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THE SOVIET SPACE YEAR OF 1984

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The Soviet Union continued its high rate of satellite launches during 1984. While many existing programmes continued as expected, there were some unusual space missions that are still not fully analysed. This paper reviews Soviet activity during 1984, looking at both the manned and unmanned programmes.

1. INTRODUCTION

During 1984, the Soviet Union made 97 launches that attained Earth orbit; two subsequently attained Earth escape trajectories. The launches represented 75% of all the national launches (129) for the year.

Following the set-backs in 1983, the manned programme regained its confidence with the crew launched on Soyuz T-10 establishing a new manned duration record, remaining in orbit for eight months. Additionally, there were two shorter "visiting" manned missions while the T-10 crew were aboard Salyut 7: the first was an eight-day Soviet-Indian mission, and the second was a 12-day flight with two men and a woman.

Of the unmanned programmes, most publicity was given to the launches of the two Vega probes that will fly past Venus before approaching Comet Halley in 1986. Less publicised was the re-introduction of the nuclear-powered Rorsat after the failure of Cosmos 1402 in late 1982.

While none of the expected new launch vehicles made a flight in 1984, the Proton booster was publically revealed with the Vega 1 launch, after 19 years of use. A new upper stage combination for the Proton was flown as Cosmos 1603 (the mission still requires a definitive analysis).

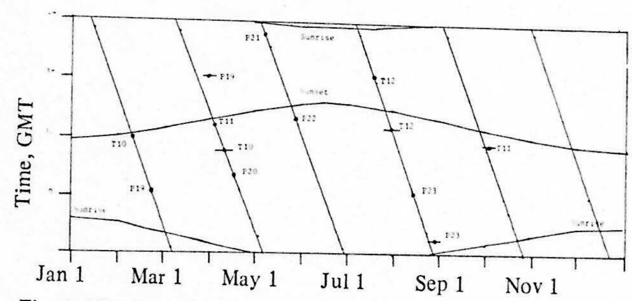

Fig. 1. The launch and landing windows for Salyut 7 during 1984. The sloping lines show the nominal launch times for each day, with the times of sunrise and sunset over the landing site indicated (converted to GMT). Soyuz T missions are shown as "T" followed by the mission number, while Progress missions are shown as "P" followed by the mission number. Launches are shown as a dot, while landings (or de-orbits for Progress) are shown as a dot with a bar. The de-orbit times were not announced for Progresses 20, 21 and 22.

2. THE MANNED PROGRAMME

The Salyut 7 space station continued in use throughout 1984, playing host to three manned visits. To support the resident crew launched in February, five unmanned Progress re-supply craft were launched and at the end of the year a further test flight of the Soviet mini-shuttle test vehicle took place. There was no flight of the heavy Cosmos module similar to Cosmos 1443 of 1983.

Table 1 provides data for all the launches in the manned programme, while Fig. 1 shows the launch and landing activity for the year. The figure can be compared with that previously published as a "forward look" to 1984 [1].

2.1 Independent Flight of Salyut 7

After the Soyuz T-9 crew left Salyut in November 1983, the station was allowed to decay until January 1984. Table 2 is a summary of all the manoeuvres completed either by Salyut 7 itself or by spacecraft while docked with it. It can be seen that in the middle of January and at the beginning of February some orbital adjustments were made, the resulting low orbit in February being indicative of a forthcoming three-man launch to Salyut.

2.2 Launch of Soyuz T-10

The launch of a new manned expedition to Salyut 7 came on 8 February, and three men were placed in orbit. As had been anticipated the "core" two-man crew consisted of L. D. Kizim and V. A. Solovyov – they had been brought together as back-up cosmonauts for the Franco-Soviet T-6 mission, and had acted as back-ups for Soyuz T-10-1, the launch abort of September 1983. They were joined by O. Y. Atkov, a graduate of the Moscow Sechneov Number 1 Medical Institute in 1973. Atkov acted as a research student, specialising in cardiology, and his inclusion in the T-10 crew suggested that a long flight could be expected. He became a cosmonaut in 1977, the first man to fly from a new group of scientist-cosmonauts.

This was to be the first serious attempt to extend the manned duration record beyond six months, established in 1979 by the Soyuz 32 (launched) crew. In 1980 the Soyuz 35 (launched) crew flew for 185 days, but since the duration did not exceed the existing record (185 days) by 10% the new duration was not officially recognised as a record. In 1982 the T-5 (launched) crew remained in orbit for 211 days, establishing a new record but, according to Lebedev who flew the mission, it should have been six months long, but was extended as the planned recovery date drew close.

Soyuz T-10 with its crew approached Salyut 7 at the front docking port the day after launch, and the spacecraft successfully docked at 14.43 GMT (all times in GMT). The crew immediately began to reactivate Salyut and expressed their thanks to the T-9 crew for leaving it in such good condition.

2.3 Flight of Progress 19

The first unmanned re-supply mission to the T-10 crew was launched on 21 February and the Progress craft docked at

TABLE 1. Launches in the Manned Space Programme.

Launch Date and Time	Mission	Launch Vehicle	Mass kg	Epoch 1984	Perigee km	Apogee km	Lifetime d.hh.mm	Comments
Fe[illegible].12.07	Soyuz-T 10	SL-4	6,850 ?	Feb 8.56	198	219	62.22.43	Craft Cdr - L D Kizim
				Feb 8.80	227	270	236.22.50	Crew FE - V A Solovyov
				Feb 10.12	289	296		RE - O Y Atkov
Feb 21.06.46	Progress 19	SL-4	7,015 ?	Feb 21.34	186	245	40.11.32	Unmanned cargo ferry
				Feb 21.70	205	325		
				Feb 22.52	272	327		
				Feb 24.02	281	286		
				Apr 1.14	190	204		
Apr 3.13.09	Soyuz-T 11	SL-4	6,850 ?	Apr 3.60	195	224	181.21.48	Craft Cdr - Y V Malyshev
				Apr 3.91	227	270	7.21.41	Crew FE - G M Strekalov
				Apr 4.10	222	271		RE - R Sharma
				Apr 4.78	287	298		
Apr 15.08.13	Progress 20	SL-4	7,015 ?	Apr 15.40	186	260	22	Unmanned cargo ferry
				Apr 15.83	183	246		
				Apr 16.63	232	276		
				Apr 16.88	237	270		
				Apr 18.25	278	290		
				May 7.04	187	312		
				May 7.29	186	304		
May 7.22.47	Progress 21	SL-4	7,015 ?	May 8.13	190	243	19	Unmanned cargo ferry
				May 8.31	243	277		
				May 10.24	276	317		
May 28.14.13	Progress 22	SL-4	7,015 ?	May 28.65	188	244	48	Unmanned cargo ferry
				May 28.89	204	296		
				May 29.89	290	330		
				May 30.96	334	358		
Jul 17.17.41	Soyuz-T 12	SL-4	6,950 ?	Jul 17.79	198	225	11.19.14	Cdr - V A Dzhanibekov
				Jul 17.85	196	232		FE - S Y Savitskaya
				Jul 18.04	276	309		RE - I P Volk
				Jul 18.54	271	304		
				Jul 19.23	334	354		
Aug 14.06.28	Progress 23	SL-4	7,015 ?	Aug 14.32	186	250	13.19.00	Unmanned cargo ferry
				Aug 15.01	187	329		
				Aug 15.57	292	361		
				(Aug 15.25)	341	369		Salyut's pre-manoeuvre orbit
Dec 19.03.53	Cosmos 1614	SL-8	1,250 ?		180 ?	220 ?	1.35 ?	Fourth mini-shuttle test-bed mission

This is a full list of all the launches in the manned programme for 1984. Cosmos 1614 was launched from Kapustin Yar at 50.7°, while all the other flights were from Tyuratam at 51.6°. The launch times for the Soyuz-T and Progress missions were announced; that for Cosmos 1614 is estimated and should be accurate to ± 3 minutes (as should all subsequent calculated launch times). The durations are launch to landing for manned flights and Cosmos 1614 (estimated duration) and launch to retrofire for Progress (numbers 20, 21 and 22 and no de-orbit time announced). The orbital data refer to manouevres performed before docking with (and, in severe cases, undocking from) Salyut 7. The first orbit docked combination is included in the listings. In the case of Progress 23 there was a manoeuvre of the docked combination almost immediately after docking and therefore the orbit in parentheses is the final one for Salyut before docking. Spacecraft manoeuvres after docking with Salyut are listed in Table 2. The orbital altitudes in this and subsequent Tables are obtained from the Two-Line Orbital Elements, issued by NASA's Goddard Space Flight Center, and assume a spherical Earth with a radius of 6,378 km.

TABLE 2. Manoeuvres Involving Salyut 7.

Pre-Manoeuvre Orbit Epoch	Perigee km	Apogee km	Post-Manoeuvre Orbit Epoch	Perigee km	Apogee km	Manoeuvring Craft	Salyut Port Front	Rear
			Jan 1.15	314	327			
Jan 11.24	312	325	Jan 13.26	298	323	Salyut 7		
Feb 1.27	293	317	Feb 1.83	292	303	Salyut 7		
Feb 25.40	282	283	Feb 25.46	280	309	Progress 19	Soyuz-T 10	Progress 19
Feb 26.28	279	308	Feb 26.53	306	311	Progress 19	Soyuz-T 10	Progress 19
Mar 30.20	291	292	Mar 30.83	289	303	Progress 19	Soyuz-T 10	Progress 19
Apr 18.25	278	290	Apr 18.57	285	326	Progress 20	Soyuz-T 11	Progress 20
May 20.35	272	312	May 23.23	296	347	Progress 21	Soyuz-T 11	Progress 21
May 25.25	295	347	May 25.76	334	359	Progress 21	Soyuz-T 11	Progress 21
Jul 10.17	328	354	Jul 11.00	307	354	Progress 22	Soyuz-T 11	Progress 22
Jul 14.22	307	353	Jul 14.92	334	355	Progress 22	Soyuz-T 11	Progress 22
Jul 28.31	333	353	Jul 28.88	342	372	Soyuz-T 12	Soyuz-T 11	Soyuz-T 12
Aug 15.25	341	369	Aug 17.95	351	375	(Progress 23)	Soyuz-T 11	Progress 23
Aug 25.25	351	376	Aug 25.37	373	375	(Progress 23)	Soyuz-T 11	Progress 23
Sep 25.28	370	374	Sep 27.96	370	375	(Soyuz-T 11)	Soyuz-T 11	
Dec 30.89	365	370						

All the manoeuvres in excess of 1 m/s implied by the Two-Lines are listed. In some cases the Soviets did not announce the manoeuvres and the probable manoeuvring craft is shown in Parentheses.

the rear port on 23 February at 08.21. One of the first tasks of Progress was to boost the complex into a higher orbit, since the Salyut propulsion system had suffered a fuel leak in 1983 while a fuel transfer was being made from Progress 17 and was therefore considered to be unsafe for manoeuvring. It was possible to by-pass the faulty connections to allow Progress to refuel Salyut, allowing the complex to be rotated as experiments require.

The work of Progress 19 was completed after about five weeks, and on 31 March at 08.40 the ferry undocked. Retrofire took place on 1 April at 18.18 over 51.1° N, 22.2° E, and the spacecraft was destroyed over the Pacific Ocean.

2.4 Soyuz T-11: An Indian in Orbit

As part of the programme to fly international crews on Salyut visiting missions, a flight involving an Indian cosmonaut was scheduled for 1984. In 1983 the crews were announced as: Prime crew; Y. V. Malyshev, N. N. Rukavishnikov and R. Sharma. Back-up crew; A. N. Berezovoi, G. M. Grechko and R. Malhotra. However, owing to medical problems, Rukavishnikov was taken off the prime crew and his place taken by G. M. Strekalov, who was being quickly re-cycled after being involved in the T-10-1 launch failure.

Soyuz T-11 with Malyshev, Strekalov and Sharma was launched on 3 April and successfully docked at the rear port on 4 April at 14.31. For the first time, the Soviets had six men on a space station and since the American Shuttle 41C mission was in progress during part of the Soviet-Indian mission, there was a record 11 men in orbit at once.

The T-10 and 11 crews undertook joint work, concentrating on medical tests and the photography of the Indian sub-continent. Some light relief was provided, with Sharma's experiments with yoga.

A further Soyuz T launch was not planned for some months, so a spacecraft switch was completed by the cosmonauts. On 11 April at 07.33 Malyshev, Strekalov and Sharma undocked from Salyut in T-10 and returned to Earth, leaving their newer craft for the resident Salyut crew. Landing came at 10.50, 46 km east of Arkelyk (50.2° N, 66.4° E).

With the recovery, the international component of the manned Soviet programme was closed for the time being; for the first time since 1976 there were no "guest" cosmonauts in training.

2.5 Three Progresses and Five EVAs

Following the return of Soyuz T-10, the Salyut crew once more began to work alone. To allow the continued flights of Progress cargo ferry craft, T-11 had to be switched from the rear port to that at the front. On 13 April the Salyut crew entered the Soyuz T and at 10.27 undocked from Salyut. The station rotated through 180° and the Soyuz redocked. The crew went back aboard to prepare for the next stage in their mission.

On 15 April Progress 20 was launched and docked with Salyut on 17 April at 09.22. In retrospect, it would seem that Progress 20 carried the major supplies for the planned spacewalks.

The first EVA began on 23 April at 04.31, when Kizim and Solovyov ventured into open space, while Atkov remained in the pressurised work compartment during this and all future EVA work. The EVA cosmonauts removed a folded ladder from the transfer module and extended it along the side of Salyut. Containers were also taken outside but no other work was done – this was merely for preparation for future EVAs. The men re-entered Salyut after 4h 15m [2].

Only three days later, Kizim and Solovyov were outside again, the second EVA having begun at 02.40. They moved to the engine bay at the rear and removed a protective cover near a "reserve conduit." A new valve was installed and the conduit was blown through to test its air-tightness. The protective cover was replaced, and the cosmonauts returned after about five hours in open space [3].

The high level of work continued when, on 29 April at 01.35, Kizim and Solovyov again went outside to return to the engine bay. They installed a new conduit, which was tested for air-tightness, and returned inside after 2h 45m [4].

The fourth EVA to repair the engine system began on 3 May at 23.15, when the cosmonauts installed a second new conduit and checked its integrity. Again the EVA time was 2h 45m, but the Soviets announced that at this point the total EVA time was 14h 45m; this allows the duration of the second EVA to be confirmed as exactly 5 hours [5].

After supporting all this work, on 6 May at 17.46, Progress 20 was undocked and de-orbited at an unspecified time the following day.

Progress 21 was launched on 7 May and docked at the rear on 10 May at 00.10. It was possibly on this craft that added solar cell units were carried into orbit, although these could have been aboard Cosmos 1443 in 1983, which had taken the cells into orbit used by the T-9 crew in November.

On 18 May at 17.52, the fifth EVA began for Kizim and Solovyov, this time to add the new solar panels to one of the three "wings" that Salyut carried at launch. The unit upon which the cosmonauts worked has not been announced, but television pictures of the T-12 EVA suggested that they were added to the solar panel on the same side as the EVA hatch. On T-9 the new panels were added to the upright solar cells (Kizim and Solovyov performed the ground simulations of this assembly work for the T-9 crew). The cosmonauts remained outside for 3h 05m, and in this time they attached two new cell units [6] – the T-9 crew assembled only one panel during each of their two EVAs the previous November.

The solar cells carried by Salyut at launch had a total area of 60 m^2, and each of the new sections added 4.6 m^2. When Kizim and Solovyov had assembled the first section and attached it to the main panel, Atkov rotated it to allow the second section to be added.

After all this activity, no more EVAs were planned for the short-term. Progress 21 undocked on 26 May at 09.41 and was de-orbited at an unspecified time the same day.

Progress 22 was launched on 28 May and docked with Salyut at the rear port on 30 May at 15.47. The cargo ferry carried more fuel for Salyut and extra scientific apparatus. After the equipment had been transferred and the suitable amount of rubbish placed aboard Progress, it undocked on 15 July at 13.36 and was de-orbited at an unspecified time the same day. Once Progress was out of the way and in preparation for a new visiting crew, Salyut performed an orbital correction, as if to prove that the repair work completed by Kizim and Solovyov had been successful.

2.6 Soyuz T-12: Savitskaya's Second Flight

It was widely expected that one of the visiting missions to Salyut 7 during 1984 would involve a woman cosmonaut – possibly "Irena," the back-up from T-7 in 1982 – who would perform an EVA. American Shuttle missions in 1984 would call for their first spacewalk by a woman and a woman making her second orbital flight.

After Progress 22 was de-orbited, the path was clear for another spacecraft to be launched to dock at the back of Salyut. For a standard eight-day mission, the nominal landing opportunity opened at the end of July, so a launch could be expected about 22 July. It was therefore a surprise when Soyuz T-12 was launched on 17 July. Moreover, at that time Salyut was in a high orbit suggesting a two-man launch, but the new craft carried three. In command was V. A. Dzhanibekov, the first Soviet to make four orbital flights, and he was joined by S. Y. Savitskaya (who had been the second woman in space) and new cosmonaut I. P. Volk. Volk was an experienced civilian test pilot, having flown the TU-144 supersonic aircraft; he joined the cosmonaut group in 1978. When Savitskaya had taken an examination at test pilot's school, Volk had acted as one of her examiners. Soyuz docked at the back of Salyut on 18 July at 19.17.

Early into the flight, the Soviets made it clear that this was a new visiting crew, rather than a resident crew to whom Salyut would be handed over and that, because of their workload, the mission would last longer than the standard visiting missions. No clues were given for the forthcoming plans.

On 25 July at 14.55 the EVA hatch opened for the sixth time in 1984; Dzhanibekov and Savitskaya were undertaking an EVA, the first involving a woman. Using an electron beam device, Savitskaya completed a series of welding tests, with the result being taken back inside for subsequent return to Earth. The EVA lasted for a total of 3h 35m [7].

Part of the work undertaken by the T-12 crew would not become clear until after the visiting mission ended (see Section 2.7).

A further surprise was in store. Soyuz T-11 had been in orbit for almost four months, equal to its nominal lifetime (although T-9 was in orbit for 149 days and the Soviets indicated that a Soyuz T could fly for up to six months), and therefore it was expected that a further spacecraft switch-around would take place. But when the Dzhanibekov crew returned to Earth they brought back their T-12 craft. Undocking was on 29 July and landing came later that day at 12.55 some 140 km SE of Dzhezkazgan, near 47.0° N, 69.0° E. Possibly the Soviets wished to prove that Soyuz T could survive for at least six months in space.

2.7 A Final EVA and Progress 23

With the return of T-12, it was thought that the T-10 (launched) crew would coast towards an October recovery with a low-key two months in space, possibly with a further Progress supply mission. Such expectations were to be quickly dashed.

As part of their mission, the T-12 crew had to train the resident Salyut cosmonauts to perform a further adjustment to the Salyut propulsion system, and the training would be put to work with a further EVA. On 8 August at 08.46 the hatch opened again and Kizim and Solovov crawled into space. They made their way to the rear and removed part of the protective cover to allow the closing off of a pipe that was part of the fuel system. Before they returned, a section of a solar panel was cut off for return to Earth and analysis. The EVA was said to have lasted about five hours and the crew's total EVA time was now 22h 50m [8].

On 14 August Progress 23 was launched on the final resupply mission for this crew, docking with the rear port on 16 August at 08.11. This was to be a short mission, with an undocking on 26 August at 16.13 and de-orbit two days later at 01.28 over 33.1° N, 32.2° E (the Soviets were once more announcing the Progress de-orbit times).

2.8 Return of Soyuz T-11

The mission continued with no further spectacular events, and it was expected that the mission would end in the first days of October. On 1 October the Soviets announced that a recovery would be made the following day and that their space tracking fleet would be returning home. On 2 October, Kizim, Solovyov and Atkov finished deactivating Salyut and then entered Soyuz T-11. The craft undocked from Salyut at about 08.40 (the actual time was not announced) and

TABLE 3. Launches in the Non-Cosmos Unmanned Programme.

Launch Date and Time	Launch Site	Launch Vehicle	Payload	Incl o	Period min	Perigee km	Apogee km	Mass kg	Comments
Feb 15.08.46	Tt	SL-12B	Raduga 14	1.2	1,435.9	35,754	35,813	1,940 ?	Statsionar-2 (85°E)
Mar 16.13.59	Tt	SL-12B	Ekran 12	0.1	1,435.9	35,774	35,791	1,970 ?	Statsionar-T (99°E)
Mar 16.23.32	Pl	SL- 6	Molniya-1 60	62.9	734.9	623	40,572	1,550 ?	Replaced Molniya-1 51
			Then	62.9	718.4	621	39,766		
Apr 22.04.19	Tt	SL-12B	Gorizont 9	1.5	1,436.0	35,743	35,827	2,120 ?	Statsionar-5 (53°E)
Jun 22.00.22	Tt	SL-12B	Raduga 15	1.2	1,435.8	35,753	35,809	1,940 ?	Statsionar-15 (130°E)
Jul 5.03.38	Pl	SL-14	Meteor-2 11	82.5	104.1	943	961	1,500 ?	Meteorological
Aug 1.21.36	Tt	SL-12B	Gorizont 10	1.4	1,436.1	35,721	35,851	2,120 ?	Statsionar-13 (80°E)
Aug 10.00.04	Pl	SL- 6	Molniya-1 61	62.9	735.7	418	40,816	1,550 ?	Replaced Molniya-1 53
			Perturbed to	62.8	735.3	496	40,722		
Aug 24.08.27	Pl	SL- 6	Molniya-1 62	62.8	737.3	462	40,850	1,550 ?	Replaced Molniya-1 54
			Then	62.9	717.8	459	39,895		
Aug 24.19.49	Tt	SL-12B	Ekran 13	0.5	1,436.0	35,761	35,807	1,970 ?	Statsionar-T (99°E)
Dec 14.22.12	Pl	SL- 6	Molniya-1 63	62.9	737.0	452	40,847	1,550 ?	Replaced Molniya-1 55
			Then	62.8	717.8	453	39,904		
Dec 15.09.16	Tt	SL-12	VEGA 1		Heliocentric Orbit			5,050 ?	To intercept Venus and Comet Halley
Dec 21.09.14	Tt	SL-12	VEGA 2		Heliocentric Orbit			5,050 ?	To intercept Venus and Comet Halley

All the launch times are estimated. In the cases of the Molniya 1 and 3 satellites the pre- and post-stabilisation orbits are quoted. There is some doubt whether the object currently listed as Molniya 1-61 is actually this satellite. The launch sites are identified as Tt: Tyuratam and Pl: Plesetsk.

landed at 10.57, about 160 km E of Dzhezkazgan (47.8° N, 69.8° E). Their record-breaking mission had lasted for 236d 22h 50m.

While the cosmonauts were recovering, the Soviets were explaining the significance of the mission. At its most simple level it had proved that men could spend eight months in space and safely return to Earth after suitable training in orbit. However, it was still uncertain how long man could remain in orbit and still came back safely. The main problem is the reduction in the body's bone marrow; some authorities suggest that after a year in space the effects cannot be reversed. To explain the duration of the mission, the Soviets said that it was long enough for a flight to Mars. This was taken in some quarters as an indication that the Soviets are planning a manned Mars mission but there is no other evidence.

2.9 Cosmos 1614: A Spaceplane Test

It has been reported that the Soviet Union is planning the introduction of two manned shuttle vehicles during the 1980's [9]. In the next year or two, it is suggested that a mini-shuttle launched on a "throw-away" booster will be introduced, this being used to ferry men and supplies to and from a space station. Later in the decade, a larger heavy lift shuttle can be expected, and this will be at least in the same class as the American series.

In support of the spaceplane programme, three sub-scale shuttles were launched during 1982 and 1983 and recovered at sea. The first two landed in the Indian Ocean (Cosmos 1374 and Cosmos 1445), while the third landed in the Black Sea (Cosmos 1517). The intervals between the launches had been 285 days or so, and it was half-expected that a fourth flight could have come in early October 1984. This failed to materialise, but on 19 December Cosmos 1614 was launched from Kapustin Yar on a mission identical with that of Cosmos 1517. Splashdown in the Black Sea was about 95 minutes after launch, and the launch announcement said that the planned research programme had been completed. A few days after the flight, a Soviet source confirmed that Cosmos 1614 had been a test of a reusable spacecraft, but indicated that the Soviets still had not decided whether to go ahead with a shuttle like the American vehicle [10].

Cosmos 1614 itself was not tracked in orbit, and the orbit quoted in Table 1 is based upon that for the earlier flights. Two-Line Orbital Elements were issued for the rocket body (1984-126B) and two fragments which remained in orbit (1984-126C and D), the data being:

1984-126B, 50.7°, 88.5 min, 176-223 km
1984-126C, 50.7°, 88.3 min, 183-199 km
1984-126D, 50.7°, 88.3 min, 183-200 km

Presumably, Cosmos 1614 was the same vehicle that had flown at least one of the previous three missions, although it is not known for certain how many different re-entry bodies have been used in the programme.

2.10 The "Bios" Experiments

On 21 May, Radio Moscow's science reporter Boris Belitsky described a recent experiment [11]. Two "researchers" named Nikolai Burgeyev and Sergei Alekseyev spent five months in a hermetically-sealed laboratory, cut off from the outside world. The volume of the living and work quarters was 300 m^3. All that the researchers received from the outside world were power and television programmes; all the food was grown inside the laboratory. Upon completion, the experiment was hailed as a step towards interplanetary missions.

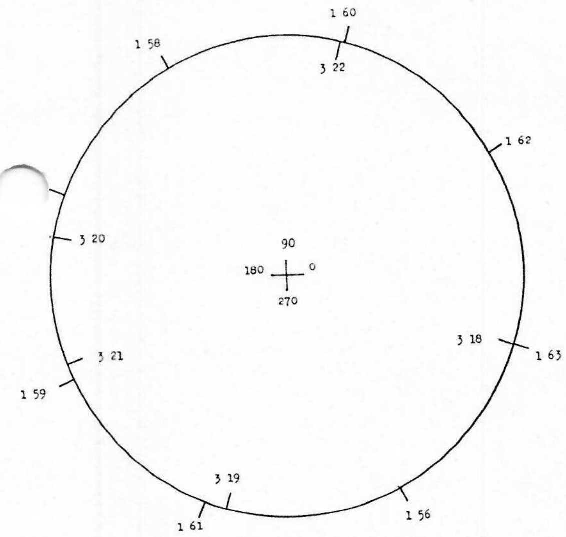

Fig. 2. The right ascensions (RAs) of the ascending nodes (degrees) for the "Orbita" network satellites, Molniya 1 and Molniya 3. Like Figs. 5, 6 and 7, the nodes are calculated to epoch 1985 Jan. 1.0. The latest satellite is shown for each location. For clarity, Molniya 1 flights are shown outside the circle and Molniya 3 flights inside.

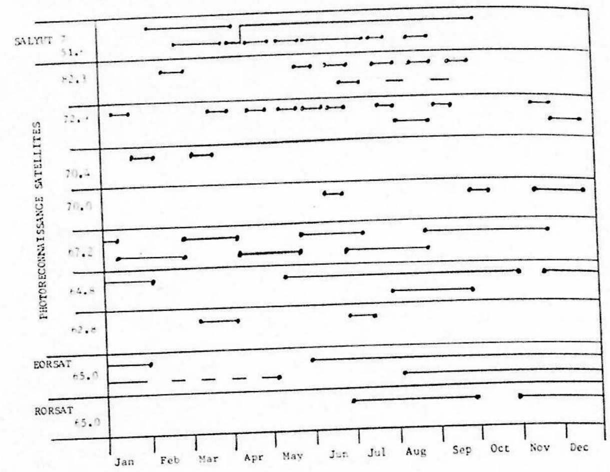

Fig. 4. All the satellites which generally have operating lifetimes of less than a year are shown, although individual satellites cannot be named on this scale. A continuous line shows the period for which the satellite operated in each case. A dotted line is shown for part of the Cosmos 1507 representation, since it is not certain when this Eorsat ended its operating life. For Salyut 7, the upper lines represent occupations of the front docking port and the lower line occupations of the rear docking port.

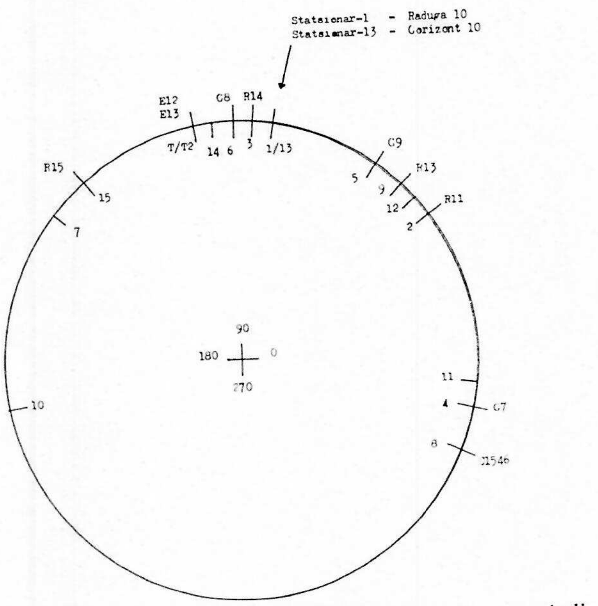

Fig. 3. The Statsionar system. The Statsionar locations are indicated inside the circle over the appropriate longitude, and the latest flight to each location (degrees East) is shown outside the circle. Flights are identified as: "R": Raduga, "E": Ekran, "G": Gorizont and "C": Cosmos. The same position has been registered for Statsionars 1 and 13, and it is assumed that Raduga and Gorizont relate to these respective locations.

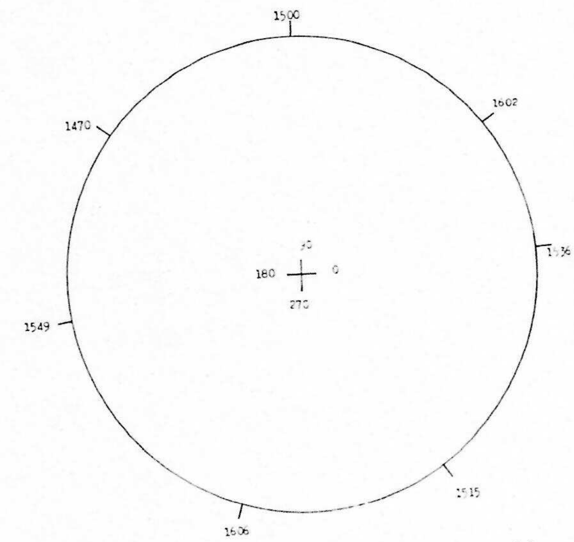

Fig. 5. The RAs of ascending nodes for the presumed larger ferret satellites launched at 82.6°. Cosmos 1500 and 1602 have been returning oceanographic data for civilian use, and it is therefore uncertain whether they should, strictly speaking, be included in this grouping.

3. NON-COSMOS UNMANNED MISSIONS

Of the many unmanned missions launched to Earth orbit or beyond, only 13 were not given a Cosmos name. Ten were communications satellites, one was a meteorological satellite and the remaining two were the Vega interplanetary missions.

3.1 Molniya Communications Satellites

There were four launches in the Molniya programme during 1984, and all were in the Molniya 1 series. The Molniya 3 series had not ended, since those satellites operating at the end of 1983 were still on station at the end of 1984. Presumably, none required replacement. (A new Molniya 3 satellite was launched in January 1985).

Molniya 1-61 seems to have failed to stabilise its orbit initially, but this was attained after some weeks of careful manoeuvring. One piece from Molniya 1-63, 1984-124C, seems to have disintegrated in orbit because extra fragments were tracked in orbits similar to this object.

Figure 2 illustrates the right ascensions of the ascending nodes of the Molniya 1 and Molniya 3 satellites still operating at the end of 1984.

3.2 Statsionar Communications Satellites

Six launches took place in the Statsionar programme in 1984, together with two Cosmos satellites, on related mis-

TABLE 4. Soviet Geostationary Satellite Location.

Name	Location °E	Frequencies GHz	Name	Location °E	Frequencies GHz
GALS 1 (8)	335	7	Statsionar 1	80	4 6
GALS 2 (9)	45	7	Statsionar 2	35	4 6
GALS 3 (3)	85	7	Statsionar 3	85	4 6
GALS 4 (10)	190	7	Statsionar 4	346	4 6
GALS 5 (15)	130	7 8	Statsionar 5	53	4 6
GALS 6 (2)	35	7 8	Statsionar 6	90	4 6
GOMSS	76	1 3	Statsionar 7	140	4 6
Loutch 1 (4)	346	11 14	Statsionar 8	335	4 6
Loutch 2 (5)	53	11 14	Statsionar 9	45	4 6
Loutch 3 (6)	90	11 14	Statsionar 10	190	4 6
Loutch 4 (7)	140	11 14	Statsionar 11	351.5	4 6
Loutch P1 (8)	335	11 14	Statsionar 12	40	4 6
Loutch P2 (9)	45	11 14	Statsionar 13	80	4 6
Loutch P3 (3)	85	11 14	Statsionar 14	95	4 6
Loutch P4 (10)	190	11 14	Statsionar 15	130	4 6
Potok 1 (~4)	345.6	4	Volna 1 (8)	335	1 3
Potok 2 (1, 13)	80	4	Volna 2 (4)	346	3
Potok 3 (~10)	192	4	Volna 3 (9)	45	1 3
SDRN-E	200	11 14 15	Volna 4 (5)	53	3
SDRN-W (~4)	344	11 14 15	Volna 5 (3)	85	1 3
SDRN-B (~14)	95	11 14 15	Volna 6 (7)	140	3
Statsionar-T	99	1 6	Volna 7 (10)	190	1 3
Statsionar-T2	99	1 6	Volna 8 (6)	90	3

A list of all the geostationary locations registered by the Soviet Union, excluding positions registered for the non-geostationary Prognoz missions. In a number of cases, the positions registered for Statsionar missions also relate to other missions. In such other missions, the corresponding Statsionar number is shown in parentheses after the position designator. GOMSS is the Soviet location for a geostationary meteorological satellite.

sions (discussed in Section 6.7).

Raduga 14 replaced or complemented Raduga 12 and Raduga 15 was the first dedicated Statsionar 15 mission. Gorizont 9 probably replaced Gorizont 5, while Gorizont 10 was the first "Gorizont" to be stationed at the Statsionar 113 location, previously used by Raduga satellites. Raduga 10 was the last "Raduga" at that location, although some Cosmos test missions have been located there. Perhaps the Raduga missions were Statsionar 1 and Gorizont is to be Statsionar 13? Ekrans 12 and 13 were Statsionar T missions, although there seems to be no way to distinguish these from Statsionar T2 missions.

Table 4 is a summary of all the geostationary satellite systems registered by the Soviet Union, but this does not imply that separate satellites will be used for each system. For example, the Statsionar 8 location has also been registered for GALS-1, Loutch P1 and Volna 1, and probably a single satellite will carry the transponders for the various systems.

Figure 3 shows the Statsionar locations, together with the latest flight to be stationed at each in use at the end of 1984.

The Soviets have discussed a test-bed antenna that was being used with the Loutch 1 geostationary satellite, deployed over the Atlantic Ocean [12]. This would have been included on the Gorizont 7 satellite, deployed over the Statsionar 4 location in the summer of 1983.

3.3 The Meteor Programme

There was a single launch in the Meteor programme during 1984: Meteor 2-11 in July. Like Meteor 2-8, launched in 1982, the new satellite used the SL-14 booster; most probably the original SL-3 usually used for such launches has now been retired.

When the launch was announced of Meteor 2-11, the Soviets indicated that the satellite carried equipment for obtaining global images of cloud cover and for observing the Earth's surface in the visible and infrared bands. Data could be either transmitted "live" or stored on board for subsequent dumping. The orbital plane of Meteor 2-11 was 50° to the west of that for 2-8.

3.4 The Astron Observatory

In March 1983 the Soviets launched a large astronomical observatory based upon the Venera spacecraft "bus" and named it Astron. The satellite, in an eccentric Earth orbit, continued operating through 1984.

On 26 March more than 200 communications sessions had been held with the vehicle. Before this, the satellite had registered the disappearance of a radiation source in Hercules. Astron had also been used to observe the large discharges of matter from stars of various spectral classes. Results indicated that the star 73 Draconis had hundreds of times more uranium than expected, while Kappa Cancri had hundreds of time more tungsten and lead than anticipated. The observatory had also been used to observe bursts of radiation that appear twice a year, each of 10 seconds duration, resulting from nuclear explosions on the surface of a neutron star. These latter observations were so regular that it had been thought that they may have been from an extraterrestrial civilisation, until the natural explanation was discovered [13, 13, 15].

3.5 The Venera Programme

In October 1980 two Venera radar mappers entered orbit about Venus and although their prime missions were completed at the end of the year, they continued to operate throughout 1984. In addition, at the end of 1984 two more probes were launched to Venus, but these were different from earlier missions in that, following Venus fly-by, the main spacecraft "buses" were to be re-targeted to the first encounter with Comet Halley.

3.5.1 Venera 15 and Venera 16

Veneras 15 and 16 are the orbiters that arrived at Venus in October 1983. At the beginning of 1984 67 communications sessions had been held with the craft, and each day more than one million square km of the Venerian surface had been mapped. According to Soviet scientists, mountain ranges reaching up to 10 km have been mapped, as well as planes of lava and both volcanic and impact craters [16].

Each day strips of the Venerian surface 9,000 km long and 150 km wide were mapped and the data immediately returned to Earth [17]. The results allowed the first maps of the northern polar region to be prepared. The craft observed temperature differences of 100° C on the planet's surface. By mid-January a total of 20 million km² had been mapped from orbit [18].

The resolution of the radar system was about 1.5 km and the images showed circular structures 350 km in diameter thought to be similar to the lunar "seas" [19]. At the end of June a total of 220 communications sessions had been completed and 100 million km² of the planet had been mapped [20].

3.5.2 Vega 1 and Vega 2

In December 1984 the Soviet Union launched its two craft in the Vega programme, which would involve an initial fly-by of Venus – with atmospheric probes being separated – and then an approach to Comet Halley in 1986. The launch of Vega 1 on 15 December was notable in that for the first

TABLE 5. *Cosmos Photoreconnaissance Satellites: Third Generation.*

Launch Date and Time	Cosmos	Launch Site	Launch Vehicle	Incl °	Orbit 1 km	Orbit 2 km	Orbit 3 km	Orbit 4 km	Final Orbit km	Lifetime Days
1. LOW RESOLUTION SATELLITES.										
13.10.25	1597 (P)	Pl	SL-14	82.3	211-244				206-234	12.868
MEDIUM RESOLUTION SATELLITES.										
Jan 11.12.21	1530	Pl	SL- 4	72.9	194-365		356-415		357-415	13.774
Jan 26.08.51	1533	Tt	SL-14	70.4	224-356		346-415		348-414	13.893
Mar 7.08.01	1542	Tt	SL-14	70.3	226-349		348-414		349-414	13.892
Mar 21.11.06	1545	Pl	SL- 4	72.8	196-370		356-415	236-397	235-397	14.767
Apr 19.11.41	1549	Pl	SL- 4	72.9	197-367		355-414		359-413	13.773
Jun 1.13.51	1568	Pl	SL- 4	72.8	196-368		356-397		357-415	12.815
Jun 11.08.41	1571	Tt	SL- 4	70.0	210-376		349-413		349-414	14.854
Jun 24.12.40	1583	Pl	SL- 4	72.9	197-362	197-367	357-415		358-415	14.802
Aug 6.14.01	1587	Pl	SL- 4	72.9	197-368		356-415		357-415	24.663
Sep 27.08.11	1600	Tt	SL- 4	70.0	204-379	363-418	350-416		349-417	13.899
Nov 14.12.20	1609	Pl	SL- 4	72.9	198-357	196-367	356-415		358-414	13.773
Nov 29.14.01	1613	Pl	SL- 4	72.8	197-356	195-358	356-416		357-415	13.773
3. HIGH RESOLUTION SATELLITES.										
Feb 16.08.15	1537 (P)	Pl	SL-14	82.3	208-288	259-273	259-274		257-272	13.861
May 11.13.00	1551	Pl	SL- 4	72.9	196-279	212-324	212-258	211-263	209-258	11.791
May 22.08.35	1557 (P)	Pl	SL-14	82.3	211-247	210-241			206-234	12.864
Jun 15.08.20	1572 (P)	Pl	SL-14	82.3	215-268	267-273	259-273	261-274	260-273	13.847
Jun 19.10.55	1573	Pl	SL- 4	72.9	197-290	199-299	228-304	229-312		
					231-309	227-261			226-260	8.832
Jun 22.07.40	1575 (P)	Pl	SL-14	82.3	216-267	261-275	257-273	260-281	259-279	14.865
Jun 29.15.00	1580	Pl	SL- 4	62.8	243-346	238-346	227-271		225-266	13.618
Jul 19.08.30	1582 (P)	Pl	SL-14	82.3	213-279	253-279	262-279		262-277	13.867
27.09.00	1584 (P)	Pl	SL-14	82.3	182-248	181-240	180-365		179-352	13.860
Aug 16.09.50	1590 (P)	Pl	SL-14	82.4	211-266	261-270	262-279		261-277	13.865
Aug 30.10.11	1591 (P)	Pl	SL-14	82.3	209-272	185-343	260-271	267-273	266-272	13.865
Sep 4.10.21	1592	Pl	SL- 4	72.9	196-355	211-386	225-290	226-334	225-335	13.795

All the post-manoeuvre orbits for Third Generation satellites are listed. For the medium resolution satellites, the operational orbit is shown under "Orbit 3," whether or not an "Orbit 2" is listed. If the calculated launch times are correct, the implied lifetimes (to 0.001 days) should be correct to ±2 minutes. No Third Generation satellite was in orbit on 1 January 1984 and they had all been recovered before 31 December 1984.

time a complete picture of the SL-12 Proton booster was released (see Section 8); further pictures were released for the Vega 2 launch on 21 December.

Vega 1 is due to arrive at Venus on 14 June 1985 and then fly-by Halley on 6 March 1986; the corresponding approach dates for Vega 2 are 18 June 1985 and 9 March 1986. At Venus, a lander complex will be separated and within each spherical heat shield will be two vehicles. The surface experiments are carried in a standard Venera lander module, with a total mass of about 700 kg, while special atmospheric experiments will be carried for the first time in an aerostat probe. The aerostat is designed to float in the atmosphere for at least 24 hours returning data. It will be deployed on the night side of Venus, but the atmospheric circulation will carry it towards the morning hemisphere. The mass of the aerostat is 115 kg, while 85 kg of scientific instrumentation is carried on the Vega fly-by probe and 117 kg on the lander [21].

THE COSMOS PROGRAMME

The majority of launches in the unmanned programme were under the Cosmos identity: during 1984 Cosmos numbers 1522 to 1615 were launched, made up of two triple payload launches, two octuplets and 72 single payloads.

The Cosmos is covered here under three headings: photoreconnaissance, non-recoverable and the unusual Cosmos 1603. Cosmos 1614, the spaceplane test, was considered in Section 2.9.

Figure 4 presents in graphical form the Cosmos satellites with limited lifetimes, as well as the man-related missions to Salyut 7. The majority of the satellites represented are from the photoreconnaissance programme, but also included are the Rorsats and Eorsats that operated during the year.

5. COSMOS PHOTORECONNAISSANCE SATELLITES

During 1984 there were 36 launches in the photoreconnaissance programme, thus confirming it as the largest single element of the Cosmos series. The launches can be classified as follows:

Third Generation (Low Resolution): 1 launch
Third Generation (Medium Resolution): 12 launches
Third Generation (High Resolution): 12 launches
Fourth Generation (Area Survey): 3 launches
Fourth Generation (Close-Look): 8 launches

This section reviews the satellites by generation and then by type within the generation.

The launch vehicles quoted in the Tables are derived from the analysis presented in the review of 1983 (see notes at the end).

5.1 Third Generation Satellites

The third generation is the oldest type to be operating and consists of three groups: the low resolution satellites perform no orbital manoeuvres, the medium resolution satellites manoeuvre to 360-415 km orbits and the high resolution satellites manoeuvre to a variety of lower orbits. Table 5 is a list of all the third generation satellites launched in 1984; none were in orbit at the beginning of the year and none were operating at the end.

5.1.1 Low Resolution Missions

Flights within the low resolution series are few and are thought to be for general mapping work. The only flight in 1984 was Cosmos 1597 at 82.3°, announced as working within the Priroda Earth resources programme.

5.1.2 Medium Resolution Missions

The medium resolution missions during 1984 can be classified by orbital inclination as:

70.0°: 2 missions
70.4°: 2 missions
72.9°: 8 missions

Previously, the medium resolution satellites were very predictable, the general variation being in the recovery – a day or two earlier or later than normal (which is 14 days). However, in 1984 there were some anomalous missions.

The first was Cosmos 1545. After launch on 21 March, it entered its operational 356-415 km orbit the following day. Normally, the satellite would have remained in this orbit (with only small orbital adjustments by a low-thrust engine) until recovery, but on this mission the orbit was reduced to 236-397 km on 2-3 April, with recovery on 5 April, one day later than usual.

Cosmos 1568 had a lifetime one day less than normal. With Cosmos 1571 and Cosmos 1583, the lifetimes were each one day longer than usual.

Perhaps the most radical change in the medium resolution missions came with Cosmos 1587, with Cosmos 1613 being a repeat mission. Cosmos 1587 was launched on 6 August, but no manoeuvre to the high orbit took place the following day. Natural decay continued until 18 August (195-358 km), when the satellite was manoeuvred to its standard 356-415 km orbit. This was maintained for its standard 13 days, after which recovery was made inside the Soviet Union, giving a lifetime of about 24.7 days. The flights could have been connected with a possible high resolution mission being undertaken on a medium resolution mission. Certainly, the manoeuvres to the operating orbits for Cosmos 1587 and 1613 were carefully chosen to allow the normal landing node to be attained after 13 days in the standard orbit; therefore they cannot be failures.

TABLE 6. Cosmos Photoreconnaissance Satellites: Fourth Generation.

Launch Date and Time	Cosmos	Launch Site	Launch Vehicle	Incl °	Altitudes km	Lifetime Days
1. AREA SURVEY SATELLITES.						
1983						
Dec 27.09.30	1516	Tt	SL-4	64.9	196-276 204-239	44
1984						
Mar 10.17.01	1543	Pl	SL-4	62.8	216-395 216-379	25
May 14.14.00	1552	Tt	SL-4	64.9	182-322 224-311 227-305	173
Nov 14.07.39	1608	Tt	SL-4	70.0	197-250 209-281 210-267	33
2. CLOSE LOOK SATELLITES.						
1983						
Nov 30.13.46	1511	Pl	SL-4	67.1	171-337 165-281	44
1984						
Jan 13.14.41	1532	Pl	SL-4	67.1	169-344 169-265	44
Feb 28.14.01	1539	Pl	SL-4	67.2	168-342 172-304	40
Apr 10.14.00	1548	Pl	SL-4	67.1	167-334 170-298	44
May 25.11.30	1558	Pl	SL-4	67.2	168-294 192-325	44
Jun 26.15.36	1576	Pl	SL-4	67.1	170-351 171-301	59
Jul 31.12.30	1585	Tt	SL-4	64.7	174-302 174-320	59
Sep 25.14.30	1599	Pl	SL-4	67.1	166-249 179-319 170-259	56
Nov 21.10.31	1611	Tt	SL-4	64.8	173-304	In Orbit

A complete list of the Fourth Generation photoreconnaissance satellites that operated during 1984. The initial and final orbits only are generally given because of the many manoeuvres usually performed on these flights. In some cases three orbits are given, the second indicating the operational orbit when it differed from the initial orbit. Lifetimes are to the nearest integer day, since the craft are probably de-orbited rather than being recovered at the end of their missions. Cosmos 1511 and 1516 were in orbit on 1 January 1984, and only Cosmos 1611 operated into 1985 (de-orbited on 11 January 1985, lifetime 51 days).

5.1.3 High Resolution Missions

There were essentially no elements in this programme. The number of flights by orbital inclination in 1984 were:

62.8°: 1
72.9°: 3
82.3°: 8

Perhaps the most interesting aspect occurred with Cosmos 1580, with a return to flights at 62.8°. This inclination was widely used during the 1970's, but has not been used since 1980 (Cosmos 1180). A fourth generation mission also flew at 62.8° in 1984 (Cosmos 1543).

5.2 Fourth Generation Satellites

At the beginning of 1984 there were two fourth generation satellites in orbit: Cosmos 1511 and 1516. The year saw 11 flights, of which one was in orbit at the end (Cosmos 1611).

The classification of the satellites presented here follows that introduced in the review of 1983, but it is not universal. Some call the close-look satellites Fourth Generation, while the area survey missions are classed as Fifth Generation.

TABLE 7. Non-Recoverable Cosmos Satellites.

Launch Site	Launch Vehicle	Launch Date and Time	Cosmos	Incl °	Period min	Perigee km	Apogee km	Notes
ELINT SATELLITES.								
KY	SL- 8	Jun 28.13.16	1578	50.7	104.4	295	1,641	-
Pl	SL- 8	Jan 26.12.02	1534	65.8	94.5	467	517	-
		Sep 27.09.32	1601	65.8	94.5	474	515	-
		Dec 20.13.02	1615	65.8	94.0	440	500	-
	SL-14	Feb 8.09.24	1536	82.5	97.7	634	666	-
		Mar 15.17.06	1544	82.5	97.7	634	664	-
		Sep 28.06.01	1602	82.5	97.7	633	667	-
		Oct 18.17.47	1606	82.5	97.7	631	665	-
NAVIGATION SATELLITES.								
Tt	SL-12B	May 19.13.42	1554-1556	64.8	681.5	19,162	19,389	C1554
		Sep 6.15.49	1593-1595	64.8	675.7	19,088	19,171	C1593
Pl	SL- 8	Jan 11.18.08	1531	82.9	105.0	982	1,010	R C1386
		Feb 2.17.39	1535	83.0	104.8	956	1,017	R C1428
		May 11.06.19	1550	83.0	105.0	975	1,012	R C1535
		May 17.14.44	1553	82.9	104.8	963	1,008	R C1383
		Jun 21.19.41	1574	83.0	104.9	969	1,008	R C1339
		Jun 27.05.00	1577	83.0	104.8	959	1,011	R C1464
		Sep 13.15.56	1598	82.9	105.0	970	1,016	R C1550
		Oct 12.14.44	1605	82.9	104.8	952	1,019	R C1459
		Nov 15.06.40	1610	83.0	104.9	968	1,013	R C1551
RADAR OCEAN SURVEILLANCE SATELLITES.								
Tt	SL-11	Jun 29.00.26	1579	65.0	89.6	250	264	Up to
			Then	65.1	103.9	903	987	27 Sep
		Oct 31.12.27	1607	65.0	89.6	250	264	-
ELINT OCEAN SURVEILLANCE SATELLITES.								
Tt	SL-11	May 30.18.45	1567	65.0	93.3	431	441	-
		Aug 7.22.51	1588	65.0	93.3	427	445	-
EARLY WARNING SATELLITES.								
Pl	SL- 6	Mar 6.17.13	1541	62.9	710.4	592	39,397	R C1278
			Then	63.0	717.6	606	39,742	
		Apr 4.01.42	1547	62.9	707.0	583	39,239	R C1382
			Then	62.9	717.6	609	39,738	
		Jun 6.15.35	1569	62.9	710.1	589	39.387	R C1518
			Then	63.0	717.8	606	39,749	
		Jul 3.21.22	1581	63.0	708.3	617	39.267	R C1317
			Then	63.0	717.6	634	39,712	
		Aug 2.08.41	1586	62.9	709.3	602	39,332	R C1456
			Then	63.0	717.6	608	39,737	
		Sep 7.19.15	1596	62.9	707.6	604	39,248	R C1348
			Then	62.9	717.8	631	39,724	
		Oct 4.19.51	1604	62.9	710.6	593	39,409	R C1367
			Then	62.9	717.1	610	39,714	
STORE-DUMP COMMUNICATIONS SATELLITES.								
Pl	SL- 8	Feb 21.15.39	1538	74.1	100.7	777	810	R C1420
		Jun 8.11.31	1570	74.1	100.9	790	810	R C1452
OCTUPLE PAYLOAD COMMUNICATIONS SATELLITES.								
Pl	SL- 8	Jan 5.20.09	1522-1529	74.0	115.5	1,461	1,494	C1522
		May 28.21.53	1559-1566	74.0	115.8	1,471	1,511	C1559
PROBABLE GEODETIC SATELLITES.								
Pl	SL-14	Aug 8.12.14	1589	82.6	115.9	1,491	1,501	-
		Nov 27.14.27	1612	82.6	98.4	135	1,230	Failure ?
GEOSTATIONARY SATELLITES.								
Tt	SL-12B	Mar 2.03.54	1540	1.4	1,435.7	35,730	35,828	80°E
		Mar 29.05.53	1546	1.2	1,436.8	35,781	35,820	338°E

A list of the non-recoverable Cosmos satellites (excluding Cosmos 1603) launched in 1984. Satellites are classified by mission and then orbital inclination. The "Notes" indicate the satellite for which the orbit is given for multiple payload missions, satellite replacement ("R C....") or for Cosmos 1579 the date to which the satellite operated. The sub-satellite locations at the end of 1984 are given for the two geostationary Cosmos missions. "KY" is the Kapustin Yar launch site.

5.2.1 *Area Survey Missions*

Cosmos 1516, in orbit at the beginning of 1984, was an area survey mission at 64.9°. There were three launches in the group during the year, one at each of the inclinations 62.8°, 64.9° and 70.0°.

Cosmos 1543 was the first photoreconnaissance mission at 62.8° since 1980; the reason for the re-introduction of this inclination is unclear. The classification of Cosmos 1543 as an area survey satellite is open to question, since its flight was somewhat unusual. After launch on 10 March, the initial orbit was 216-395 km. Although apogee decayed to 379 km during the satellite's lifetime, the perigee remained almost at its original altitude, as if small corrections were being made to maintain the altitude. However, no large manoeuvres were made until re-entry.

The satellite is classed as an area survey mission for two reasons:

1. The orbital altitudes are similar to those found on some area survey missions.
2. The lifetime of 25 days is longer than one would expect for a third generation mission (despite Cosmos 1587 and 1613).

Additionally, Cosmos 1543 came mid-way between two other area survey missions (Cosmos 1516 from 1983 and Cosmos 1552).

Cosmos 1552 was unusual in that the initial perigee of 182 km was more akin to a close look satellite, but three days after launch the perigee had been raised to 224 km – typical for an area survey satellite. The most notable feature was the lifetime of 173 days, nearly three times the previous duration record of a Soviet photoreconnaissance satellite.

The final area survey launch of 1984 was Cosmos 1608. After the long life of Cosmos 1552, it was surprising that Cosmos 1608 was recalled after only 33 days. This was the first fourth generation flight at 70.0° (although some flights had been made at 70.4°).

5.2.2 *Close Look Missions*

Cosmos 1511, in orbit at the end of 1983, was a close look satellite, and the only photoreconnaissance satellite in orbit at the end of 1984 was Cosmos 1611, a close look mission at 64.8°. During 1984 there were two launches at 64.8° and six launches at 67.2°.

The flights of Cosmos 1576, 1585 and 1599 were somewhat longer than usual for this type of mission, although by no means in the same class as Cosmos 1552.

It is interesting to note that during 1984 there was a close look photoreconnaissance satellite in orbit for almost every day, the first time that such coverage has been obtained.

A record in satellite coverage was set during 22-26 June when six photoreconnaissance were in orbit at once:

Cosmos 1552; 64.9°; 4G-AS
Cosmos 1558; 67.2°; 4G-CL
Cosmos 1571; 70.0°; 3G-MR
Cosmos 1572; 82.3°; 3G-HR
Cosmos 1573; 72.9°; 3G-HR
Cosmos 1575; 82.3°; 3G-HR

6. NON-RECOVERABLE COSMOS SATELLITES

The vast majority of Cosmos satellites within this classification falls into well-established groups, with only a few anomalies appearing. The most anomalous flight was Cosmos 1603, which is considered in Section 7.

6.1 Electronic Intelligence Satellites

There were eight launches during 1984 of the Cosmos satellites considered to be primarily electronic intelligence gatherers, this figure excluding the flights dedicated to ocean surveillance. Cosmos 1578 was a unique mission from

Kapustin Yar, the SL-8 booster never having flown with such a high apogee from that site before. It is possible that scientific experiments may be announced later, but here the flight is assumed to be of the Elint type.

Cosmos 1534 and 1601 were launched into standard orbits at 65.8°, but the orbit for Cosmos 1615 was more eccentric than normal for this inclination. These flights are generally considered to be radar calibration missions.

During 1984 there were no launches of the Elint satellites which had flown at 81.2° into 97-98 minute orbits. Their demise marks the retirement of the original Vostok SL-3 booster after continual use between 1959 and 1983. The replacement missions are probably the Cosmos flights at 82.6°.

There were four flights in the presumed Elint group at 82.6° during 1984. The missions might not be totally military, since some of the Cosmos flights have been identified by the Soviets as oceanographic research satellites, Cosmos 1602 being so identified in 1984. Figure 5 presents the ascending nodes of the satellites in the group launched in recent years. It is uncertain how many orbital planes should be considered for this system: the displayed spacings vary from 33° to 64°, the mean being 51°, which a seven satellite system would require. However, replacement missions are not easy to identify from orbital planes. The original 81.2° system consisted of six satellites separated by 60°.

The Soviets have described the work of Cosmos 1500, launched in 1983 and announced as oceanographic. The satellite uses sideways-looking radar to observe ice coverage in the Arctic and Antarctic and helps to co-ordinate ship movements at sea. The radar operates at a wavelength of 3 cm and obtains a ground resolution of 1.5-2 km. The satellite also carries a multi-channel low-resolution scanner (operating at 4 Hz and resolution is 1.5 km) and a multi-channel microwave radiometer (operating at 0.8, 1.35 and 8.5 cm) [22].

6.2 Navigation Satellites

Launches took place in the two programmes of navigation satellites during 1984: two flights were in the triple-payload Glonass system and nine were in the single-payload SL-8 series.

The Glonass launches were named Cosmos 1554-1556 and 1593-1595, placed in orbit using the Proton SL-12 derived booster. Cosmos 1554-1556 were co-planar with the previous launch, Cosmos 1519-1521, while Cosmos 1593-1595 were co-planar with the triplets Cosmos 1413-1415 and 1490-1492. Since the orbital planes are spaced 120° apart, there is still one potential orbital plane that is empty.

There seem to have been some problems in replacing satellites at 83° in the small navigation satellite programme. Cosmos 1386 was initially replaced by Cosmos 1513, but that seems to have failed quickly to be replaced with Cosmos 1610. Similarly, Cosmos 1428 was replaced initially by Cosmos 1535, but that failed to be replaced by Cosmos 1550. This latter satellite also seems to have failed and the last launch to the orbital plane was Cosmos 1598. Cosmos 1383 (given the Kospas-1 number in the international air-sea rescue system) was replaced by Cosmos 1553, which was not given a Kospas number. Cosmos 1339 was replaced by Cosmos 1574, which was identified as a Kospas satellite, but not given a Kospas number.

6.3 Early Warning Satellites

Seven of the nine early warning satellites were replaced in 1984, and since most appeared to be operating at the end of the year it is the nearest that the Soviets have come to a perfect 40° spacing in orbital planes for the system.

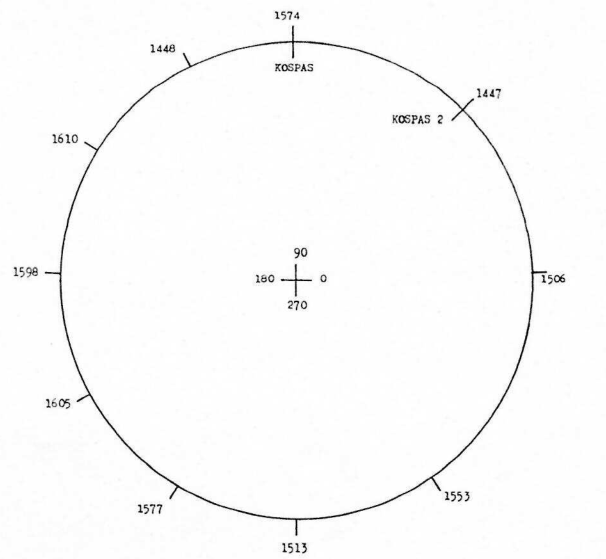

Fig. 6. The RAs of the ascending nodes for the navigation satellites launched into 83°, 105 minute orbit. Cosmos 1383 for which a Kospas number was given was replaced by Cosmos 1553 which had no Kospas number. Cosmos 1574 was said to have been part of the Kospas system, but no number was allocated to it. Not reflected in this figure are the presumed failures launched in 1984: Cosmos 1531 (replaced by Cosmos 1610), 1535 (replaced by 1550) and 1550 (replaced by 1598).

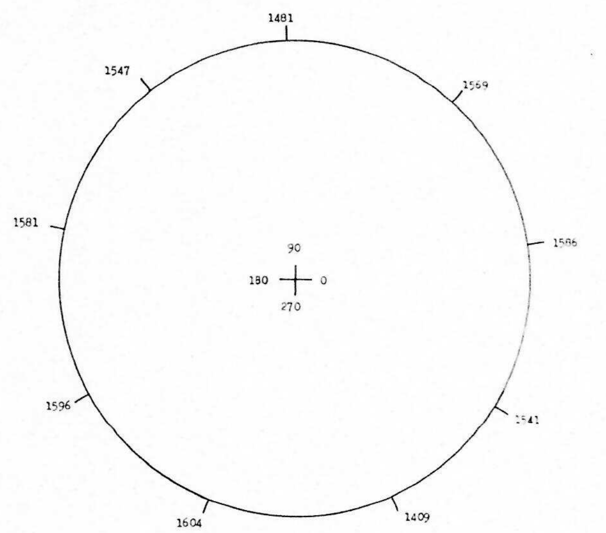

Fig. 7. The RAs of the ascending nodes for the Cosmos early warning satellites. It is uncertain whether the two earliest launches are still returning data.

6.4 Radar Ocean Surveillance Satellites

These are the Rorsats that gained publicity in 1978 and 1983 when Cosmos 954 and 1402 failed to manoeuvre their nuclear power source into high orbits at the end of operations. After the second failure, there was a break of 18 months before another mission was launched.

Cosmos 1579 was launched on 29 June and entered a standard 250-264 km orbit in which it operated for three months. On 27 September, on the orbit beginning at 09.53, the satellite split into three sections and one object manoeuvred to a high 903-987 km orbit, at which time a fourth object (the uranium power source) separated.

A month after Cosmos 1579 ended operations, Cosmos 1607 was launched into an identical initial orbit. It was still operating at the end of 1984.

6.5 Elint Ocean Surveillance Satellites

At the end of 1983 there were two Eorsats operating in orbit, Cosmos 1461 and 1507. These were phased out of operational use during the first half of 1984, and two new satellites were launched, Cosmos 1567 and 1588.

6.5.1 Cosmos 1461 and 1507

At the beginning of 1984 Cosmos 1461 and 1507 were operating together. Cosmos 1461 would cross the equator 47.2 minutes before Cosmos 1507, and the node would be 5.9° to the east as a result. Cosmos 1507 would repeat any Cosmos 1461 node 24h 8m later. This continued until 30 January, when Cosmos 1461 was manoeuvred from its 324-444 km operational orbit initially to 472-557 km and then to 589-870 km. The satellite ended operations, with slow orbital decay beginning.

It is difficult to assess from the orbital data when Cosmos 1507 ended operations. The operational orbit was generally maintained but perigee was slowly reduced and apogee increased by a few kilometres over the next few months. When Cosmos 1461 was manoeuvred, Cosmos 1507 was in a 429-443 km orbit, but when the next satellite in the series was launched on 30 May the orbit was 423-449 km, and Cosmos 1507 seems to have never operated with the new Cosmos 1567.

The orbital altitude of Cosmos 1507 continued to change slowly, with the maximum altitude being attained about 19 November (orbit 421-458 km). Presumably, the manoeuvres were being performed by the low-thrust engine normally used to maintain the orbital spacings of pairs of these satellites, but it was being burned to depletion. After about 19 November, natural decay seems to have set in and on 30 December the orbit had decayed to 418-454 km.

6.5.2 Cosmos 1567 and 1588

A new Eorsat was launched on 30 May and named Cosmos 1567. There was a delay of more than two months before a second satellite in the series was launched, Cosmos 1588. The orbits were chosen to allow Cosmos 1567 to cross the equator 46.8 minutes ahead of Cosmos 1588, and with its node 11.8° to the east. This spacing meant that any node of Cosmos 1567 would be repeated by Cosmos 1588 1d 22h 27m later. At the end of 1984 this orbital spacing was still being maintained.

6.6 Military Communications Satellites

Two groups of satellites are to be considered here: the singleton launches of store-dump satellites into 101 minute, 74° orbits and the octuple launches into 115 minute, 74° orbits.

Two satellites in the store-dump series were launched, replacing satellites launched in 1982 and 1983. At the end of 1984 the three satellites operating in the system were Cosmos 1503, 1570 and 1538 in order of increasing ascending node longitude.

The octuple launches were Cosmos 1522-1529 and 1559-1566. The first launch continued the recent policy of launches being at six-monthly intervals, but the second was only five months later. The flights continued in the same orbital planes used for all the earlier missions in this series.

6.7 Geostationary Satellites

There is not a proper Cosmos geostationary satellite programme as such, and any flights in this group would normally be classified as either test flights of Statsionar (or another system) improvements or possible failures.

Cosmos 1540 was launched on 2 March and allowed to drift to 80° E, where it remained until the end of the year. The flight was reminiscent of Cosmos 1366 launched in 1982, and it was said to be carrying "experimental equipment for relaying telegraph and telephone communications in the centimetre waveband."

At the end of March a second geostationary Cosmos was launched, number 1546. This time, however, no comment was made about the satellite carrying experimental equipment, and since the satellite was allowed to drift (according to the Two-Line Orbital Elements) for more than a month, it was initially thought to be a failed Statsionar. Towards the end of May the westwards drift stopped, and the satellite was stationed over 338° E. This does not exactly correspond to a registered Soviet geostationary location, but it is close to that registered for GALS 1, Loutch P1, Statsionar 8 and Volna 1. Possibly this was either a test flight or an intended Statsionar 8 which initially was thought to be failing and therefore given the "Cosmos" cover name. At the end of 1984 Cosmos 1546 was situated over 336° E.

6.8 Geodetic Satellites

Cosmos missions assigned to the geodetic category are generally those singleton launches that fly at more than 1,000 km altitude and have no other mission assigned. There was one such mission in 1984, together with another mission that may have been a failure.

Cosmos 1589 was launched into an orbital altitude slot similar to that previously assigned to geodetic missions: Cosmos 1312 (1981) and 1410 (1982) at 82.6° and 1510 (1983) at 73.6°.

The orbit attained by Cosmos 1612 is an anomaly, and the perigee of 135 km was so low that the orbit would not be maintained for many months. However, some clues about the flight may be obtained from the orbit:

1. The perigee of 135 km is akin to that sometimes found when the Two-Lines list the initial ascent orbit of a high circular payload orbit mission.
2. The perigee is in the nothern hemisphere, while most high circular orbit missions have a southern hemisphere perigee, indicating a manoeuvre to circularise the orbit.

It would thus appear that Cosmos 1612 should have entered a circular orbit more than 1,200 km high, but the final booster stage failed to circularise the orbit. The displayed apogee of 1,230 km is lower than for recent geodetic flight circular orbits, but possibly the initial orbital injection was also cut short, thus not allowing the full altitude to be attained.

7. COSMOS 1603: A UNIQUE MISSION

Cosmos 1603 is the most interesting manoeuvrable mission to have been launched by the Soviet Union for many years. The launch was made from Tyuratam on 28 September at

14.00, and a Proton variant was used. The launch announcement gave the orbit as follows: 71.2°; 102.2 min, 852-877 km. However, this hid the manoeuvres that had been made.

7.1 Objects from Cosmos 1603

Six objects were tracked in orbit; the initial orbital data from the Two-Lines are given in Table 8.

The number of objects suggests either a Statsionar or Glonass launch, neglecting the number of payloads carried by the latter:

1. Two-three objects in a low orbit at 51.6°.
2. Two objects in an intermediate transfer orbit (Statsionar: 47°; Glonass: 52°).
3. Payload(s) and apogee motor in final circular orbit.

Radar cross-section measurements of the non-payload objects in the low, intermediate and high orbits for Cosmos 1603 also strongly resembled those found on the Statsionar and Glonass missions in the corresponding orbits. The initial low orbit was more like that of a Statsionar (Ekran 13: 182-192 km) or a Glonass (Cosmos 1593-1595: 183-191 km) mission using the SL-12 derived Proton than a space station mission (Salyut 7: 212-227 km or Cosmos 1443: 193-231 km) using the SL-13 Proton.

7.2 Cosmos 1603 Manoeuvres

According to Refs. 23 and 24, the manoeuvres took place the day after launch. However, more detailed analysis showed this to be incorrect.

The final manoeuvre from 66.56° to 71.01° was the easiest to pin-point, and this was done by searching for the minimum distance between 1984-106A and 1984-106F in their different orbits. Calculations showed that the final manoeuvre had taken place 15h 42m 05s on the day of launch when the satellite was situated over 62.60° N, 40.05° E – almost over the Plesetsk launch site.

Taking the orbits into account, two further manoeuvres must have taken place, and these would have been on the first southbound equator crossing at 14h 32m 51s (51.61°, 188-193 km to 51.61°, 190-844 km) and the first equator crossing northbound at 15h 21m 05s (51.61°, 190-844 km to 66.56°, 835-854 km). The resulting orbital manoeuvres were therefore: Manoeuvre 1 182, Manoeuvre 2 1,918 and Manoeuvre 3 1,913 m/s. These do not directly tie-in with any mission. For Statsionar, two manoeuvres are made, 2,461 and 2.313 m/s (for Ekran 13), while those on the Glonass launches are 1,862 and 1,561 m/s (Cosmos 1593-1595). The significance of the second and third manoeuvres being almost identical is uncertain.

It is difficult to decide which objects made the manoeuvres. There could be a rocket body and fragment in the 66.56° orbit and a separate rocket body and fragment in the 71.01° orbit. If so, the rocket in the 66.56° orbit must be the first restartable rocket stage to be flown on a Proton. Alternatively, a single rocket could have performed all three manoeuvres, with the objects in the intermediate orbit being discarded equipment (possibly strap-on fuel tanks).

One clue may be the rapidity of the three manoeuvres, suggesting that non-storable propellants were being used. A further speculation is that the manoeuvres were performed using high-energy propellants. Possibly liquid oxygen and liquid hydrogen are being introduced to the programme at last.

The actual purpose of Cosmos 1603 is obscure at present,

TABLE 8. Orbital Data for Cosmos 1603.

Object	Epoch 1984	Incl °	Period min	Perigee km	Apegee km
1984-106A	Sep 29.63	71.01	101.98	850	856
1984-106P	Sep 30.20	71.00	101.98	849	855
1984-106C	Sep 30.19	66.56	101.59	814	854
1984-106D	Sep 28.94	51.61	88.30	188	193
1984-106E	Sep 28.94	51.60	88.22	180	193
1984-106F	Sep 29.49	66.56	101.82	835	854

The six objects that resulted from the Cosmos 1603 launch, together with their orbits. These data are the starting point for any analysis of this mysterious mission.

but probably it was the testing of a new restartable high energy propellant upper stage for the Proton. Such a stage is difficult to find an application for within the Proton programme at present, so possibly it is connected with the reported new generation of launch vehicles.

A subsequent report in Ref. 25 suggested that Cosmos 1603 was the first of a new generation of Elint satellite, launched by the SL-12 booster. The theory cannot be confirmed as of early 1985. If the SL-12 was used, then taking a Proton escape stage as 1,900 kg dry and having a specific impulse of 285 seconds, suggests that an initial mass in low parking orbit of 22.5 tonnes would place 10.6 tonnes into the 66.56° orbit. This would imply 4.5-5 tonnes into the 71° operational orbit. These calculations assume that the first two manoeuvres (182+1,918 = 2,100 m/s) were performed by the Proton escape stage – the first time that it would have re-ignited in orbit.

8. THE PROTON BOOSTER REVEALED

Of the five types of launch vehicle (Sapwood, Sandal, Skean, Proton and Scarp) used operationally in the Soviet space programme, the Proton has been the most mysterious. During its 19 years of use only a few glimpses have been given of its upper stages and the complete booster had not been depicted. With the launch of Vega 1 in December 1984 the first full views were released.

Previously, the pictures available of the booster on the pad were:

1. Salyut 1 launch, showing the booster at night. The payload and upper stages were shown and a glimpse of the tips of strap-on boosters [26].
2. Venera 9 and 10 on the pad, showing the upper part of the orbital stage, the escape stage and the payload shroud.

Stills from a film dealing with Venera 9 and 10 showing the upper part of the Proton booster have not been published. Additionally, there were pictures of Luna 17 being mated to its escape stage [27] and Venera 9/10 attached to the escape stages with the shrouds about to be mated (in the film commented upon above).

Figures 8a and 8b are based upon the Venera and Salyut pictures, with the limits of photographic coverage indicated. The pictures of the Vega launch allowed the lower part of the booster to be scaled for the first time from official Soviet data; this is reflected in Fig. 8c.

The launch pictures showed the vehicle initially on the pad, the lift-off and the pitch-over manoeuvre. Six strap-ons were clearly shown, and at pitch-over the central core was still awaiting ignition.

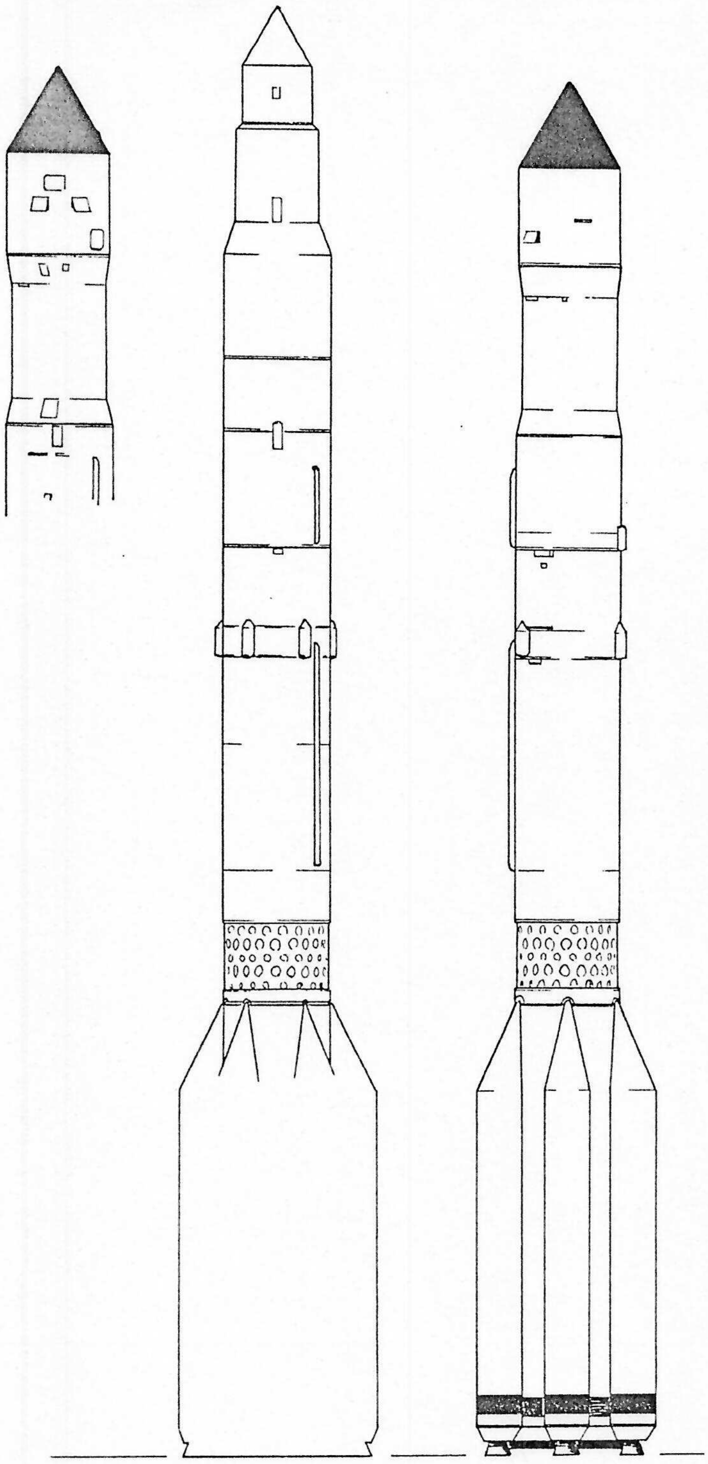

Fig. 8. Three drawings of the Proton booster. At left (a) is the upper part of the booster as shown in a film dealing with Veneras 9 and 10 (1975) and centre (b) shows the upper core, orbital stage and payload for the Salyut 1 booster, with the six strap-ons now extrapolated below the previous limit of vision (indicated by the dotted line). Right (c) shows the Vega 1 booster, with data incorporated from the illustrations at left.

Using the drawings in Fig. 8, approximate dimensions for the stages can be obtained; those are given in Table 9. Different missions will have different lengths, particularly for the SL-13. The boosters for Salyuts 1 and 4 were of the same length, while a question mark must be left for Salyuts 2, 3 and 5 which were of a different (unrevealed design). The different engine arrangements for Salyuts 6 and 7 would not require as long an engine shroud as Salyut 1. The major SL-12 variant would be for the Zond missions, which used a totally different payload shroud with a shroud tower.

TABLE 9.

Stage Name	SL-12 Venera	SL-13 Salyut 1
First stage strap-ons (6)		
Length (m)	18.5	18.5
Diameter (m)	1.7	1.7
Second stage central core		
Length (m)	31.4*	31.4*
Diameter (m)	4.2	4.2
Third (orbital) stage		
Length (m)	8.3	8.3
Diameter (m)	4.2	4.2
Fourth (escape) stage		
Length (m)	4.4	-
Diameter (m)	3.7	-
Salyut + Payload shroud		
Length (m)	-	16.2
Diameter (m)	-	4.15
Probe shroud		
Length (m)	4.4	-
Diameter (max) (m)	3.9	-
Total length (m)	52.4	55.2

* It is just possible that the core has two stages, in which case this length is for the combined stages.

Approximate dimensions of the Proton booster. Data for the Salyut 1 vehicle combine the launch picture for that mission and the Vega 1 launch pictures. Data for the Venera booster combine the pictures from 1975 with the Salyut 1 orbital stage and the Vega 1 pictures. The dimensions are still estimated, and assume that the core and orbital stage diameters are 4.15 m – the same as the maximum for Salyut.

9. THE FUTURE

The manned programme during 1985 will continue to revolve around the Salyut 7/Soyuz T/Progress combination, possibly with an added heavy Cosmos module docked with Salyut. The sub-scale spaceplane has now had four flights, and the time must be ripe for the full-scale vehicle to be flown. A series of new boosters are on the point of being introduced according to some reports [28]. The order of development could be:

1. Test flight of the new Intermediate booster, with a token payload.
2. Test flight of the spaceplane on the Intermediate booster.
3. Test flight of the Heavy Lift booster carrying ballast into orbit.

There are some reports that a manned flight of the spaceplane can be expected during 1985, but it is not known whether this will be preceeded by an unmanned test mission.

If these flights are successful, the Soviet Union will be ready to begin its next major space station project. According to Rukavishnikov, the next space station will be modular and it should be completed by 1990. It is possible that the Heavy Lift booster will be used to orbit a large core station, with further sections being carried into orbit by either the Proton or Intermediate boosters. The core launch could take place in late 1986 or 1987, at which time the spaceplane will replace Soyuz T and Progress at the routine manned

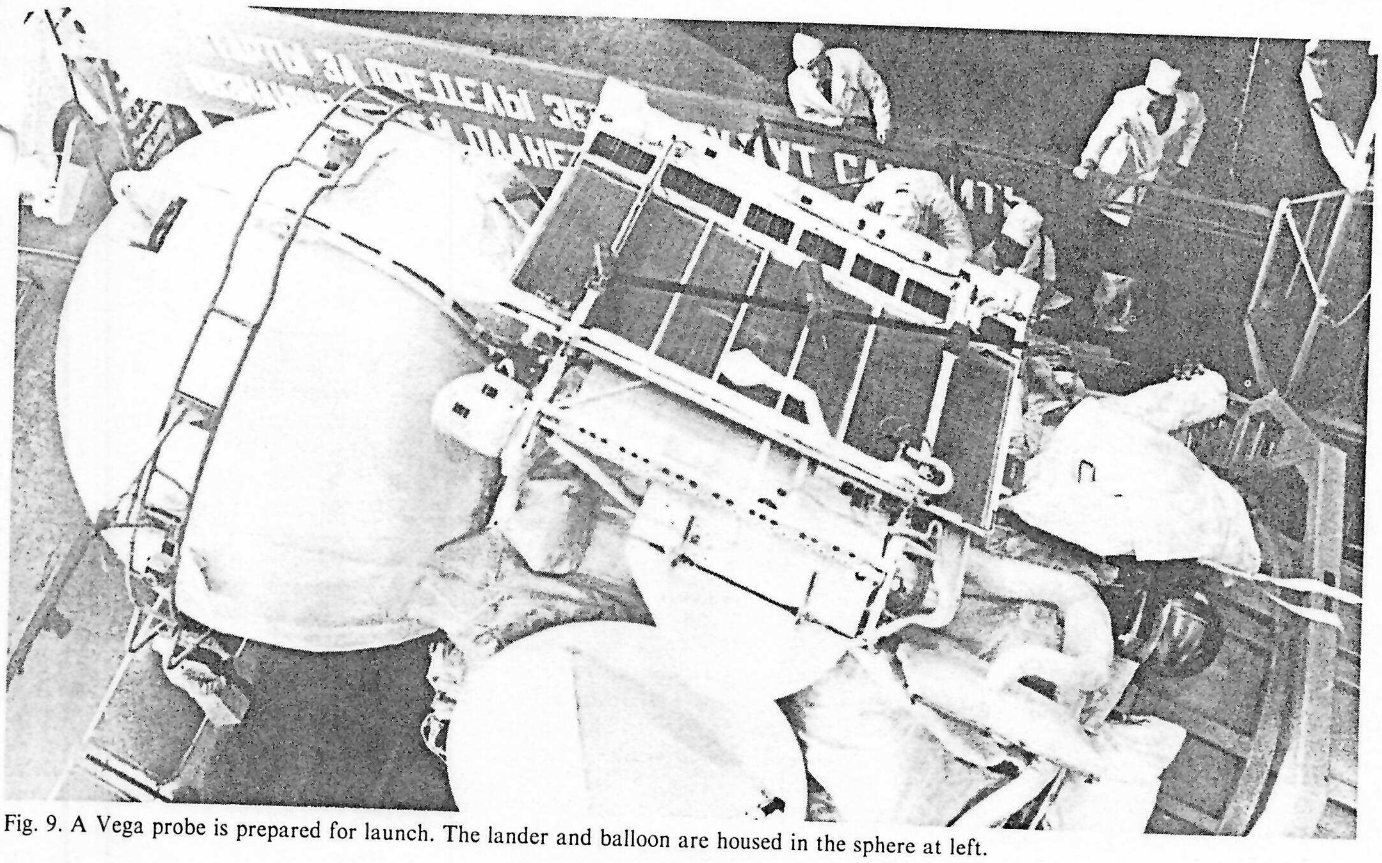

Fig. 9. A Vega probe is prepared for launch. The lander and balloon are housed in the sphere at left.

Novosti

and cargo ferry craft.

Following Vega, planetary interest will switch to Mars, with an orbiter mission being planned for launching during the May 1986 opportunity. This will be placed in an orbit such that Phobos and Deimos can also be investigated. If Mars probes are in transit in the summer of 1986, it remains to be seen whether the Soviets will also launch probes to Venus again when that opportunity next presents itself in August 1986. If they are launched, they will be arriving at Venus during the same time period as the Mars probes will be entering Martian orbit.

10. SUMMARY

The year of 1984 was particularly successful for the Soviets, with no major failures. The most surprising aspect was the non-appearance of the new family of launch vehicles, when flights by the Intermediate booster in summer and the Heavy Lift booster later in the year had been predicted.

One other event during 1984 does not fall within any of the above headings. On 8 December the death of Vladimir Nikolayevich Chelomei took place at the age of 71. Chelomei was a major designer within the Soviet space programme, his interests rivalling those of Korolyov. He is generally credited with being the chief designer of the Proton and Salyut. In his official obituary none of his space work was mentioned, although details might be revealed some months after his death, as happened with Korolyov.

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