening the Link between Scientists and Radio Amateurs", itself implied that the relationship was no longer as warm as it once had been.⁹⁴ The articles in October, November and December, which celebrated the lunar impact achieved by *Lunik 2* in September and the relaying of photographs of the far side of the Moon by *Lunik 3*, took on an increasingly passive, acclamatory tone. In November 1960 a four-page article on "Cosmic Radio-Electronics" managed to survey the space successes of the Soviet Union, and to salute the

achievements of its people, without a single reference to the part that had been played by the readers of *Radio*. By that stage the magazine had even removed the recently-introduced "Space" category from its annual index. Gone for ever were the early hours of 5 October 1957, when it could at least seem that "For a while, the sputnik was under the unsleeping control of the radio amateurs."⁹⁵

In Soviet scientific literature, one rather sketchy account of the work of the Soviet amateurs was put before the Fifth CSAGI Assembly at Moscow in August 1958, but only in response to a specific request from American delegates.⁹⁶ Other scientific papers tended merely to refer vaguely to, for example, "mass measurements . . . of the signal levels of radio waves received" from the Soviet satellites.⁹⁷

In the United States, the achievement of the San Gabriel Valley Radio Club, near Pasadena, in being one of the first stations to pick up the signal of Explorer 1 at the end of its first orbit, was readily acknowledged.⁹⁸ Amateur observers were of course fully capable of recording satellite telemetry signals, but their equipment was felt to have been inadequate for the exact timing of satellite passes. Some attempt was made to study ionospheric conditions by recording variations in signal strength, in the same way as was proposed in the Soviet Union. But, in contrast with its optical counterpart Project Moonwatch, no full report on Project Moonbeam was published, and "The principal use to which volunteer interferometer stations were put was in providing confirmation of achievement of orbit during the period immediately after launch."⁹⁹ However, the American Radio Relay League also organized its members in a major autonomous study of ionospheric propagation, which seems to have had no counterpart in the USSR.¹⁰⁰

In Britain, amateur recording of satellite telemetry was also thought to have been highly successful. Interferometers were not ready in time for the first two sputniks, but rough orbital estimates were based on Doppler shift measurements. The project's director concluded that there might be an advantage in amateurs continuing to make such observations, and in using their skill at recognizing other special aural effects.¹⁰¹

CONCLUSIONS

If Sputnik 1 came as a surprise both to officials and to members of the public in the United States and other western countries, it was a

complex and qualified one, since, with the exception of its rocket vehicle, the Soviet project had clearly not been treated as a closely guarded secret by the standards of its time and place. Indeed, as has been shown above, somewhat more information and pointers to information were made publicly available than have been described in previous accounts. Nothing better demonstrates the adequacy of this informal Soviet material as forewarning of an imminent launch attempt, than the fact that, three and a half months before it happened, and even before he had seen the copious material provided by *Radio* in the summer of 1957, RAND analyst Firmin Krieger succeeded in predicting the event to within 17 days. Perhaps a new category of 'open surprise' is needed, for sudden developments in international relations in which the conjuror of future events keeps nothing up her sleeves. Other accounts of the American response to the sputniks seem closer to calling it a 'self-inflicted surprise', though national complacency on such a scale does not so much provide an explanation as require one.

Past discussions of surprise in international relations have contrasted warfare, in which surprise is often thought desirable, with diplomacy, in which it is usually thought undesirable. Perhaps strategic preparation, which shares some characteristics with each of these two sorts of behaviour, is a field in which surprise is sometimes pursued and sometimes shunned, depending on complex factors, and may even be both pursued and shunned simultaneously, at different levels of the game. The Soviet preparations for the participation of radio amateurs in their IGY programme in general, and in satellite tracking in particular, were necessarily made in advance, and outside the high security of the Baykonur Cosmodrome. The process began, perhaps, with Ben'kova's general survey of IGY radio science for an audience of radio amateurs, if that was given before the end of 1956. There followed Shmakov's suggestion about amateur satellite tracking, published in January 1957. The detailed technical arrangements were prepared at the Institute of Radio Technology and Electronics in the first months of 1957, and then published with all the necessary detail, between June and August, both in *Radio* and in *Soviet Patriot*. General information about the Soviet satellite programme was also given informally between 1955 and 1957, both in the Soviet media and at international scientific meetings in Copenhagen, Freudenstadt, Paris, London, or Cranfield. In sharp contrast, only the sparsest official, documentary information about the Soviet satellite programme was dribbled out to the

international IGY organization. Nor was there any readiness on the Soviet part to cooperate on drawing up new international arrangements in respect of satellites.¹⁰²

The narrative that has been explored above suggests that there was a skilful ambivalence in the Soviet position. On the one hand, enough information was left lying about, so to speak, in just about enough time to avoid the risks of *inter-governmental* surprise, always on the assumption that it would be gathered and processed efficiently. On the other hand, there was much to be gained by a maximum of restraint in the matter of explicit advance information on the Soviet satellite programme, and this approach was in any case conformable to the 'standard operating procedures' of its society. International agreements which might have undesirable legal implications would be avoided. The sleeping hare of the American satellite programme would be left undisturbed. No hostages would be given to fortune in an area of untried technology. And lastly, the potential for a world-wide *popular* surprise would be left broadly undiminished, thus hopefully adding to the intended kudos of the Soviet achievement.

Whether or not this apparently two-pronged approach was indeed a conscious tactic on the part of the Soviet government can only be determined, if at all, from an examination of its official archives. Related questions which also need resolving concern the nature and extent of the political guidance provided to the Soviet IGY committee; the relationship between public bodies such as the ICIC and the IGY committee, on the one hand, and the Korolev 'rocket team' at Baykonur, on the other; and lastly the relationship between all such bodies and the Soviet media.

Whatever the origins of the two-sided presentation of the Soviet satellite programme, it occasioned severe problems for the United States. Quite apart from the usual difficulty of reading the opponents' game plan aright, there would seem to have been very few options available for countering it. The first one, of simply doing everything possible to put up any sort of primitive, barely-instrumented satellite before the Russians, was seriously considered at the time by the Eisenhower Administration, but was finally rejected on the grounds that such an unscientific stunt would be demeaning and politically counter-productive. In retrospect, that was a consistent and intelligible decision.¹⁰³ Space historians will never agree as to whether it was the 'right' one, but fortunately it is not their job to do so. A second option, on the face of it, might have been to announce very clearly and in good time that the United States no longer expected to

come first with its "Vanguard" satellite after all. In March and December 1956 the U.S. Secretary of the Air Force, Donald Quarles, made public statements which went first a little and then a long way in that direction, but neither press nor public wanted to hear what he was muttering.¹⁰⁴ Quite apart from what were probably insuperable cultural barriers to such a move, posed by the American self-image of the day, there could also have been the thought that no game is lost before the final whistle. With rocket technology still a very high-risk enterprise, there could have been one or two additional launch failures in the Soviet Union, one or two fewer in the United States, and the contest might have gone the other way. Perhaps the Soviet government was using a somewhat less secretive strategy, and the American government a far more consciously chancy one, in their respective IGY satellite programmes, than has hitherto been generally believed.

Notes

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1. The dates and times of satellite events are given in Universal Time, the time at the Greenwich meridian. According to recent work by Russian space historians, Sputnik 1 was launched at 19.28 on 4 October 1957 (UT), or 22.28 Moscow time (MSK): Georgiy S. Vetrov, "The first sputnik", a chapter from his book *The Discovery of Space* (Открытие космоса), posted to an internet website on 3 October 1997. This is two minutes later than the time previously given by western experts. Eye-witness descriptions of the launch as 'shortly before midnight' may have related it to local mean time at the Baykonur launch site, which would have been approximately 23.48. Because of the more easterly location of its capital, Alma Ata, the official time in the Kazakh Republic as a whole, and hence presumably at Baykonur, was 00.28 on 5 October 1957.
2. G.P. Hastedt, "Sputnik as Technological Surprise", paper to symposium on *Reconsidering Sputnik* organized by the NASA History Office, with support from the Smithsonian Institution, the Woodrow Wilson Center, and George Washington University, Washington, 30 September and 1 October 1997. The literature on surprise in international relations has tended to focus on a few examples taken from the recent history of the United States, amongst which the first Soviet atomic bomb test, in 1949, is probably seen as the closest parallel to Sputnik I.

3. P. Kecskemeti, *The Satellite Rocket Vehicle: Political and Psychological Problems*, RM-567, RAND, 4 October 1950.
4. G.A. Tokaev, *Stalin Means War* (London: Weidenfeld & Nicholson, 1951), pp. 91–108.
5. G.P. Sutton, "Evaluation of Russian Rocket Developments" *Journal of the British Interplanetary Society* (1954) 13, # 5, 262–8, on p. 267.
6. AP release, 16 April 1955; *New York Times*, 17 April 1955. The ICIC had in fact been formed some time before the end of 1954, since it was referred to in V.G. Fesenkov, "Problems of Astronautics" *Vestnik Akademii Nauk Kazakh SSR*, (1955), 11, # 1, January, pp. 3–11.
7. By coincidence, the Komsomol magazine *Technology for Youth* devoted most of its July 1955 issue to the subject of space travel.
8. *The Times*, 2 August 1955.
9. *The Times*, 3 August 1955, and *Pravda*, 5 August 1955. The *Pravda* report omitted some of what was given in *The Times*, including the reference to a future statement. But the two reports agree on the substance of Sedov's remarks, including his refusal to comment on the timing of any Soviet project. Sedov issued a further account of the Copenhagen meeting and his remarks to the press in a statement published in *Pravda* on 26 September 1955. Both these *Pravda* articles were translated in F.J. Krieger, *A Casebook of Soviet Astronautics*, RM-1760, 21 June 1956, (Santa Monica: RAND, 1956) pp. 2–3, 205–211.
10. Despite the thoroughly researched accounts of the Soviet response that were produced at the time by Firmin Krieger at the RAND Corporation, the myth of an official Soviet announcement in August 1955 has been perpetuated by historians who neglect to check the sources of their sources. See Krieger, *Casebook of Soviet Astronautics* (note 9) pp. 1–2; repeated at F.J. Krieger, *Behind the Sputniks: a Survey of Soviet Space Science*, R-311, 3 November 1957, (Washington: Political Affairs Press, 1958), pp. 4–5. See also *The Times*, 8 September 1955, which stressed that there had still been no official statement from Moscow on the subject. Then compare A. Parry, *Russia's Rockets and Missiles* (London: Macmillan, 1960), pp. 185–6; M. Caidin, *Red Star in Space* (New York: Crowell-Collier, 1963), p. 72; and W. McDougall, ... *the Heavens and the Earth* (New York: Basic Books, 1985), p. 60. Parry, for example, tried to make a meal out of the venue of the Sedov press conference, "not at the Congress but ... in the Soviet legation in the Danish capital, a solemn function in an official building" (p. 185). The simple facts were that Sedov had only just arrived, reporters were demanding interviews, and he gave them over an hour of his time in the most convenient place available to him. Since, unfortunately, many scholars now use McDougall's historical masterpiece as their only factual source, such minor myths as this one will probably be perpetuated for some time to come.
11. *Moskovskaya Pravda*, 14 August 1955.
12. *Daily Worker* (New York), 4 January 1956, based on UP and AP reports from the previous day, describing a recent article by Georgiy I. Pokrovskiy (below) in *Trud*.
13. Canadian Department of National Defence, *The USSR Satellite Program for the International Geophysical Year*, DSI Report # 8/56, July 1956, pp. 6–7. Sedov was reported as saying that he could only answer "questions of general scientific interest". While he may simply have been being evasive for security reasons, there is also the possibility that there was a real separation between the Academy scientists who prepared the instrumental payload and the Baykonur rocket team, under Korolev, who were preparing the launch vehicle and satellite shell under conditions of strict secrecy. Nor is it known that Sedov was actually involved with Sputnik I in any 'hands on' capacity. He probably discussed the instrumentation issues simply because those were what interested him and what he was competent to discuss.

From Freudenstadt, Porter went on to see Marcel Nicolet, the General Secretary of the IGY, in Brussels. Presumably inspired by his meeting with Sedov, Porter suggested holding a special IGY meeting "on the subject of IGY satellite instrumentation": Nicolet to Chapman and Berkner, 22 February 1956 - Sydney Chapman Papers, Rasmuson Library, University of Alaska, Box 54, File 79.

14. "The USSR rocket and satellite Program" *Annals of the International Geophysical Year* (hereafter *Annals*), (1958), *IIA*, pp. 310-11.
15. Mirtov and Poloskov were included in the first official Soviet request for visas, sent over a month before the meeting: Nicolet to Cardus, 15 August 1956 - Sydney Chapman Papers, Rasmuson Library, University of Alaska, Box 54, File 79. But their names were absent from the lists of working groups, which would have included every delegate attending - *Annals*, (1958), *IIA*, 338-40. And contemporary sources described Bardin as having been unaccompanied at sessions of the satellites working group. A few months later Mirtov and Poloskov were amongst a 13-strong Soviet delegation to the first International Congress on Rockets and Guided Missiles, held in Paris in December 1956, at which they gave an important paper on Soviet sounding rockets - S.M. Poloskov and B.A. Mirtov, "Study of the Upper Atmosphere by means of Rockets at the USSR Academy of Sciences", trans. in F.J. Krieger (ed.) *A Casebook on Soviet Astronautics - Part II*, RM-1922, 21 June 1957, (Santa Monica: RAND, 1957), pp. 151-162. Perhaps there was an administrative blunder in preparing the list for Nicolet, and Mirtov and Poloskov had never been considered as delegates for the Barcelona CSAGI meeting. Or perhaps the invitation to Paris, a major conference in their field, arrived later, and if their access to foreign travel was limited, was simply more attractive than Barcelona.
16. Since the approximate size of the first Soviet satellite had already been given by several sources (see the DSI Report cited in note 13 above), and the orbit was to some extent a function of the latitude of the launch site, Simpson's account is plausible. There is a problem, however, since neither Sedov nor Herbert Friedman, whom Simpson recalls as also having been present, were listed as participants in the Barcelona meeting - *Annals*, (1958), *IIA*, pp. 338-40. Even if Sedov had overcome the obstacles to making such a journey in a private capacity, posed by both the Soviet and the Spanish governments, both as an Academician and as chairman of the ICIC he would certainly have been given full delegate status. The same applies to Friedman, a brilliant scientist then reaching the peak of his career. Sedov did however take a prominent part in the proceedings of the 7th Congress of the International Astronautical Federation, which convened in Rome on 17 September, immediately after the CSAGI meeting in Barcelona. Perhaps the conversation recalled by Simpson in fact took place in Rome, but in correspondence with him it has not been possible to confirm this conjecture.
Further doubts are raised by the comments of a former British officer in the IAF, who knew Sedov well in the 1950s and 1960s, and who recalls him as a taciturn individual with, in the early years, a very poor command of English - personal communication.
17. "CSAGI Conference Resolutions" *Annals*, (1958), *VI*, 453-465, on p. 457.
18. John Hagen, the director of the Vanguard programme, sent details of the American satellite, including its telemetry frequency, to the British IGY committee on 1 August 1956 - Royal Society, IGY Archives, NGY/74 (56). The same document was sent to all national committees by Nicolet a few days later: CN-CIR-15-568/6, 6 August 1956 - Archives of the International Council of Scientific Unions.
19. "Soviets Plan 100-lb, 20-24 in. Satellite" *Aviation Week*, (1956), *65*, 29 October, 62.
20. W. Ley, *Rockets, Missiles, and Men in Space* (New York: New American Library, 1969), p. 382. Although noticed by other American commentators at the time,

this particular article by Pokrovskiy was not mentioned in any of Krieger's compilations (notes 9, 10 and 15).

21. "USSR Rocket and Earth-Satellite Program for the IGY", 10 June 1957 – U.S. National Academy of Sciences, IGY Archives, Drawer 19, File: TPESP Sat. Corr. June 1957.
22. *Komsomol'skaya Pravda*, 9 June 1957; see also *Pravda*, 1 June 1957.
23. To save space, articles from *Radio* will receive full citations only when matter from them is quoted in the text. In all other cases, they will be identified by month and/or author in the text, which is enough to locate them in the magazine. In general, editorial material was prepared by the middle of the biantecedent month, as for example 16 April 1956 for the June 1956 issue, and sent to press at the end of the preceding month. In rare cases, however, the magazine did not go to press until several days into the publication month.
One of the July articles was a description of the American Minitrack-2 satellite-tracking system, intended for use by amateurs, based on an article in the July 1956 issue of *QST*. One of the August articles was the second part of an article which began in the July issue. Further information was also given in editorial text boxes in the July issue. Translations of the articles describing Soviet apparatus and tracking methods were published in 1958 in the *IGY Manual on Rockets and Satellites, Annals*, (1958), VI, pp. 222–54.
24. U.S. Secretary of the Navy to U.S. Secretary of Defense, "The U.S. Satellite Program", n.d. but early November 1957 – NASA History Office, File: 006596; *High Altitude and Satellite Rockets*, proceedings of a symposium at Cranfield College, 18–20 July 1957, (London: British Interplanetary and Royal Aeronautical Societies, 1958). The symposium was attended by about 200 people, including some ten Americans, mostly from the aviation industry, and one Pole. Petrov's presentation was probably confined to the text of Bardin's June statement (note 21), which was distributed at the symposium and was the only Soviet paper in the proceedings volume (pp. 56–57). No Soviet contributions to the extensive discussions of the other papers were recorded. In addition to Boris Petrov, who later succeeded Sedov as chairman of the ICIC, the Soviet party included Sedov's deputy chairman Georgiy I. Petrov, Andrey M. Kasatkin, Sergey M. Poloskov, and a military attaché from the Soviet Embassy.
25. "Report of a Meeting at University College London – Friday July 26th, 1957", Guided Weapons Department, Royal Aircraft Establishment, 13 August 1957 – Australian National Archives, Adelaide, Series D174/T1, Piece A750/1/1 Pt. 1. According to Harrie Massey, who convened the satellites subcommittee of the British IGY committee, the account of a Soviet meteorological rocket, given to the IGY Conference on Rockets and Satellites held in Washington at the end of September, was not substantially different from that which had already been given to the British over two months earlier: Massey, Report on the Washington Conference – Royal Society, IGY Archives, NGY/117 (57).
26. Bardin to Berkner, 16 August 1957 – Sydney Chapman Papers, Rasmuson Library, University of Alaska, Box 62, File 257. Chapman, who was much preoccupied with other IGY matters at the time, including a crisis over the participation of the rival scientific academies of Peking and Taipei, had no reason to do anything about the Soviet information himself as long as he supposed it was being taken care of by the appropriate person, namely Berkner. Six weeks later, however, at the Washington Conference, he expressed his regret that the Soviet Union had not used the frequency "agreed" at Barcelona in 1956.
27. W. Sullivan, "The International Geophysical Year" *International Reconciliation*, # 521, January 1959, pp. 259–336, on p. 305.
28. The British subcommittee on satellites formally discussed the Soviet frequencies on 9 September 1957, three weeks before the Washington conference – Royal

Society, IGY Archives, NGY/93 (57). The subcommittee was "profoundly disappointed that the resolution adopted at Barcelona whereby both types of satellites would radiate the same frequency has been disregarded".

Nicolet seems to have first learned of the existence of Bardin's letter giving notice of the Soviet frequencies from a press report at the end of October or early November, and only then to have obtained a copy of it from David Martin, the Assistant Secretary of the Royal Society: Nicolet to Berkner, 5 November 1957 – Sydney Chapman Papers, Rasmuson Library, University of Alaska, Box 62, File 257. When Nicolet complained that Berkner had failed to keep him informed, Berkner excused his omission by stating that he thought the information on frequencies had already appeared in the *New York Times* at the end of July: Berkner to Nicolet, 7 November 1957 – *ibid.* A careful search of that newspaper's files did not succeed in tracing such a report.

29. H. Massey and M.O. Robbins, *History of British Space Science* (Cambridge: Cambridge U.P. 1986), p. 39.
30. *Advances in the Physical Sciences* (1957) (trans. Israeli Prog. Sci. Trans.), 63, pt. 1, September. The collection was comparable to J.A. Van Allen (ed.), *Scientific Uses of Earth Satellites*, (Ann Arbor: U. Michigan Press, 1956), and concentrated even more than the latter on scientific applications, with no discussion of technical aspects of satellite launching and tracking. (An article about the International Geophysical Year appeared in volume 62 of the same journal earlier in 1957, but did not refer to satellites.)
- Tsiolkovskiy's date of birth was 5 September 1857 in the old Russian calendar; this was transposed into 17 September when the Gregorian calendar was introduced in February 1918.
31. Krieger (ed.) *Casebook – Part II*, (note 15), p. 10; c.f. for example, A. Parry, "Behind the Curtain" *Missiles and Rockets*, July 1957. The predictions were later recalled in Ley, *Rockets* (note 20), p. 383, and M. Stoiko, *Soviet Rocketry: Past, Present, and Future* (New York: Holt, Reinhart & Winston, 1970), p. 78.
32. R. Bulkeley, "The Sputniks and the IGY", paper to NASA History Office symposium on *Reconsidering Sputnik*, 1997, (note 2). Korolev himself is said to have been concerned about the poor quality of Soviet representation at previous international discussions of the IGY satellite programme – Vetrov, "The first sputnik" (note 1).
33. Berkner to Chapman, 7 November 1957 – Sydney Chapman Papers, Rasmuson Library, University of Alaska, Box 62, File 257. Walter Sullivan identified the Soviet scientist as S.M. Poloskov, and the preceding American speaker as John Hagen – W. Sullivan, *Assault on the Unknown* (London: Hodder & Stoughton, 1961), pp. 63–64. The Sullivan account was also clearly the only basis for these identifications in C.M. Green and M. Lomask, *Vanguard: a History* (Washington: Smithsonian Institution Press, 1971), pp. 185–6. Sullivan seems to have confused the opening plenary on 30 September, at which Hagen spoke and to which Sullivan and other journalists would have been admitted, with the working group of 1 October, which would probably have been held in private. With considerable hesitation, the author prefers to rely on an unsigned contemporary minute of the working group session, which identifies the two speakers as J.T. Mengel and A.M. Kasatkin, respectively – Draft Minutes, Working Group on Satellite Launching, Tracking and Computation, CSAGI Conference on Rockets and Satellites, 1 October 1957 – U.S. National Academy of Sciences, IGY Archives, Drawer 72, File: Porter 16 C (continued).
34. Sullivan, *Assault* (note 33), pp. 1–2.
35. In fact the Russian expression «накануне» is no more precise than the English "on the eve".
36. R. Calder, "The Red Moon" *New Statesman* (1957), 54, # 1387, 12 October.

37. E.N. Hayes, "Tracking Sputnik 1", in A.C. Clarke (ed.), *The Coming of the Space Age* (London: Gollancz, 1974), pp. 5–15, on p. 10.
38. R. Bulkeley, *The Sputniks Crisis and Early United States Space Policy* (London: Macmillan, 1991), p. 114.
39. Krieger, *Casebook*, 1956, (note 9), p. 4.
40. Leon Gouré, *Civil Defense in the Soviet Union* (Berkeley: U. California Press, 1962), p. 39 – emphasis added. Most of the general information about DOSAAF is taken from this source or from the same author's *The Military Indoctrination of Soviet Youth* (New York: National Strategy Information Center, 1973). But see also D. Holloway, *The Soviet Union and the Arms Race* (New Haven: Yale University Press, 1983).
41. In 1971, by which time DOSAAF membership had climbed to an estimated 40 million, the chairman of its Central Committee could claim that "more than 28 million boys and girls have mastered the skills of radio operation", although since he went on to add other skills to his list it was unclear whether the 28 million was the total of those who had learned at least one skill, or the number of those who had learned them all – "Patriotic Organization of Millions" *Communist On Guard* (1971), # 23, December.
42. Khlebtsevich's article was a digest of his earlier piece "On the Way to the Stars" *Young Technician*, July 1954, which was later expanded as "The Road to the Cosmos" *Science and Life*, November 1955.
43. In contrast with the text, the illustrations showed the lunar rocket as landing directly on the Moon, rather than making a rendezvous with a lunar satellite.
44. V. Petrov, "The Television of the Future" *Radio* (1956), # 6, August, pp. 28–31, on p. 28. The ambivalent use of "we" was typical in Soviet sources of this type. This was probably the V.M. Petrov who created the Soviet Union's first amateur radio station in February 1925, and should not be confused with either of the Petrovs who attended the symposium at Cranfield College in July 1957 (note 24).
45. See for example S.F. Singer, "A Minimal Orbital Instrumented Satellite – Now" *J. Brit. Interplanetary Soc.* (1954), 13, # 2, March.
46. See for example W. von Braun, "Prelude to Space Travel", in C. Ryan (ed.), *Across the Space Frontier* (London: Sidgwick and Jackson, 1952), pp. 12–70.
47. «над» – presumably in the sense of being located above the equator to the south of the country in question.
48. The Council of Ministers issued a decree authorizing the development of a Soviet IGY satellite on 30 January 1956 – J. Harford, *Korolev* (New York: Wiley, 1997), p. 125. However this was not publicly announced at the time.
49. Boris Stepanov (UW3AX), deputy editor of *Radio* since 1975, and Leonid Labutin (UA3CR), veteran member of the Society of Russian Radio Amateurs – personal communications.
50. Leonid Labutin (UA3CR) – personal communication.
51. Editorial box, *Radio*, July 1957, p. 17.
52. N.V. Kazanskiy – personal communication.
53. N. Grigoryeva, "Radio Amateurs and Space" *Radio*, # 10, October 1982, pp. 5–7.
54. Boris Stepanov (UW3AX) – personal communication. It has not been possible to establish whether V. Vakhnin and A. Kazantsev, the authors of the first articles on radio tracking in the June 1957 issue of *Radio*, were also at the Institute of Radio Technology and Electronics, but it seems probable in the circumstances.
55. "International Geophysical Year" *Radio* (1957), # 5, May, pp. 20–21.
56. It is impossible to date Ben'kova's lecture precisely. Working back from the production schedule of *Radio*, it must have preceded 16 March 1957. Allowing for the Popov interview to be processed, and for the fact that Popov in turn referred back to the lecture, it may have been given some months earlier. In its February 1957 issue, prepared in December, *Radio* carried a report on a symposium for radio amateurs in

the Moscow region, which may have been held during the annual nationwide commemoration of the Bolshevik Revolution in November, and would have been an appropriate occasion for the Ben'kova lecture. Unfortunately for the historian no date was ascribed to the symposium, nor was Ben'kova listed as a speaker.

57. N.P. Ben'kova, *The International Geophysical Year and Upper Atmospheric Research* (Международный геофизический год и исследования верхних слоев атмосферы) (Moscow: Govt. Press for Communications and Radio, 1958). Although *Radio* regularly listed new books and pamphlets of interest to its readership, the printed version of Ben'kova's lecture was never mentioned in its pages. One explanation for this may be that at about this time *Radio* seems to have stopped listing books published by the Ministry of Communications altogether, though it continued to list relevant books published by the DOSAAF Press. In December 1957 *Radio* published an article by L. Karyakin, the director of the ionospheric prediction service at the Ministry of Communications, on "Upper Atmospheric Research", and another by V. Ivanitskiy on "Geophysical Observations and Radio Forecasting". These covered some of the ground that had been dealt with in Ben'kova's lecture, with no obvious textual borrowings. The second even mentioned her by name, while describing the work of scientists at NIZMIR, but did not refer to her lecture.
58. V. Vakhnin, "Artificial Earth Satellites" *Soviet Patriot*, 30 June 1957. According to Boris Stepanov (UW3AX), the second article reprinted in *Soviet Patriot* was O.N. Rzhiga and A.M. Shakhovskoy, "UHF Receiver" *Radio*, July 1957, p. 17-20, but he has not provided the date of the reprint - personal communication. In its *Radio* version, the article by Rzhiga and Shakhovskoy carried the unusual and superfluous epigraph "Prepared for the work of *Radio* magazine". Since this would have been more appropriate in *Soviet Patriot*, it is possible that the same text was used in both publications at about the same time. See also: P.A. Belov, "A Vital Mission for the Radio Amateurs" *Radio*, October 1957, 6.
59. This estimate is based on the national membership of DOSAAF, the likely size of its organizational structure and number of its clubs for different activities, and the statement in the third edition of the *Large Soviet Encyclopaedia* that the print-run of *Soviet Patriot* had reached 500,000 by 1975.
60. The total number was given variously, by different sources, as 26, 28, or 30, the last two figures both occurring, for example, in the December 1957 issue of *Radio*. Shakhovskoy lists the 28 locations (without explicitly referring to them as the DOSAAF network) as: Moscow, Leningrad, Archangel'sk, Kaliningrad, Vilnyus, L'vov, Kiev, Odessa, Simferopol', Armavir, Baku, Kazan', Sverdlovsk, Ashkabad, Tashkent, Alma Ata, Omsk, Novosibirsk, Krasnoyarsk, Irkutsk, Chita, Blagoveshchensk, Khabarovsk, Vladivostok, Aleksandrov-Sakhalinskiy, Yakutsk, Magadan, and Petropavlovsk-Kamchatskiy: A.M. Shakhovskoy, "USSR Amateur Radio Observations of Signals from the Soviet Artificial Satellites" *Annals*, (1960), *XII*, pt. II, 916-18, on p. 918. Other clubs or individuals that played a prominent role in tracking Sputniks 1 and 2 were located in Astrakhan, Gorkiy, Minsk, Norilsk, Riga, Saratov, and Semipalatinsk. See also: "The Soviet Artificial Earth Satellite" *Pravda*, 9 October 1957; R.A. Svoren, "The First Days" *Radio* (1957) November, 19; "At the DOSAAF Observation Posts" *Radio* (1957), December, pp. 17-18; and "From the Log-Book of Station UA3KAA" *ibid.*, pp. 14-16.
61. Grigoryeva, "Radio Amateurs" (note 53).
62. Shakhovskoy, "Amateur Radio Observations" (note 60), on p. 916.
63. Pat J.A. Gowen (G3IOR) - personal communication.
64. "Khronika" *Radio*, September 1957, 32. NB - the author's conjecture that sample signals were included in such training broadcasts has not been confirmed by any surviving witness.

Academician Anatoliy A. Blagonravov held a senior administrative post at the Academy of Sciences, and was not directly involved in preparing either the

launch vehicle or the satellite for Sputnik 1. It therefore seems likely that his cry of recognition when, at his request, the first American recordings of its radio signals, made at the U.S. Naval Research Laboratory, were played to the closing session of the Washington Conference on 5 October 1957, was based on having previously heard either such test broadcasts themselves or else, courtesy of the DOSAAF Central Radio Station, a recording of them. Quite possibly all the Soviet delegates had been briefed in that way.

65. Grigoryeva, "Radio Amateurs" (note 53); also Kazanskiy – personal communication. The actual time between receiving the information at Rastorguyev and the announcement on Radio Moscow was later said to have been four minutes – *ibid.*
66. Belov, "Mission" (note 58). His article would have been written by mid-August.
67. On the optical tracking side, the chairman of the Astronomical Council of the Academy of Sciences, Alexander A. Mikhailov, placed a one-page article, "On the Observation of the Artificial Satellite", on the front pages of the *Astronomical Circular* for 18 May 1957, and the May–June issue of *Astronomical Journal*, 34, # 3, 313 (sent to press on 25 June). In it he predicted an orbital period of about 90 minutes (the initial figure was close to 95), and called on "all astronomical organizations, all astronomers of the Soviet Union, and all members of the All-Union Astronomical and Geodetic Society to participate actively in preparations for the visual observations of artificial satellites. Instructions and special apparatus for observation can be obtained through the Astronomical Council." – Krieger, *Behind the Sputniks* (note 10), p. 10.
68. DSI, Canadian Department of National Defence, *USSR Satellite Program* (note 13).
69. The DSI report did not in fact refer to *any* Soviet material published after 31 December 1955.
70. The first part of Krieger's *Casebook* (note 9) listed only two pieces of original Soviet writing published after 31 December 1955, without discussing them. One was a reworking in English of Khlebtsevich's article about lunar exploration, in *Soviet Weekly*, # 738, 22 March 1956. The other was a work for young readers, Karl A. Gil'zin, *Travel to Distant Worlds* (Путешествие к далеким мирам) (Moscow: Detgiz, 1956).
71. The exception, noted above, was the Satellites Subcommittee of the Royal Society, which became aware of the Soviet arrangements, not from the pages of *Radio*, but through Bardin's letter of 16 August 1957. According to Albert Parry, the article in the May astronomy journals (note 67) and the *Radio* articles in June and July "... were at once spotted by certain lower-echelon intelligence experts in the United States, who immediately sent the gist of the data up to their superiors." – *Russia's Rockets* (note 10), p. 187, emphasis added. While this statement is too vague to be disproved, no hard supporting evidence for it has emerged in forty years. Krieger's second compilation, released on 21 June 1957, translated two and listed four further items published earlier in the same month, but neither the article in the May astronomy journals nor the June *Radio* articles, which probably reached him too late: *Casebook – Part II*, (note 15). These were translated in his third and final compilation, *Behind the Sputniks* (note 10), which was released on 3 November 1957. But it is now impossible to say when Krieger first saw them, between June and October, let alone whether or when he passed on word about their contents.
72. *Annals*, (1959), II A, pp. 377, 379.
73. R.L. Smith-Rose, "Amateur Radio and the I.G.Y." *Bulletin of the Radio Society of Great Britain* (1957), 32, March, 396–7. Smith-Rose became president of the RSGB in 1959.
74. "I.G.Y. News" *Bull. RSGB* (1957), 32, April, 460, June, pp. 556–8; *ibid.*, 33, August, pp. 69–70.
75. *The Short Wave Magazine* (1957), XIV, January, 597; *ibid.*, XV, March, 38.

76. A.J.G. and J.M.O., "More on the Satellites" *ibid.*, (1957), XV, December.
77. "Artificial Satellites of the Earth" *Wireless World* (1957), 63, December, pp. 574–5.
78. Green and Lomask, *Vanguard* (note 33), p. 101.
79. R.L. Easton, "Radio Tracking of the Earth Satellite: an Opportunity for Amateur Collaboration" *QST* (1956), 40, July, 38–41, 134. Several further items on the Minitrack-2 apparatus for satellite tracking by radio amateurs appeared in American publications before the general idea was first mooted in the Soviet Union in January 1957. See for example: "Radio 'Hams' and Satellite" *Naval Aviation News* (1956), September, 10; J. Dailey, "One Orbit out of Twelve 'Good' Satellite Average Martin Says" *Aviation Week* (1956), 65, 15 October, 30–31; V.R. Simas, "A Low-noise Pre-amplifier for Satellite Tracking" *QST* (1956), 40, December, 42–43.
80. By 1956 the previous 'verbal admonition' against importing issues of *QST* had been allowed to lapse, but they could only be obtained from supportive foreign amateurs, not by direct subscription: Leonid Labutin (UA3CR) – personal communication.
81. See for example: R.L. Easton, "Calibration of the Mark II Minitrack: Using Radio Stars as Signal Sources" *QST* (1957), 41, April, 42–44; R.L. Easton, "Mark II Minitrack: Base-line Components" *QST* (1957), 41, September, 37–41; and G[eorge] G[ammer], "Satellite Tracking" *ibid.*, 31.
82. Pat Gowen (G3IOR) – personal communication. Another British amateur told the author that, in the early days: "Contact with Russian amateurs was very much the 'hello-goodbye' rubber stamp type."
83. John Clarricoats, *World at their Fingertips* (London: RSGB, 1967), pp. 106–7.
84. Lloyd Mallan, *Russia and the Big Red Lie* (Greenwich, Conn.: Fawcett Press, 1959), pp. 30–35.
85. Draft Minutes, Working Group on Satellite Launching (note 33).
86. The BBC Monitoring Service recorded the TASS bulletin as having been first broadcast in the English-language service of Radio Moscow at 01.22 MSK, and only later repeated in Russian for the domestic audience, at an unspecified time. The reference to an earlier newsflash is based on a strong oral tradition amongst Russian radio amateurs, who usually ascribe it to the famous announcer Yuri Levitan, but this has been impossible to verify – L. Labutin, "For the Fortieth Anniversary of Sputnik 1", 1997, e-mailed MS, no bibliography supplied.
87. See for example: Harford, *Korolev* (note 48), p. 129.
88. A recently published report, written by Korolev and his colleagues in October 1957, suggests that the first of these conjectures can now be eliminated: S.P. Korolev, V.P. Glushko, N.A. Pilyugin, and V.P. Barmin, "Basic Data on the Flight of the Carrier Rocket for the first Artificial Earth Satellite on 4 October 1957", 1 November 1957, in B.V. Raushenbach et al. (eds) *S.P. Korolev and His Work* (Moscow: Russian Academy of Sciences, 1998), 239–242.
89. Boris Stepanov (UW3AX) – personal communication; the author does not find this idea convincing.
90. Svoren, "First Days" (note 60).
91. A special laboratory was established at the Institute of Radio Technology to process the hundreds of kilometres of magnetic tape that were received from radio amateurs all over the world: Grigoryeva, "Radio Amateurs" (note 53).
92. "What Sort of Programme Are The Radio Amateurs Following?" *Radio* (1958), # 6, June, 4–5, on p. 5.
93. Captions to photographs of eight individual prize-winners, from Yerevan, Leningrad, Riga, Tbilisi, Omsk, Ufa, Gorkiy, and Barnaul – *Radio*, January 1958, inside covers.
94. A.L. Mintz, "Strengthening the Link between Scientists and Radio Amateurs" *Radio* (1959), # 7, July.
95. Svoren, "First Days" (note 60).

96. Shakhovskoy, "Amateur Radio Observations" (note 60). For the request, see *ibid.*, p. 847, footnote.
97. V.I. Krassovskiy, "Soviet Exploration of the Ionosphere with the Help of Rockets and Earth Satellites", paper to the Fifth CSAGI Assembly, Moscow, July-August 1958, in *Annals*, (1960), *XII*, pt. II, 529-46, on p. 530.
98. W.H. Pickering, with J.H. Wilson, "Countdown to Space Exploration: a Memoir of the Jet Propulsion Laboratory, 1944-1958", in R.C. Hall (ed.), *Essays on the History of Rocketry and Astronautics* (Washington: NASA, 1977), 2, 385-421, on p. 418.
99. *Report on the U.S. Program for the International Geophysical Year, IGY General Report # 21*, (Washington: U.S. National Academy of Sciences - National Research Council, 1965), p. 588.
100. M.P. Southworth, "Night-Time Equatorial Propagation at 50 Mc/s - First Results from an IGY Amateur Observing Program" *Journal of Geophysical Research* (1960), 65, # 2, 601-7; a shortened version also appeared in the U.S. National Academy of Sciences *IGY Bulletin* (1960), # 40, October, pp. 9-14.
101. J. Heywood, "Concerning the Use of Amateur Radio Observations on Artificial Earth Satellites", paper to the Fifth CSAGI Assembly, Moscow, July-August 1958, in *Annals*, (1960), *XII*, pt. II, pp. 912-16.
102. Bulkeley, "The Sputniks and the IGY" (note 32).
103. Bulkeley, *Sputniks Crisis* (note 38), ch. 11.
104. Bulkeley, *Sputniks Crisis* (note 38), p. 149.