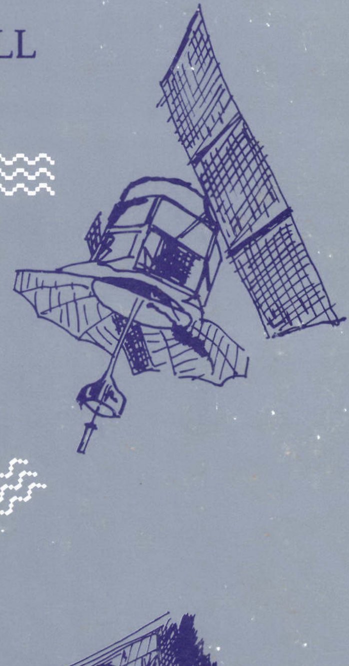
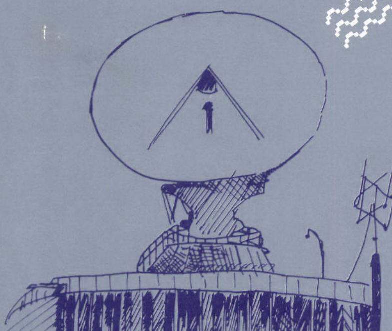
Canberra Papers on Strategy and Defence No. 53

SOVIET SIGNALS INTELLIGENCE (SIGINT): INTERCEPTING SATELLITE COMMUNICATIONS

DESMOND BALL





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Desmond Ball

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ABSTRACT

The Soviet Union maintains the largest signals intelligence (SIGINT) establishment in the world. It is capable of monitoring virtually the whole radio frequency spectrum on an almost global scale, with particular attention being accorded high frequency (HF) radio transmissions, terrestrial microwave telecommunications, and satellite communications (SATCOMs).

This monograph is concerned with Soviet capabilities and operations with respect to the intercepting of satellite communications (SATCOMs) - both commercial SATCOMs and defence and intelligence SATCOMs. The monograph describes the Soviet SATCOM SIGINT ground station capability and, most particularly, the major SIGINT facility at Lourdes in Cuba; the Soviet use of diplomatic establishments for intercepting SATCOMs; and Soviet ship-based SATCOM monitoring capabilities. The monograph concludes that the scope and sophistication of Soviet SATCOM SIGINT activities is inadequately appreciated by Western publics, and that greater public awareness of the vulnerability of SATCOMs is necessary for the implementation of effective and comprehensive communications security (COMSEC) policies and practices.

Professor Desmond Ball is Head of the Strategic and Defence Studies Centre at the Australian National University, Canberra. He has previously been a Lecturer in International Relations and Military Politics in the Department of Government at the University of Sydney, a Research Fellow in the Center for International Affairs at Harvard University, and a Research Associate at the International Institute for Strategic Studies in London. He is the author of more than 120 academic monographs and articles on nuclear strategy, nuclear weapons, national security decision-making, and Australia's defence policy. His major books include *Politics and Force Levels: The Strategic Missile Program of the Kennedy Administration* (University of California Press, Berkeley, 1980), *A Suitable Piece of Real Estate: American Installations in Australia* (Hale & Iremonger, Sydney, 1980), *A Base for Debate: The US Satellite Station at Nurrungar* (Allen & Unwin, Sydney, London and Boston, 1987), and *Pine Gap: Australia and the US Geostationary Signals Intelligence Satellite Program* (Allen & Unwin, Sydney, 1988). He is the co-author of *The Ties That Bind: Intelligence Cooperation Between the UKUSA Countries* (George Allen & Unwin, Sydney, London and Boston, 1985); co-author of *Defend the North: The Case for the Alice Springs-Darwin Railway* (George Allen & Unwin, Sydney 1985); co-author of *Crisis Stability and Nuclear War*, (American Academy of Arts and Sciences, and Cornell University Peace Studies Program, Ithaca, New York, 1987); editor of *The ANZAC Connection* (George Allen & Unwin, Sydney, 1985); editor of *Strategy & Defence: Australian Essays* (George Allen & Unwin, Sydney, 1982); editor of *The Future of Tactical Air Power in the Defence of Australia* (Australian National University, Canberra, 1976); editor of *Air Power: Global Developments and Australian Perspectives* (Pergamon-Brassey's Defence Publishers, Sydney, 1988); co-editor of *Problems of Mobilisation in the Defence of Australia* (Phoenix Defence Publications, Canberra, 1980); co-editor of *Strategic Nuclear Targeting* (Cornell University Press, Ithaca, New York, 1986); co-editor of *A Vulnerable Country? Civil Resources in the Defence of Australia* (Australian National University Press, Canberra, 1986); co-editor of *The Future of Arms Control* (Australian National University Press, Sydney, 1986); and co-editor of *Civil Defence and Australia's Security in the Nuclear Age* (Strategic and Defence Studies Centre, Australian National University, Canberra, and George Allen & Unwin Australia Ltd., Sydney, 1983).

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CHAPTER ONE

INTRODUCTION

The Soviet Union maintains the largest signals intelligence (SIGINT) establishment in the world.[1] It is capable of monitoring virtually the whole radio frequency spectrum on an almost global scale, with particular attention being accorded high frequency (HF) radio transmissions, terrestrial microwave telecommunications, and satellite communications (SATCOMs).

The Soviet Union and its Warsaw Pact allies have possessed the capability to monitor certain foreign satellite signals for more than two decades. A study by the US Naval Intelligence Support Center (NISC) for the US Defense Intelligence Agency (DIA), for example, has noted that this capability was evinced in 1967 with respect to signals transmitted by the NASA Applications Technology Satellite ATS-3 (1967-111A), launched on 5 November 1967 and positioned in

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1 This monograph is a product of a major research project by the author concerning Soviet signals intelligence (SIGINT) capabilities and operations. Other papers by the author on this subject include 'Soviet Signals Intelligence', in Bruce L. Gumble (ed.), *The International Countermeasures Handbook,* (EW Communications Inc., Palo Alto, California, 12th Edition, 1987), pp.73-79; 'Soviet Signals Intelligence (SIGINT): The Use of Diplomatic Establishments', in Floyd C. Painter (ed.), *The International Countermeasures Handbook,* (EW Communications, Inc., Palo Alto, California, 13th Edition, November 1987), pp.24-45; 'The Use of the Soviet Embassy in Canberra for Signals Intelligence (SIGINT) Collection', (Working Paper No.134, Strategic and Defence Studies Centre, Australian National University, Canberra, October 1987); 'Soviet Signals Intelligence: Vehicular Systems and Operations', *Intelligence and National Security,* (Vol.4, No.1), January 1989, pp.5-27; and *Soviet Signals Intelligence (SIGINT),* (Canberra Papers on Strategy and Defence No.47, Strategic and Defence Studies Centre, Australian National University, Canberra, 1989).

geostationary orbit above Brazil at 47° West longitude. According to the NISC/DIA study,

> Signals from the NASA equatorial synchronous satellite ATS-3 were recorded in 1967 by the Neustrelitz Observatory in the GDR [German Democratic Republic]. A yagi antenna was used to record signals from the satellite.... The transmitted signal was on 137.35 MHz, was vertically polarized, and emanated from a 16W transmitter on the ATS-3. Although there appears to be no military involvement, it demonstrates that U.S. spacecraft signals have been received and recorded in Communist countries.[2]

The Soviet Union now maintains a comprehensive capability for monitoring commercial communications satellite (COMSAT) transmissions worldwide. Its capabilities against US and other Western defence and intelligence satellite transmissions are somewhat less comprehensive, being dependent upon the size and shape of the 'spot' beams and the location of the Soviet interception facilities, but they are nevertheless very extensive and include coverage of some extremely important defence and intelligence satellite down-links.

There are several large COMSAT monitoring stations located within the Soviet Union itself, and others have been built in Eastern Europe, Cuba, and Vietnam. SATCOM monitoring facilities have also been established at numerous other Soviet SIGINT sites abroad, including the island of Socotra (People's Democratic Republic of Yemen or South Yemen)[3] and Dire-Dawa in Ethiopia.[4] Satellite signal collection systems have also been deployed on various Soviet ships. In addition, SATCOM antennas have been noted at more than a dozen

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2 US Naval Intelligence Support Center for the Defense Intelligence Agency (DIA), *Soviet Surveillance Capabilities Against US Naval Forces (SSC)*, (Defense Intelligence Agency, DST-12805-607-79, Washington, D.C., August 1979), p.IV-14.

3 'Behind the Coup in Aden', *Foreign Report*, (Published by the Economist Newspaper Limited, London), 5 July 1978, p.6.

4 Mark Urban, 'Soviet Intervention and the Ogaden Counter-offensive of 1978', *RUSI: Journal of the Royal United Services Institute for Defence Studies*, (Vol.128, No.2), June 1983, p.44.

Soviet diplomatic establishments abroad - including diplomatic sites in Tokyo, New Delhi (2), Kathmandu, London, Ankara, Milan, Paris, Amsterdam (2), Copenhagen, Gothenburg and Reykjavik. Other SATCOM monitoring systems are operated covertly. For example, the Soviets have conducted covert activities within Indonesia since the mid-1970s which have involved the utilisation of small (4-foot or 1.2 metre diameter) dish antennas for intercepting MARISAT/INMARSAT maritime satellite communications and US Navy Fleet Satellite Communications (FLTSATCOM) transmissions. Several Soviet diplomatic establishments in the United States - including the Soviet Military Office in Washington, D.C., the Soviet residential complex in Riverdale, New York, and the Soviet Consulate in San Francisco - are also believed to operate SATCOM systems for covert burst-transmission communications with Soviet STRELA store-dump communications satellites. These would also have some capability for monitoring other COMSATs.

CHAPTER TWO

THE ACQUISITION OF SIGNALS FROM COMSATs

Communications over satellite microwave systems are easily received by appropriate ground facilities. The ground areas where interception of satellite down-link radiation is possible ranges from several tens of thousands of square miles (for 'spot' beams) to the entire continental United States and adjacent oceanic and land area (for US domestic COMSATs) to nearly a full hemisphere (for the INTELSAT global beam).

The COMSAT microwave radio intercept equipment is also relatively easy to conceal. As a study by the MITRE Corporation has noted,

> The intercept equipment (including the antenna) could ... be 'hidden' by adding the intercept receiving equipment to legitimate antenna installations such as a subscriber-owned earth station for use with domestic satellites, a radio astronomy station or manufacturing plants which build and test radar and/or radio antennas. INTELSAT earth station equipment in one country could also be used to intercept traffic between two other countries.[1]

The principles involved in the interception of COMSAT signals have been described in detail in the MITRE Corporation study, which considered the INTELSAT IV system for exemplary purposes. The INTELSAT IV system employs frequency-division-multiple-access (FDMA) to achieve multi-carrier FDMA-FM transponder operations, and typifies the configuration of almost all US communications satellite systems and associated earth stations. Nearly all these systems, which typically require earth stations with gain-to-temperature (G/T) ratios in excess of 30 dB/°K, employ large steerable

---

1 C.W. Sanders, G.F. Sandy, J.F. Sawyer and A. Schneider, *Study of Vulnerability of Electronic Communication Systems to Electronic Interception*, (The Mitre Corporation, Metrek Division, MITRE Technical Report MTR-7439, January 1977), Volume 1, p.17.

antennas with diameters larger than 10 metres. However, much smaller antennas can be used in conjunction with sophisticated low-noise receiving equipments.[2]

The INTELSAT IV SATCOM system achieves a G/T of 40.7 dB/°K with a standard earth station of a 30 metre diameter steerable parabolic reflector antenna and a system noise temperature of about 78°K. However, the use of helium-cooled parametric amplifiers rather than the standard nitrogen-cooled parametric amplifier, together with the use of a threshold extension applique-unit, can increase the sensitivity of the receiving system to the point where the antenna diameter can be reduced to about 12 metres. Moreover, in the case of the global beam carriers which provide greater-than-standard traffic densities within standard bandwidths, the earth station antenna diameter can be further reduced to about 5 metres for satisfactory interception.[3]

The Soviet Union maintains three INTELSAT ground stations. The first, located in Moscow, became operational in 1974, and was designed to receive communications from the INTELSAT Atlantic Ocean Regional Primary Satellite (positioned at 335.5° East) as part of the Washington to Moscow Direct Communications Link (DCL) or Hotline.[4] The second station, which is located about 50 miles from Lvov, receives communications from the Indian Ocean Regional Primary Satellite (positioned at 60° E).[5] The third station is located at Dubna and also accesses the INTELSAT Atlantic Ocean Regional Primary Satellite.[6] The Dubna INTELSAT terminal (Dubna Terminal 2) has been described as follows:

---

2 *Ibid.*, Volume 1, pp.88-93, and Volume 2, pp.86-94.

3 *Ibid.*

4 John G. Whitman Jr. and William W. Davison, 'The New Hotline - Via Satellite Direct Communications Link', *Signal*, March 1974, pp.52-55.

5 Larry Van Horn, *Communications Satellites: A Monitor's Guide*, (Grove Enterprises, Brasstown, North Carolina, Third Edition, 1987), p.79; and 'Soviets and INTELSAT', *Signal*, November 1985, p.11.

6 *Ibid.*

> The Dubna Terminal 2 is a 105-foot (32 m) Intelsat Standard A earth station manufactured by the Nippon Electronics Corporation (NEC). This earth station interacts solely with the Intelsat Atlantic Ocean Primary Path satellite at 24.5 degrees west longitude. Dubna 2 directly can exchange television and telephone traffic with 15 other countries, including the United States, France and Great Britain. A terrestrial microwave link between Moscow and Dubna 2 can handle as many as 600 telephone circuits and six TV channels.[7]

The Dubna complex has several other terminals, including

> a fully steerable 23-foot (7m) antenna that can receive or transmit to any satellite in geostationary orbit visible from the site. This antenna can monitor satellites, or restore services if one of the other earth stations malfunctions.[8]

The Moscow, Lvov and Dubna stations, or similar others elsewhere in the Soviet Union, could easily be employed for the reception of all the traffic transmitted by INTELSAT satellites within the purview of the USSR. As the MITRE Corporation study noted,

> An INTELSAT earth station in one country could be employed to receive and demodulate r-f [radio frequency] carriers intended for INTELSAT subscribers of other countries. This capability is available since the low-noise parametric amplifiers employed for most subscriber earth stations are nearly always broad-band (500 MHz) and therefore are capable of receiving the entire frequency band allocated to space communications. Following amplification by the parametric amplifiers, the r-f

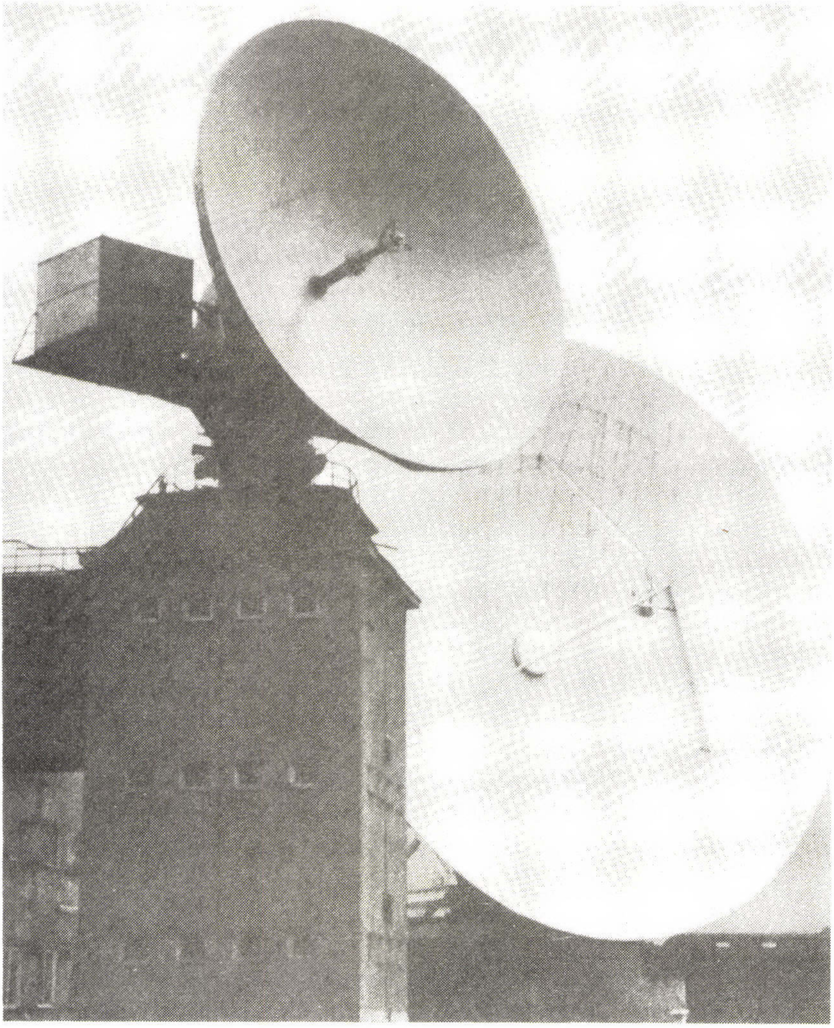
---

7 Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology,* (Howard W. Sams & Company, Indianapolis, Indiana, Second Edition, 1987), p.88.

8 *Ibid.*

FIGURE 1

INTELSAT TERMINAL, DUBNA, USSR



Source: Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, (Howard W. Sams & Company, Indianapolis, Indiana, Second Edition, 1987), p.87.

> carriers can be separated by filtering and the signals targeted for interception passed to a conventional microwave receiver for demodulation. Since the frequency assignments of subscribers are changed only infrequently, a crystal-controlled, fixed frequency microwave receiver would appear acceptable.... A selective level meter is employed to select and demodulate the single FDM telephone channel of interest.[9]

In the case of other COMSAT systems, such as the Hughes/Western Union WESTAR and the COMSAT Corporation COMSTAR, earth stations can equally easily be constructed or modified for the unauthorised reception of the communications traffic.

In addition to the INTELSAT ground stations at Moscow, Lvov and Dubna, there are several other satellite ground stations in the USSR which are designed for compatibility with various other international COMSAT systems. For example, 39 foot (12 metre) diameter ground terminals at Dubna, Lvov and Vladimir (approximately 175 km northeast of Moscow) are main control centres for the INTERSPUTNIK SATCOM system, which serves some six East European countries, Cuba, Mongolia, Afghanistan, Laos, Vietnam, South Yemen, North Korea, and Nicaragua.[10] Table 1 gives the locations of the INTERSPUTNIK ground stations in these countries. The Dubna, Lvov and Vladimir stations could easily be used to monitor the INTERSPUTNIK communications traffic. In addition, two INMARSAT ground stations at Odessa and Nakhodka are able to monitor INMARSAT international maritime satellite communications. The Soviet Union also maintains ground stations at Archangel and Vladivostok, with a control centre at Zhadanov Street in Moscow,

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9 Sanders, Sandy, Sawyer and Schneider, *Study of Vulnerability of Electronic Communication Systems to Electronic Interception*, Volume 1, pp.90, 93.

10 Harriet R. Shinn and R. Blake Swensrud, 'Intersputnik: Current Status and Future Options', *Signal*, July 1985, pp.75-78; and Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, pp.81-103.

TABLE 1
INTERSPUTNIK SATELLITE GROUND STATIONS

Country	Earth Station Location	Earth Station Operational Date
Bulgaria	Plan (near Sofia)	1979
Cuba	Jaruco	1974
Czechoslovakia	Near Prague	1974
East Germany	Furstenwalde	1976
Hungary	Taliandorogd	1978
Mongolia	Near Ulan Bator	1974
Nicaragua	-	1985
North Korea	-	1988
Poland	Kielce	1974
USSR	Dubna, Lvov, Vladimir	1974
Afghanistan	Shamshad	1982
Laos	-	1982
Vietnam	Hanoi, Ho Chi Minh	1980, 1985
Yemen	Near Aden	1986

Source: Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, p.83.

which serve as part of the international search and rescue satellite (SARSAT) system.[11]

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11 *Aviation Week and Space Technology*, 22 October 1984, p.15.

CHAPTER 3

THE INTERCEPTION OF DEFENCE AND INTELLIGENCE SATELLITE COMMUNICATIONS

The US Department of Defense and the US intelligence community, as well as Allied defence and intelligence agencies, make extensive use of commercial satellite communications networks. In the case of the US, almost 10 per cent of all channels carried on US commercial communications satellites (COMSATS) - more than 1,100 circuits - are dedicated to use by the Department of Defense. These circuits are leased from the satellite communications companies by the Defense Communications Agency (DCA) at an annual cost of more than $1.2 billion. The satellite systems most used are Western Union's WESTAR, GE Americom's SATCOM, COMSAT Corporation's COMSTAR, Telesat Canada's ANIK, and CONTEL's ASC-1. The DCA also leases a small number of circuits from INTELSAT. These commercial COMSAT circuits are used for operational communications, administrative and logistic communications, and communications with the US defence contracting community.

Until 1983, the critical US missile early warning system was dependent upon commercial communications satellite links for communication between the major early warning stations - such as the Ballistic Missile Early Warning System (BMEWs) station at Fylingdales in England, the Pave Paws submarine-launched ballistic missile (SLBM) early warning station at Otis Air National Guard Base, Massachusetts, and the Defense Support Program (DSP) satellite early warning system ground stations at Nurrungar in South Australia and Buckley Aerospace Data Facility outside Denver in Colorado - and the US Air Force Space Command/Peterson Air Force Base and North American Aerospace Defense Command (NORAD) complex at Colorado Springs, Colorado. In 1981, the US Air Force informed Congress of its requirement to install a Defense Satellite Communications System (DSCS) terminal at Peterson Air Force Base to receive early warning data from the various early warning stations for direct transmission to the NORAD facility in nearby Cheyenne Mountain. According to the Air Force justification for this terminal,

> [F]acilities are required to house a Defense Satellite Communications System (DSCS) ground terminal....
>
> This terminal will be the hub of a 14 terminal tactical warning and attack assessment network and will handle traffic in both voice and data modes to support NORAD.
>
> Currently, there is no DSCS terminal in the Colorado Springs area. Existing long distance communications links to NORAD are now routed through various circuits via leased terrestrial links and commercial satellite links.
>
> These circuits do not provide essential JRSC [Jam Resistant Secure Communications] features and do not provide an adequate, survivable and non-vulnerable communications network.
>
> This project will provide a new ground terminal to properly support NORAD with missile warning data through the DSCS.
>
> Without this project NORAD will be forced to rely on the vulnerable leased circuits for critical warning and assessment communications.[1]

In the case of the communications link between the DSP Overseas Ground Station (OGS) at Nurrungar, South Australia, and the Continental US (CONUS), until the installation of DSCS terminals at Buckley and Peterson in Colorado in 1983, the primary communications link involved the DSCS system from Nurrungar to either Wahiawa in Hawaii or Camp Roberts in California and thence to Colorado via submarine cable and the American Telephone and Telegraph (AT&T) transcontinental underground cable and microwave network - or the AT&T/COMSAT General Corporation INTELSAT SATCOM link. (Figures 2 and 3 show the DSP ground stations at Nurrungar and Buckley.) It remains the case that, as a back-

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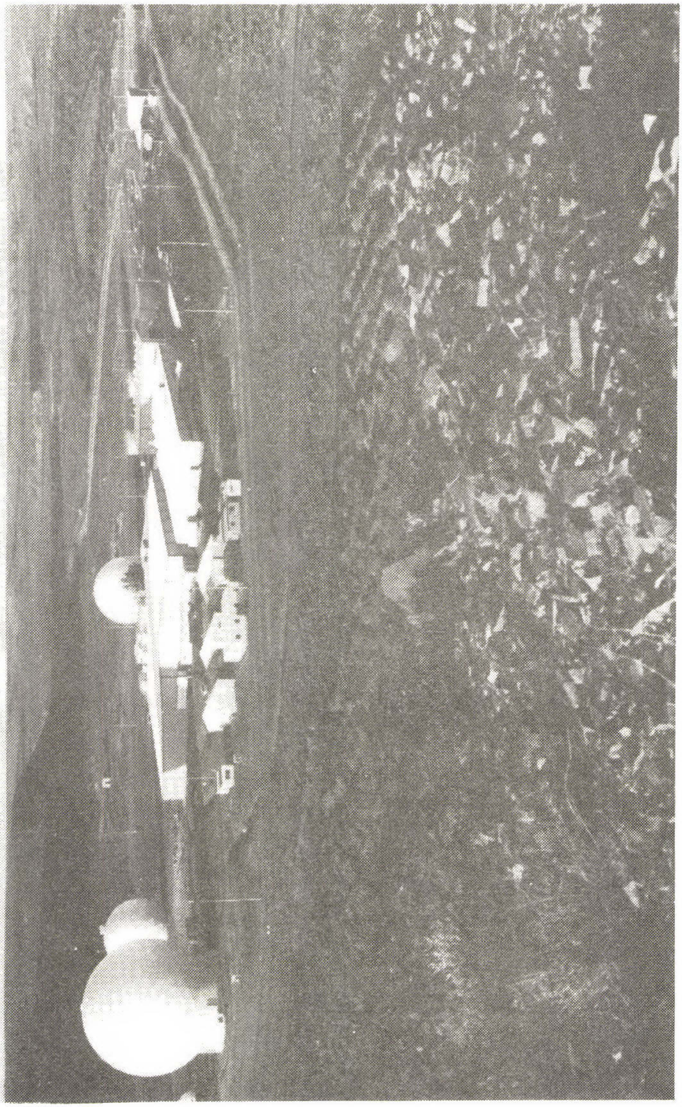
1 US Congress, House Appropriations Committee, Subcommittee on Military Construction Appropriations, *Military Construction Appropriations for 1982*, (U.S. Government Printing Office, Washington, D.C., 1981), Part 1, p.1731. See also Desmond Ball, *A Base for Debate: The US Satellite Station at Nurrungar*, (Allen & Unwin, Sydney, 1987), pp.47-57.

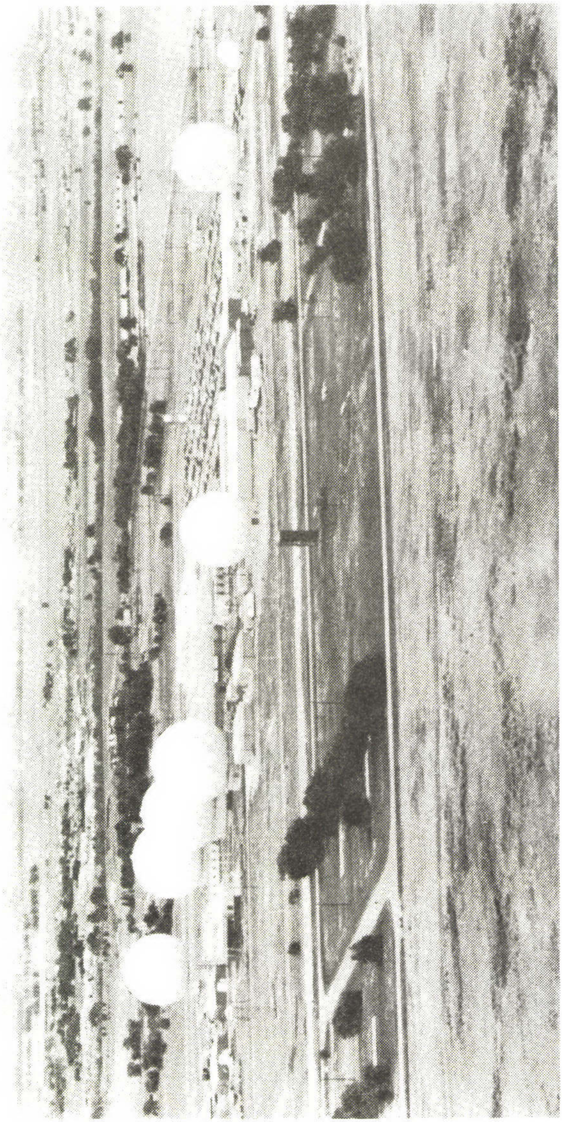
FIGURE 2

DSP OVERSEAS GROUND STATION (OGS) AT NURRUNGAR, S.A.



Source: Australian Department of Defence.

FIGURE 3
DSP CONTINENTAL US (CONUS) GROUND STATION AT BUCKLEY, COLORADO



up service, Nurrungar also uses commercial communications satellite links provided by the INTELSAT satellites stationed over the Pacific, with access through the Overseas Telecommunications Corporation (OTC) station, formerly located at Moree and now in Sydney.[2] Since 1983, with the installation of DSCS terminals at Buckley, Peterson and the various missile early warning stations, the use of INTELSAT for missile early warning communications has been effectively relegated to a back-up service more generally.

The INTELSAT system is also used for intelligence communications. For example, ocean surveillance information collected by the Defence Signals Directorate (DSD) high frequency direction finding (HF DF) SIGINT stations in Australia, and which is appropriate for the US Ocean Surveillance Information System (OSIS), is transmitted from Australia to Wahiawa, Hawaii, on a leased OTC/INTELSAT circuit code-named SIMPSON.

The RCA Americom SATCOM system is also used extensively for defence and intelligence communications. For example, SIGINT collected at the joint Australian DSD/British Government Communications Headquarters (GCHQ) SATCOM intercept station at Stanley Fort in Hong Kong is transmitted to the satellite communications station at Watsonia Barracks in Melbourne (code-named Project SPARROW) via an intelligence communications network code-named MAROON SHIELD (formerly DRAWSTRING). (Figure 4 shows the Project SPARROW AN/FSC-78 Satellite Communications Terminal at Watsonia, Victoria.) Designed by RCA for the US National Security Agency (NSA), the network employs special wide-band transponders on RCA SATCOM communications satellites as well as DSCS satellites capable of transmitting bulk-encrypted data and secure voice communications.[3]

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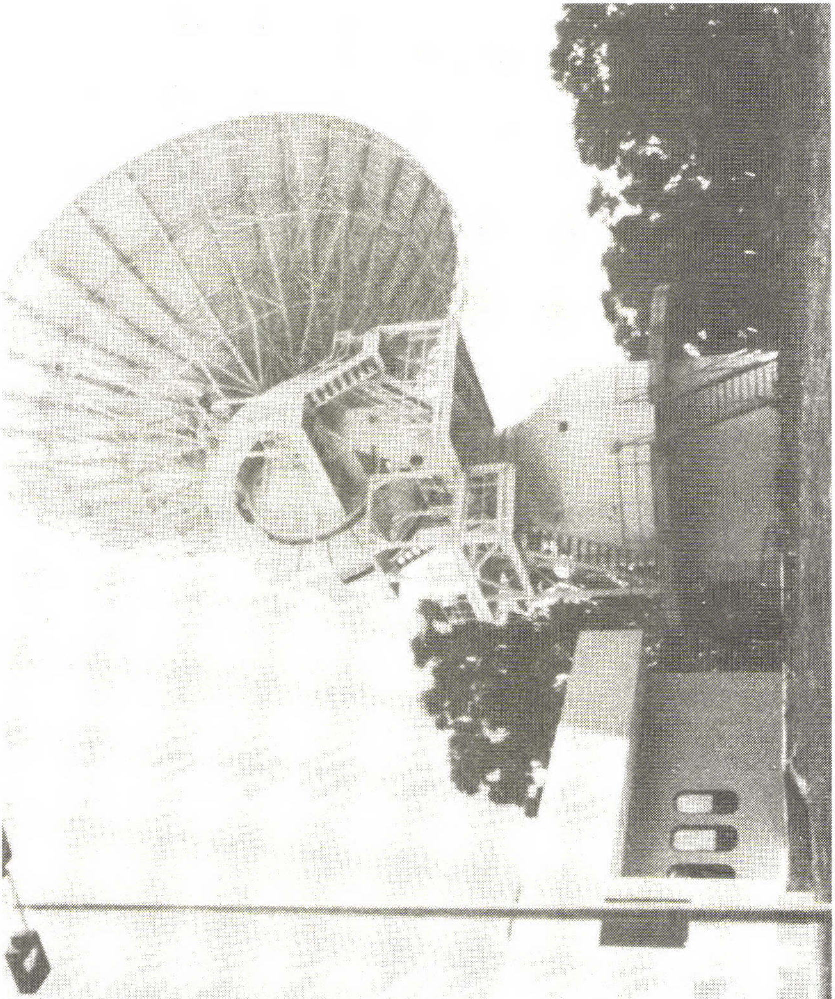
2 *Ibid.*, p.49; and Daniel Ford, *The Button: The Pentagon's Strategic Command and Control System*, (Simon and Schuster, New York, 1985), p.69.

3 See Desmond Ball, *Australia's Secret Space Programs*, (Canberra Papers on Strategy and Defence No.43, Strategic and Defence Studies Centre, Australian National University, Canberra, 1988), Chapters 2 and 5.

FIGURE 4
AN/FSC-78 60-FOOT SATELLITE COMMUNICATIONS TERMINAL AT WATSONIA, VICTORIA



Source: Corporal Ken Scott, Photographic Training Section, School of Signals, Watsonia Barracks, July 1981.

RCA, through the corporation's operating company which serves Alaska, RCA Alaska Communications (RCA Alascom), also has a major responsibility for providing satellite communications services for critical defence and intelligence activities in Alaska - such as communications between NORAD and the NORAD Regional Operations Control Center (ROCC) at the headquarters of Alaskan Air Command at Elmendorf Air Force Base at Anchorage, Alaska. Until 1986, Alaskan satellite communications used only a single broadcast footprint, which overlapped the Soviet Far East and could have been monitored by Soviet SATCOM SIGINT capabilities.[4] Since 1982-83, RCA Alascom has operated Advanced SATCOM satellites which, in addition to providing broadcast transmissions, are also equipped with Alascom transponders with multiple feedhorns whose size, location, power division and relative phasing enable spot coverages with desired Effective Isotropic Radiated Power (EIRP) contours within the Alaskan area.[5] In 1986, a SATCOM ground terminal was installed at the Alaskan ROCC at Elmendorf Air Force Base to provide a more limited footprint for more secure, bulk-encrypted transmissions between the ROCC and the Alaskan Air Command's network of long-range radar sites around the Alaskan coast (Figure 5).[6]

The Western Union WESTAR communications satellite system is also used for various defence and intelligence communications purposes. The WESTAR system consists of Hughes WESTAR geostationary communications satellites located at around 90°W and 123°W longitudes; a Control Center at Glenwood, in Vernon Valley, New Jersey (Figure 6); and Tracking, Telemetry and Command Support ground facilities at Dallas, Texas, and Atlanta, Georgia. One of

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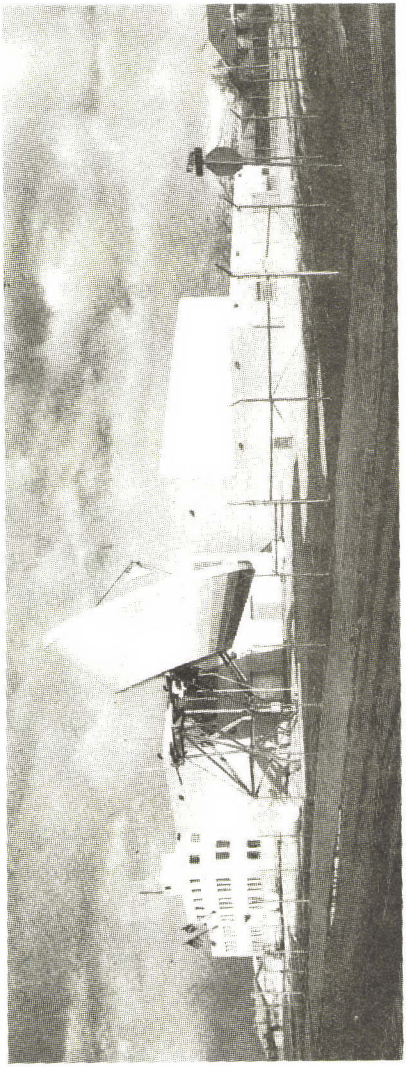
4 Craig Covault, 'Airborne Intercepts Bolstered With New Radar Data Links', *Aviation Week and Space Technology*, 11 July 1988, p.113.

5 Stan Prentiss, *Satellite Communications*, (TAB Books, Inc., Blue Ridge Summit, Pennsylvania, 1983), p.13; and Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, (Howard W. Sams & Company, Indianapolis, Indiana, Second Edition, 1987), pp.424-427, and 429-433.

6 Craig Covault, 'Airborne Intercepts Bolstered With New Radar Data Links', pp.111-115

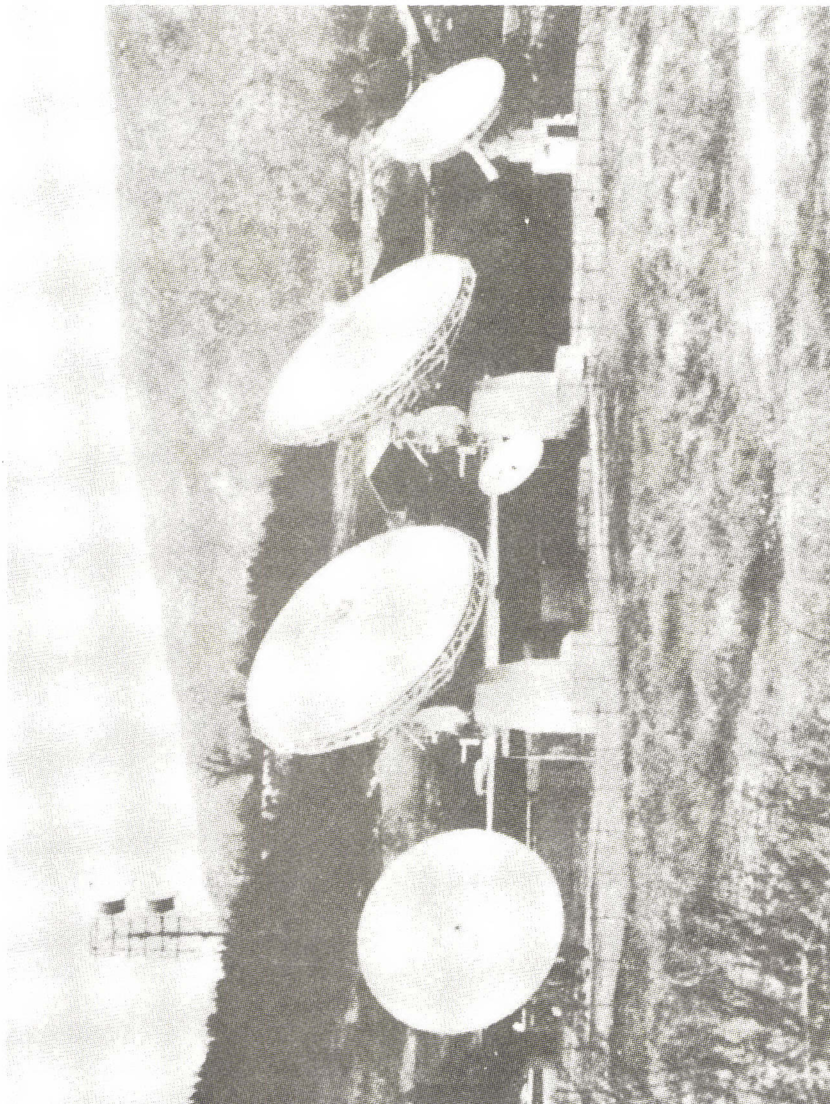
FIGURE 5

SATCOM GROUND TERMINAL AT ELMENDORF AIR FORCE BASE ALASKA



Source: *Aviation Week and Space Technology*, 11 July 1988, p.114.

FIGURE 6
WESTERN UNION WESTAR SATELLITE CONTROL CENTER, GLENWOOD, NEW JERSEY



Source: Western Union.

the primary defence uses of the WESTAR system is in connection with the US Defense Meteorological Satellite Program (DMSP). Meteorological data collected by the DMSP satellites is 'dumped' to three US Air Force command readout stations (CRSs) at Fairchild Air Force Base in Washington, Loring Air Force Base in Main (currently being replaced by a new CRS at Thule in Greenland), and Kaena Point Remote Tracking Station (RTS) in Hawaii; it is then transmitted through the Western Union/Hughes WESTAR satellite system to the Air Force Global Weather Central (AFGWC) at Offutt Air Force Base, Nebraska, and the Navy's Fleet Numerical Oceanographic Central (FNOC) at Monterey, California.[7] DMSP meteorological data is used for a wide variety of strategic and tactical military purposes - including targeting of US strategic nuclear forces and supporting the US photographic intelligence (PHOTINT) satellite program.[8] The DMSP satellites also carry classified communications systems which are unrelated to their meteorological functions. One of these is a small single channel transponder (SCT) which is built by Hughes Aircraft, weighs about 60 lb, and operates in the UHF range.[9] This SCT is part of the Air Force Satellite Communications (AFSATCOM) system, the primary purpose of which is the dissemination of Emergency Action Messages (EAMSs) from the US National Command Authorities (NCA) to the strategic nuclear (SIOP) forces.[10]

The second communications system which operates under the 'cover' of the Defense Meteorological Satellite Program is the CIA's covert communication system. This system is used by the CIA to communicate with agents in so-called 'denied areas', to relay signals from unmanned sensor systems, and to serve as a back-up for

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7 RCA Astro-Electronics, 'Defense Meteorological Satellite Program', (Undated set of briefing charts produced by RCA Astro-Electronics).

8 See Desmond Ball, 'The Defense Meteorological Satellite Program (DMSP)', *JBIS: Journal of the British Interplanetary Society*, (Vol.39, No.1), January 1986, pp.43-45.

9 *Ibid.*, p.45; RCA Astro-Electronics, 'Defense Meteorological Satellite Program'; *Aviation Week and Space Technology*, 12 March 1973, p.18; and *Defense Electronics*, March 1983, p.59.

10 General Russell E. Dougherty, 'SAC Command Control Communications', *Signal*, March 1977, p.30.

communications with US Embassies and CIA installations outside the continental US (CONUS).[11] The WESTAR satellites and the Control Center at Glenwood in Vernon Valley, New Jersey, provide SATCOM links for these classified communications. The Glenwood station is believed to be a primary target of Soviet SIGINT activities conducted from the Soviet residential complex at Riverdale in the Bronx, New York.[12] It is also noteworthy that the SATCOM SIGINT facilities at the Soviet SIGINT station at Lourdes in Cuba was completed in early 1974, just three months before the first Western Union/Hughes WESTAR satellite and the Glenwood station became operational.[13]

The US Navy is a particular user of the MARISAT/ INMARSAT maritime satellite communications system. The MARISATs are multifrequency satellites launched in 1976 to provide modern satellite communications to ships in the Indian, Atlantic and Pacific Oceans. In October 1976, the US Navy began leasing UHF relay capability on the MARISATs under the Gapfiller program.[14] Some capacity on the Atlantic Ocean MARISAT is also leased by the UK.[15] The International Maritime Organization (INMARSAT) provides an international maritime SATCOM service through leased circuits on MARISAT, INTELSAT V and MARECS satellites.[16] These INMARSAT circuits are widely used by numerous defence agencies, including the US Navy and the Japanese Maritime Self Defense Force.[17] The Soviet Union maintains INMARSAT ground stations at Odessa (which covers

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11 Desmond Ball, 'The Defense Meteorological Satellite Program (DMSP)', p.45.

12 Bob Windrem and Oksana Makarushka-Chomut, 'The Vernon Valley Earth Control Stations as Soviet Intelligence Targets', *The Sussex County Voice,* (Vol.2, No.4), September 1987, pp.8-11.

13 *Ibid.*, p.10.

14 Defense Market Service (DMS), *FLTSATCOM*, (DMS Market Intelligence Report, DMS Inc., Greenwich, Connecticut, 1983), p.3.

15 Stan Prentiss, *Satellite Communications*, p.7.

16 Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, pp.105-116.

17 Japan Defense Agency, *Defense of Japan 1985*, (Japan Defense Agency, Tokyo, 1986), p.119.

FIGURE 7
MARSAT MARITIME COMMUNICATIONS SATELLITE

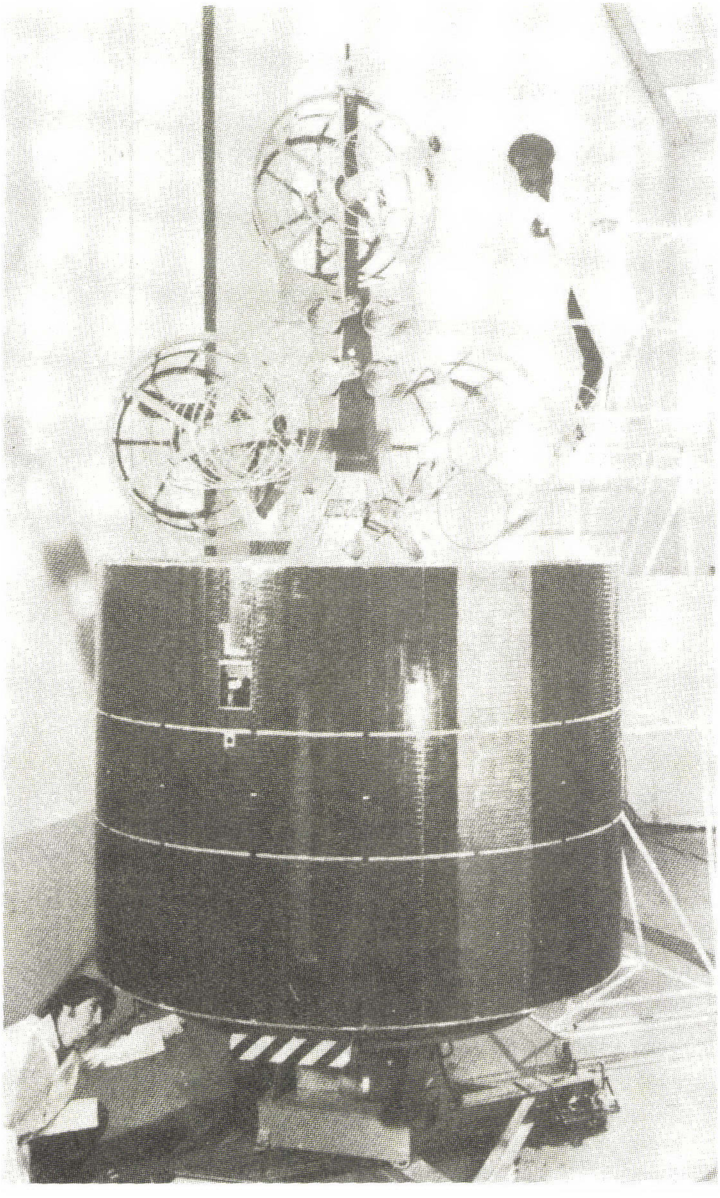
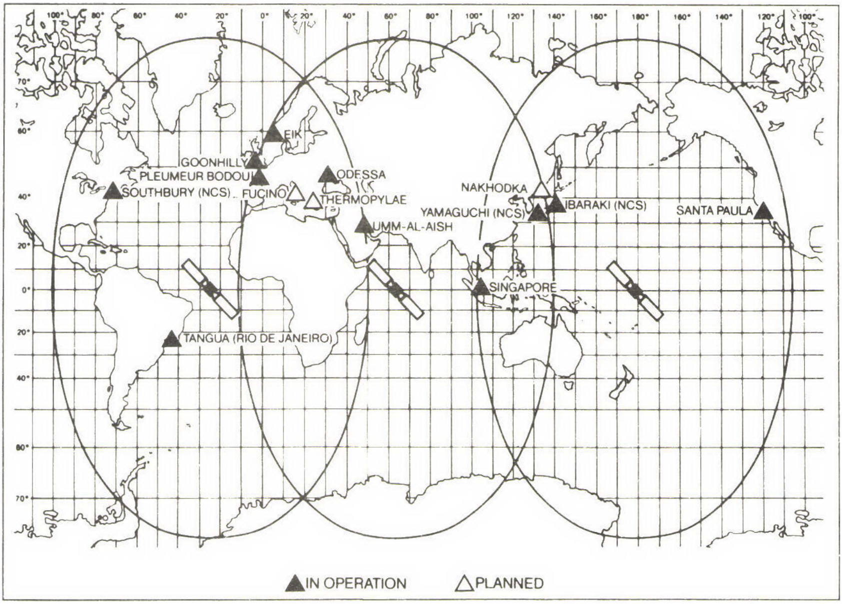


FIGURE 8
INMARSAT SATELLITE SYSTEM



Source: INMARSAT.

both the Atlantic Ocean and Indian Ocean INMARSAT satellites) and Nakhodka (covering the Pacific and Indian Oceans).[18] (The INMARSAT satellite system is shown in Figure 8.) These Soviet ground stations can easily be used to monitor the INMARSAT circuits used by subscribers in other countries.

Although the US Department of Defense and the intelligence community continues to make extensive use of the INTELSAT, RCA SATCOM, WESTAR and other commercial communications systems, the US has also developed several other communications satellite systems for more particular or specialised military and intelligence communications purposes - the US Navy's Fleet Satellite Communications (FLTSATCOM) system, the Defense Satellite Communications System (DSCS), the Air Force Satellite Communications (AFSATCOM) system, the Satellite Data System (SDS), and other CIA covert satellite communications system.

The US Navy's Fleet Satellite Communications (FLTSATCOM) system was designed in the early 1970s to provide an Ultra High Frequency (UHF) fleet broadcast service to all US Navy ships, as well as providing command and control links for computer-to-computer exchange of digital data among shore stations, fleet ballistic missile (FBM) submarines, aircraft carriers, cruisers, selected aircraft, and other ships and submarines. It instantly connects the President and Secretary of Defense (collectively known as the National Command Authority) to field-level commanders over virtually the entire globe. It is also used for naval intelligence communications, providing a link between ocean surveillance information collection stations (such as SOSUS sites and Classic Wizard/White Cloud Ocean Surveillance Satellite ground stations), central ocean surveillance information processing and analysis stations, antisubmarine warfare (ASW) operations centres, and fleet assets.[19]

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18 Reginald Turnill (ed.), *Jane's Spaceflight Directory 1987*, (Jane's Publishing Company Limited, London, Third Edition, 1987), p.312; and Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmissions and Technology*, p.109.

19 See Desmond Ball, 'The US Fleet Satellite Communications (FLTSATCOM) System: The Australian Connection', *Pacific Defence Reporter*, February 1982, pp.30-33; and 'Navy Space

The FLTSATCOM space segment currently consists of five satellites placed in geostationary orbit around the globe - FLTSATCOM 1 (1978-16A), launched on 9 February 1978 and stationed at 110°W over the eastern Pacific Ocean, which provides fleet broadcast service from Midway Island and Hawaii in the Pacific across the continental US (CONUS) to the Azores in the Atlantic; FLTSATCOM 2 (1979-38A), launched on 4 May 1979 and now stationed at 72.5°E, which provides coverage of the Indo-Pacific region from the African continent across Eurasia and the Indian Ocean to the South China Sea; FLTSATCOM 3 (1980-4A), launched on 17 January 1980 and stationed at 23°W, which covers the middle of the US eastward across the Atlantic and Mediterranean to the Indian Ocean; FLATSATCOM 4 (1980-87A), launched on 30 October 1980 and stationed at 172°E, which services the area from Southeast Asia across the Pacific to the west coast of the United States; and FLTSATCOM 7 (1986-96A), launched on 10 December 1986 and stationed together with FLTSATCOM 1 at around 110°W, which serves as an in-orbit spare satellite as well as a vehicle to test a new Extremely High Frequency (EHF) payload.[20]

The FLTSATCOM satellites themselves weigh more than 4000 lbs (1860 kg) at launch and more than 2000 lbs (912 kg) in geostationary orbit. They consist of two principal components, a payload module and the spacecraft module, each with a basic 8-foot (2.44 metres) hexagonal body. (See Figure 9.) The antenna systems include a 16-foot (4.88 metres) parabolic UHF system, a helical UHF receive antenna, an S-band omni-directional antenna, and a Super High Frequency (SHF) horn antenna used for up-link communications. Each spacecraft is equipped with 23 channels - nine 25 kHz wide-band channels for Navy relay communications; twelve 5 kHz narrow-band channels used by the Air Force as part of the AFSATCOM system for communications with Strategic Air Command (SAC) strategic nuclear forces; one 500 kHz wide-band channel used by the National Command Authorities (NCA); and one 25 kHz channel (SHF up and

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Expansion Requires Dedicated Satellites', *Defense Electronics*, (Vol.13, No.7), July 1981, pp.79-84.

20 'Fleet Satellite Communications System', in Floyd C. Painter (Executive Editor), *The C³I Handbook*, (EW Communications, Inc., Palo Alto, California, Second Edition, 1987), pp.71-72.

FIGURE 9
FLTSATCOM SATELLITE

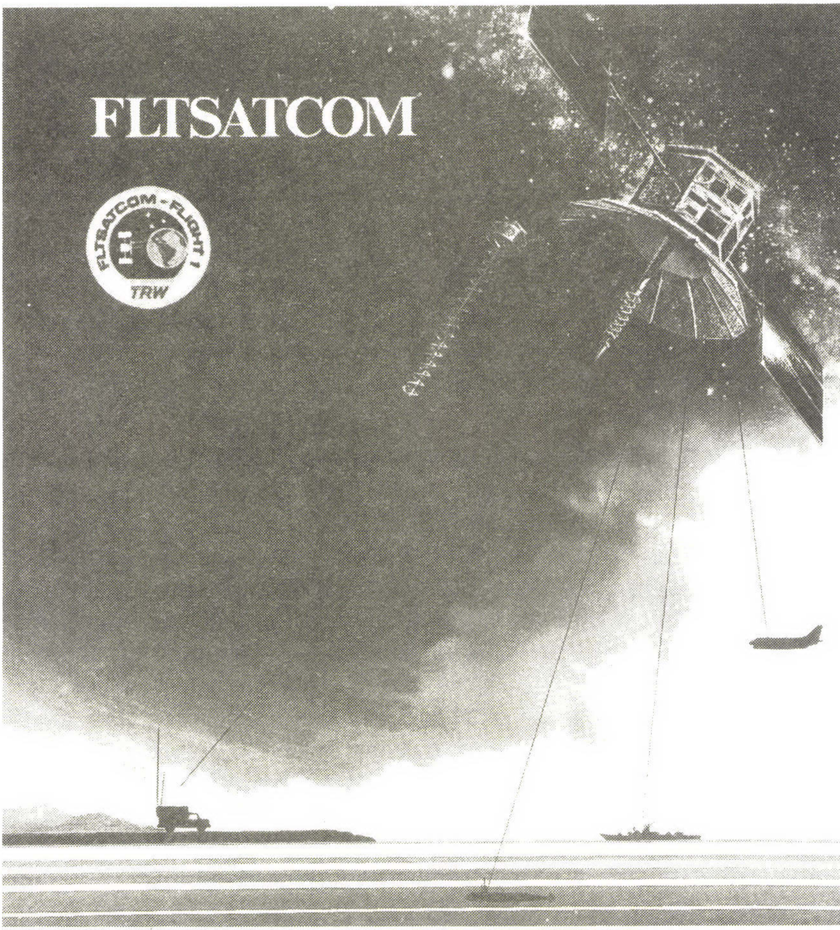
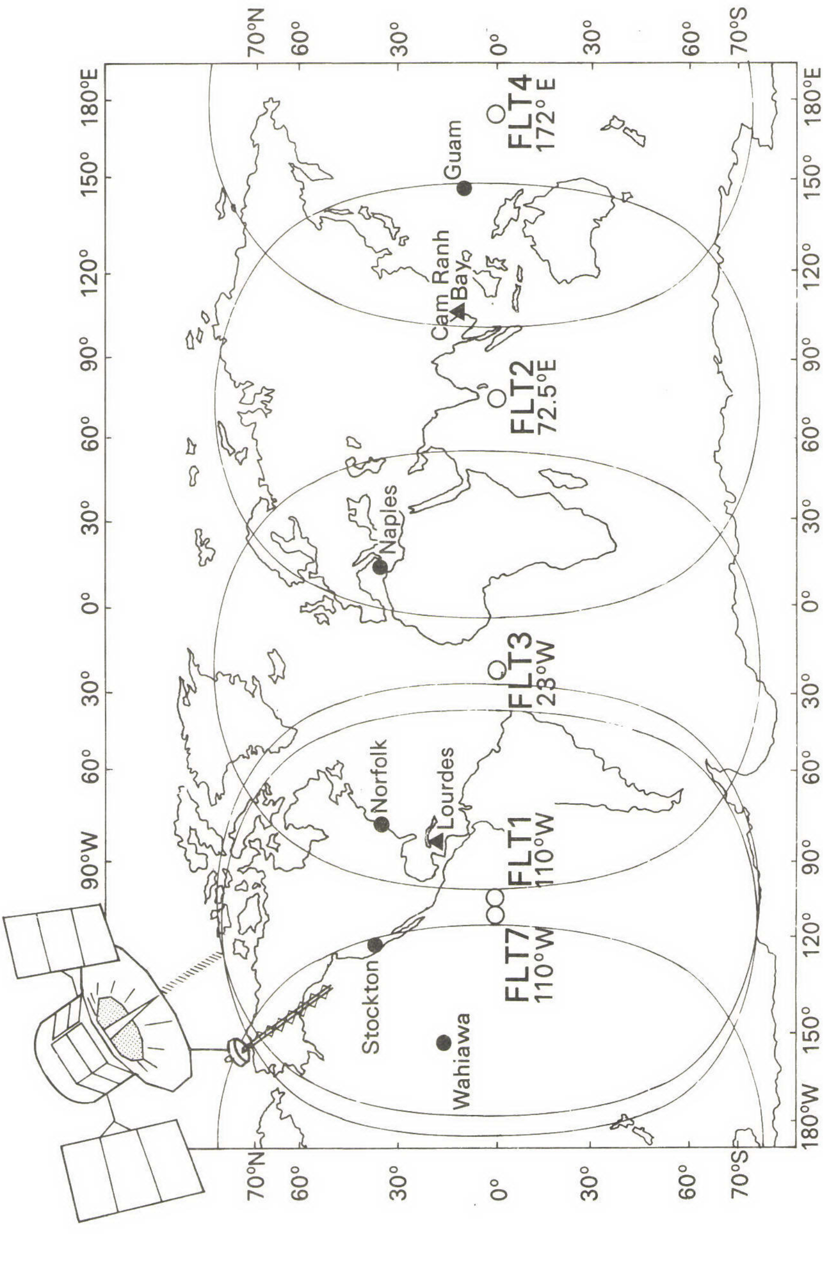


FIGURE 10
FLTSATCOM COVERAGE



UHF down) for fleet broadcast. As noted above, FLTSATCOM 7 also carries an EHF test package.[21]

There are five ground control stations which control access to the communications channels on the FLTSATCOM satellites. These are located at Norfolk, Virginia; Wahiawa in Hawaii; Finegayan on Guam; Naples in Italy; and Stockton in California. These stations are equipped with AN/FSC-79 terminals. Numerous other stations and fleet assets are equipped with receive-only and receive-transmit terminals, including the AN/SSR-1, AN/SSC-2, AN/SSC-3, AN/SSC-6, AN/WSC-2, AN/WSC-3, and AN/WSC-5 systems.[22]

Figure 10 shows the location of the FLTSATCOM ground control stations and the coverage areas of the five FLTSATCOM satellites. It is clear that the whole FLTSATCOM fleet broadcast area can be monitored by only two Soviet SATCOM SIGINT facilities - Lourdes in Cuba (FLTSATCOMs 1, 3 and 7), and a site in either the Soviet Union itself or Cam Ranh Bay in Vietnam (FLTSATCOMs 2 and 4).

In order to complement the FLTSATCOMs and replace the MARISAT/Gapfiller UHF broadcast satellites, the US Navy contracted with Hughes Communications Services Inc. in September 1978 to design, build and maintain a leased service of five LEASATs (including one ground spare) for world-wide UHF communications between ships, aircraft and fixed facilities. The LEASATs were designed to be launched by the Shuttle. The satellites are approximately 4.22 metres (13 feet 10 inches) in diameter and 6.16 metres (20 feet 2.5 inches) long with the antennas deployed, and weigh nearly 1315 kg (2900 lbs) in geostationary orbit. The LEASATs are equipped with 13 channels - a single SHF uplink and UHF downlink channel for fleet broadcast; six 25 KHz channels - four for the Navy and two for the Army; a wideband (500 KHz) channel for use by the Department of Defense; and five 5 KHz channels which serve the US Air Force Satellite Communications (AFSATCOM) system.[23]

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21 *Ibid.*.

22 See Desmond Ball, 'The US Fleet Satellite Communications (FLTSATCOM) System: The Australian Connection', *Pacific Defence Reporter*, February 1982, pp.30-33.

23 US Congress, House of Representatives, Committee on Armed

LEASAT I (1984-93C) was launched on 30 August 1984 and stationed at 15°W to provide coverage over the Atlantic Ocean; its wideband (500 KHz) channel began malfunctioning in September 1985, although the other 12 channels have continued to function.[24] LEASAT 2 (1984-113C) was launched on 8 November 1984 and placed at 105°W to provide coverage over the continental United States (CONUS). LEASAT 3 (1985-28C) was launched on 12 April 1985 and was originally intended for placement at 72°E over the Indian Ocean, but after initially being stranded in orbit and then repaired in space by astronauts from the **Discovery** Shuttle Mission 51-D in September 1985 it was stationed at 178°E to provide coverage over the Pacific Ocean.[25] LEASAT 4 (1985-76D) was launched on 29 August 1985 aboard the **Discovery** Shuttle Mission 51-I, but although it was successfully placed in geostationary orbit at 178°E its communications systems failed on 6 September 1985.[26] LEASAT 5 is currently scheduled for launch in 1990. The LEASATs are controlled by the FLTSATCOM ground control stations at Norfolk, Virginia; Wahiawa, Hawaii; Finegayan, Guam; Naples, Italy; and Stockton, California. In addition, the Hughes Aircraft Company ground station at Fillmore in California has some control capabilities.

Services, *Navy Leased Satellite (LEASAT) and Fleet Satellite (FLTSAT) Programs,* (U.S. Government Printing Office, Washington, D.C., 1981), pp.3, 10-11.

24 Reginald Turnill (ed.), *Jane's Spaceflight Directory 1987*, p.351.

25 *Ibid.*; Craig Covault, 'Astronauts, Controllers Mobilize for Leasat Rescue Attempt', *Aviation Week and Space Technology*, 22 April 1985, pp.18-21; Bruce A. Smith, 'Hughes Plans Leasat Modifications to Retain August Launch Date', *Aviation Week and Space Technology,* 29 April 1985, pp.40-41; Craig Covault, 'Astronauts Repair, Deploy Leasat During Two Space Shuttle EVAs', *Aviation Week and Space Technology,* 9 September 1985, pp.21-23; and Tina D. Thompson (ed.), *TRW Space Log 1957-1987,* (Space and Technology Group, Space and Defense Sector, TRW, Redondo Beach, California, Vol. 23, 1988), p.220.

26 *Ibid.*, p.224; and 'Hughes Communications May Pay Fine for Failure of Leasat 4 Satellite', *Aviation Week and Space Technology*, 23 September 1985, p.21.

The US Navy has long recognised the vulnerability of UHF SATCOM systems to interception. For example, Vice Admiral Gordon R. Nagler, Director of Command and Control in the Office of the Chief of Naval Operations, testified on 23 June 1981 as follows:

> UHF satellites are susceptible to electronic jamming and earth terminal transmissions are vulnerable to intercept within line of sight. Because of the vulnerability to intercept and for reasons of communications security, the Navy requires that all transmissions on satellites be cryptographically encrypted.[27]

The ability of the Soviet Union to monitor and decrypt FLTSATCOM communications was greatly enhanced by the espionage activities of John A. Walker and Jerry A. Whitworth in the 1970s and early 1980s. In February 1975, Whitworth, who had just completed a SATCOM training course at the Army Communications School at Fort Monmouth, New Jersey, provided Walker with technical manuals which were subsequently passed to Walker's KGB case officer. These included manuals entitled *A Tactical Satellite Communications System Preliminary Tech Manual* and *Tactical Satellite Communications System AN/WSC-5*.[28] From March 1975 to early 1976, Whitworth served as the petty officer in charge of the Satellite Communications Division of the US Naval Communications Station at Diego Garcia from where he was able to provide Walker and the KGB with further technical manuals and cryptographic material concerning the FLTSATCOM system. In 1977, Whitworth also delivered copies of the technical manuals and key lists for the KG-36 cryptographic machine, used to decrypt data transmitted through the Navy's SATCOM system.[29]

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27 US Congress, House of Representatives, Committee on Armed Services, *Navy Leased Satellite (LEASAT) and Fleet Satellite (FLTSAT) Programs*, p.8.

28 Howard Blum, *I Pledge Allegiance ... The True Story of the Walkers: An American Spy Family*, (Weidenfeld and Nicholson, London, 1988), pp.176-177; and Thomas B. Allen and Norman Polmar, *Merchants of Treason: America's Secrets for Sale*, (Delacorte Press, New York, 1988), p.111.

29 Howard Blum, *I Pledge Allegiance ...*, pp.194-195.

In addition to broadcast satellites, the US Department of Defense and the intelligence community operate various satellites which have down-link 'spot' beams providing selective coverage over areas less than several thousand kilometers in diameter. These include the narrow and area coverage beams transmitted by the Defense Satellite Communications System (DSCS) Phase II communications satellites, the high-gain and multi-beam transmissions of the DSCS III satellites, and the down-links of the US photographic intelligence (PHOTINT) and signals intelligence (SIGINT) satellite systems. The interception of these down-links would be very high Soviet intelligence priority.

The DSCS was designed primarily to support the long-haul communication requirements of a number of US Defense agencies and services, including the Defense Communications System (DCS) and the World Wide Military Command and Control System (WWMCCS). It provides communication services for the President, the National Command Authorities (NCA) and the unified and specified commands; the military services and combat forces; the early warning and other critical intelligence sites, including those maintained by the Central Intelligence Agency (CIA) and the National Security Agency (NSA); and NATO and allied governments as specified by international agreements. It provides analogue and digital transmission paths for virtually every type of telecommunication, including voice, data, facsimile, and high resolution imagery.[30]

The DSCS space segment consists of four satellites, positioned in geostationary orbits at 135°W (DSCS EPAC), 12°W (DSCS LANT), 60°E (DSCS IND), and 175°E (DSCS WPAC). The satellite stationed at 175°E (DSCS EPAC) is a DSCS Phase II satellite (DSCS II F-15), launched on 30 October 1982 (1982-106A). The other three are DSCS III satellites - DSCS III A-1, launched also on 30 October 1982 (1982-106B) and stationed at 135°W (DSCS EPAC); and DSCS III B-4 and DSCS III B-5, launched on 4 October 1985 (1985-92B and 1985-92C) and stationed at 12°W (DSCS LANT) and 60°E (DSCS IND) respectively. (See Figure 11.)

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30 R.J. Raggett (ed.), *Jane's Military Communications 1986*, (Jane's Publishing Company Limited, London, 7th Edition, 1986), p.369.

FIGURE 11
DSCS SATELLITE STATIONS AND NET CONTROL FACILITIES (NCFs)

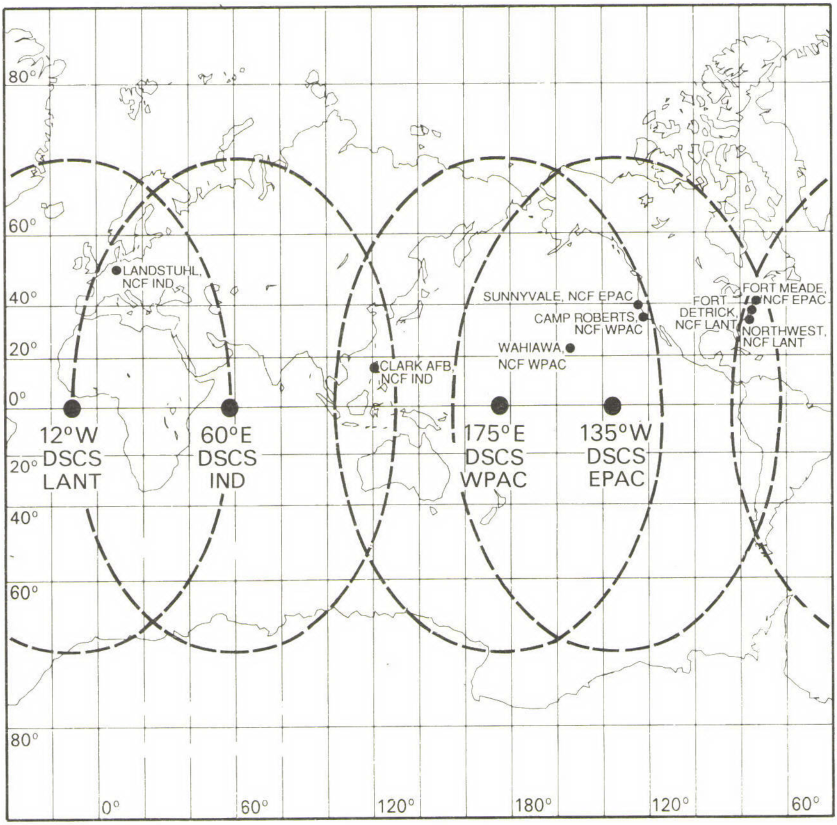


FIGURE 12
DSCS II SATELLITE

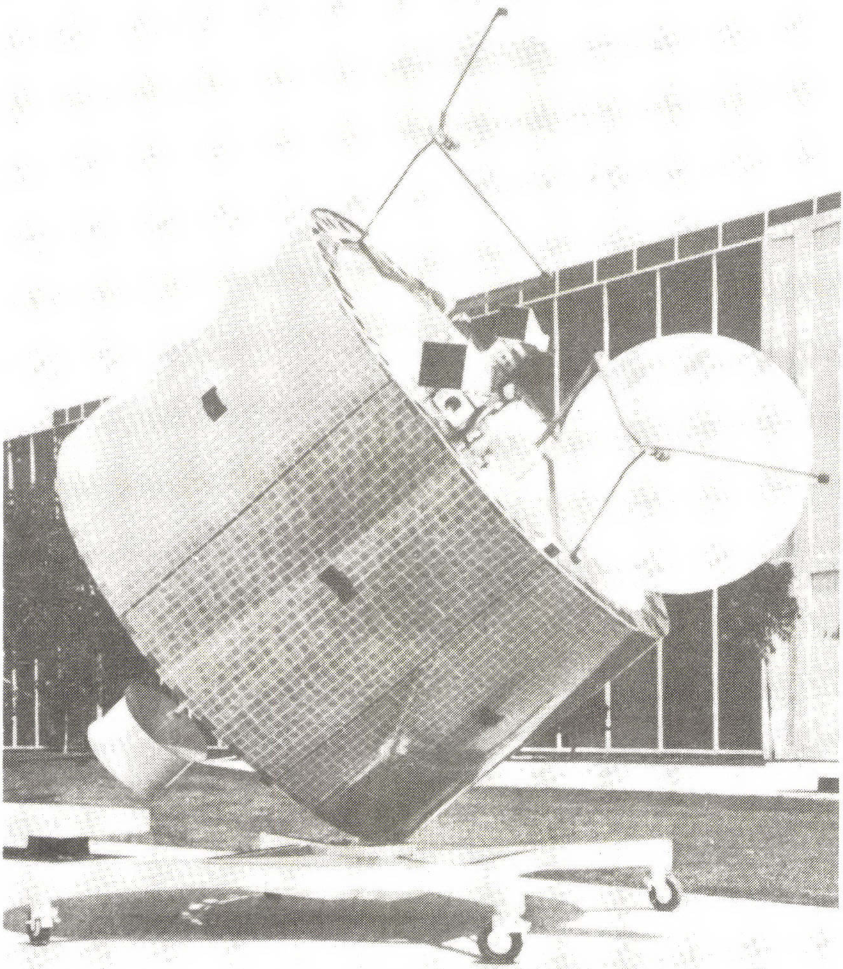


FIGURE 13
DSCS II SATELLITE COVERAGE

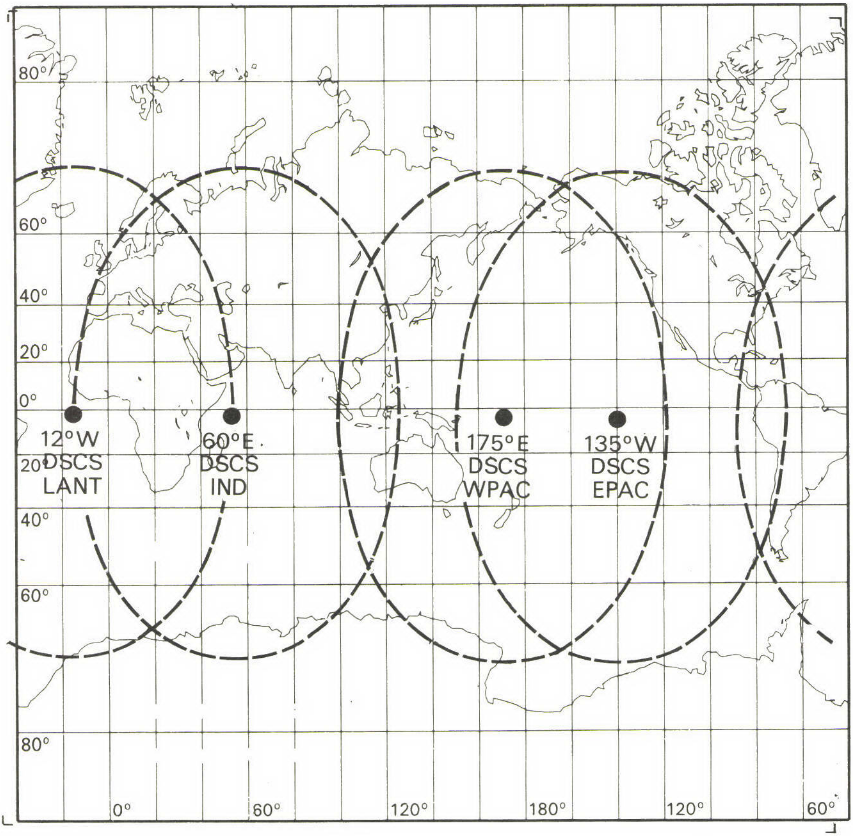


FIGURE 14

DSCS II SATELLITE COVERAGE (NARROW BEAM ANTENNA PATTERNS)

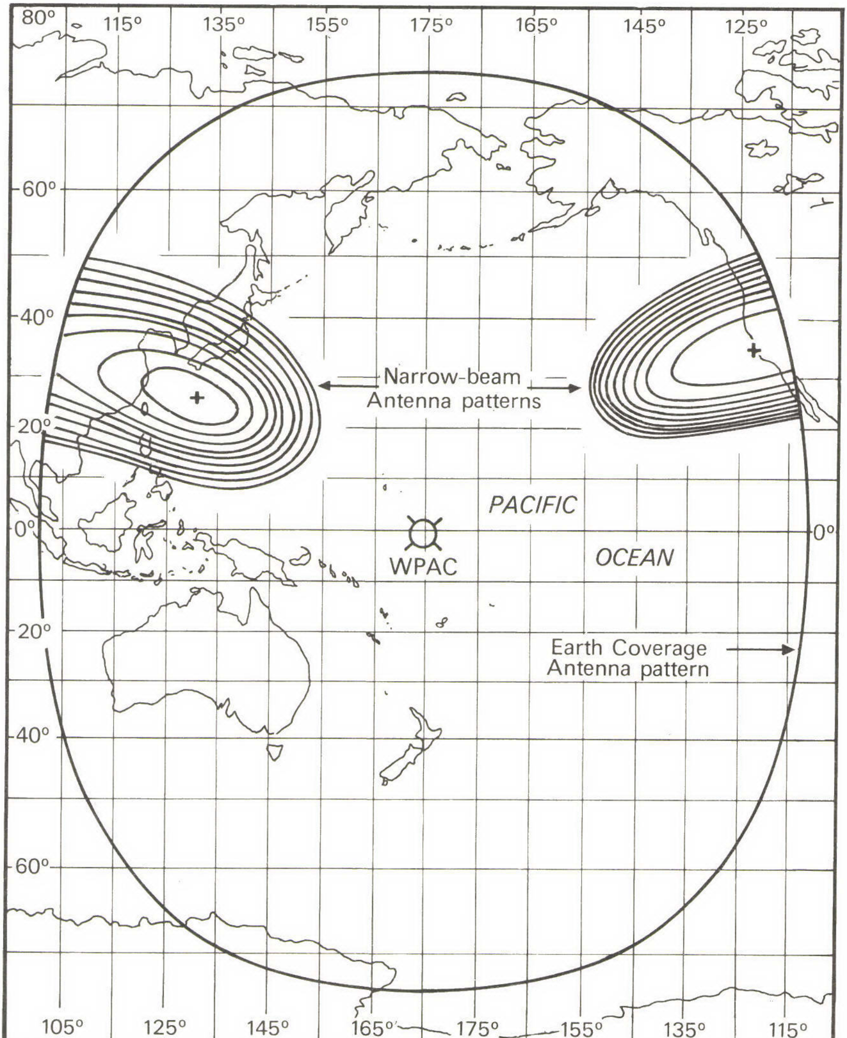


FIGURE 15

DSCS II SATELLITE COVERAGE (EARTH, AREA AND NARROW COVERAGE)

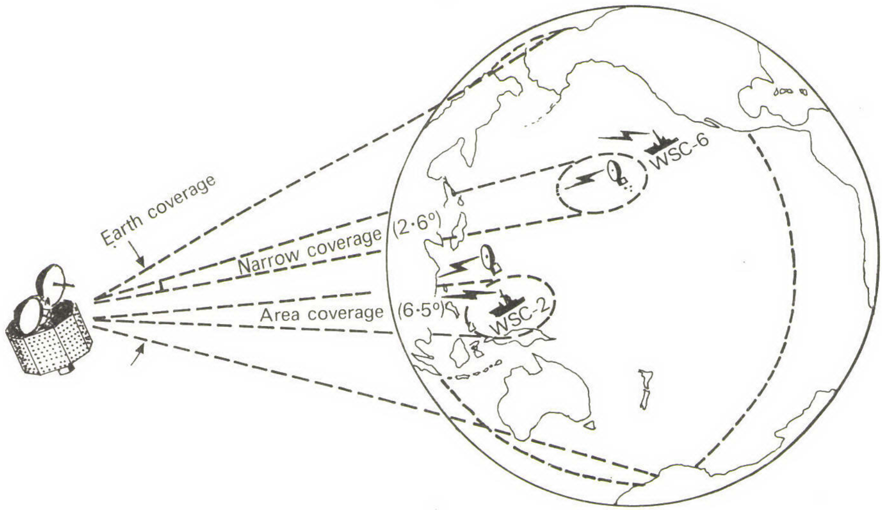


FIGURE 16

SPOT BEAM OF DSCS II EPAC SATELLITE FOCUSSED ON WAHIAWA, HAWAII

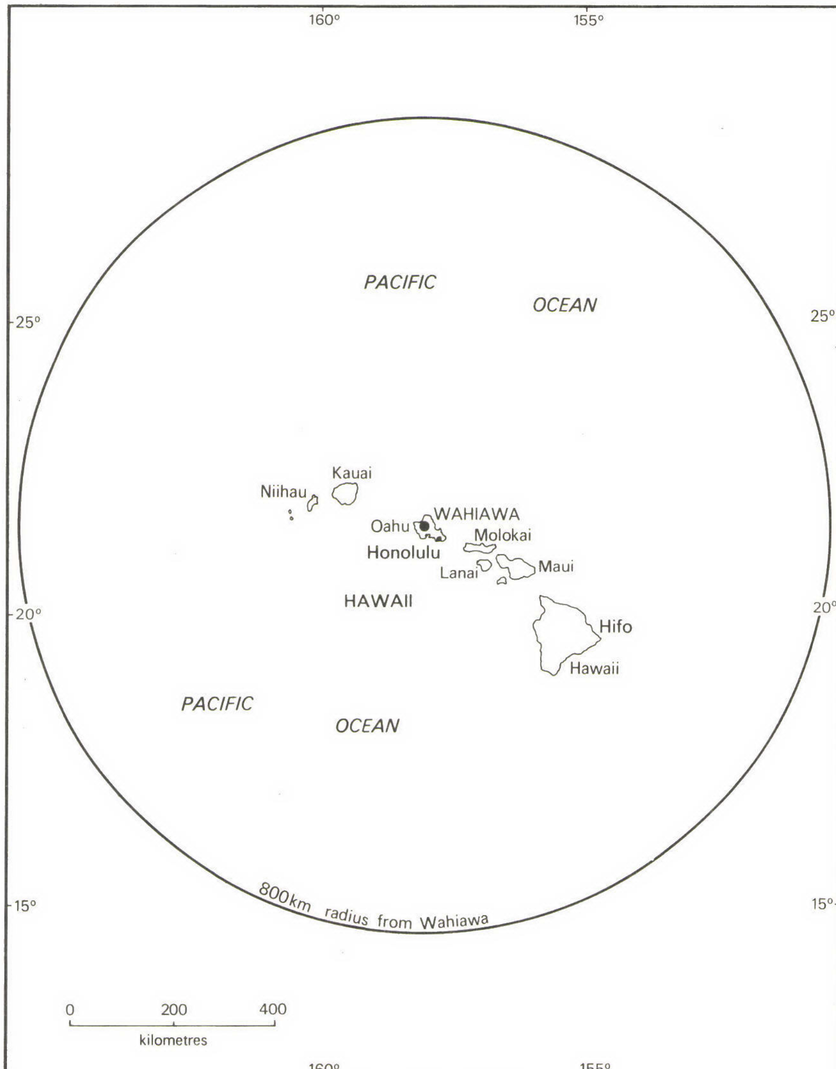
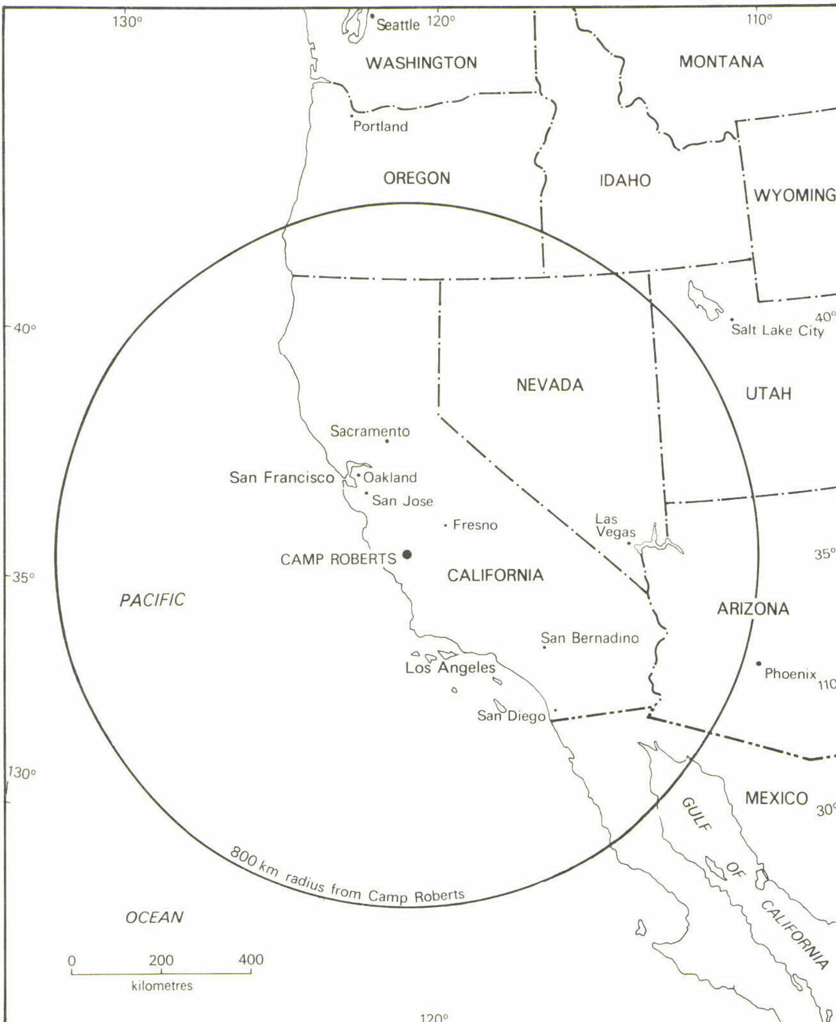


FIGURE 17

SPOT BEAM OF DSCS II SATELLITE FOCUSSED ON CAMP ROBERTS, CALIFORNIA



The DSCS II satellites each weigh 590 kg (1,300 lb), are 2.75 metres (9 feet) in diameter, and 3.95 metres (13 feet) tall with antennae extended (Figure 12). The electrical power is supplied by solar arrays which provide an output of 535 watts at launch, decreasing to a minimum of 358 watts after five years.[31]

The antennae systems on the DSCS II satellites consist of an X-band multi-channel single-frequency conversion repeater with a bandwidth of 410 MHz and a capacity of 1,300 voice channels or up to 100 megabits per second of data; an Earth coverage (ec) antenna with a transmit beamwidth of 18°, a gain of 16-18 dBi, and an effective radiated power of 28 dBw; a steerable narrow-coverage (nc) antenna, with a beamwidth of 2.6°, a gain of 33 dBi, and an effective radiated power of 43 dBw; and a steerable area coverage (ac) antenna, with a beamwidth of 6.5°, a gain of 22 dBi, and an effective radiated power of 32 dBw. The nc and ac antennae are each steerable to ±10°, and they are both capable of receiving and transmitting simultaneously. This arrangement provides four different channels of operation - Earth coverage to Earth coverage (ec - ec); Earth coverage to narrow coverage/area coverage (ec - nc/ac); narrow coverage/area coverage to Earth coverage (nc/ac - ec); and narrow coverage/area coverage to narrow coverage/area coverage (nc/ac - nc/ac). In addition, the satellites are equipped with an S-band biconical horn antenna with a torroidal beamwidth of 32° for the reception and transmission of telemetry and command data for satellite control.[32]

The earth coverage antenna on the DSCS II EPAC satellite, with a transmit beamwidth of 18°, provides coverage of an area measuring some 11,340 km in diameter - i.e. from Singapore across to California. The steerable area coverage antenna has a beamwidth of 6.5°, and provides coverage of an area some 4,100 km in diameter. The steerable narrow coverage antenna has a beamwidth of 2.5° and provides coverage of an area some 1,600 km in diameter. Hence, for example, communications from the Defense Support Program (DSP)

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31 John W.R. Taylor (ed.), *Jane's All the World's Aircraft 1978-79*, (Macdonald and Jane's Publishers Limited, London, 1978), p.670.

32 *Ibid.*; and R.J. Ragget (ed.), *Jane's Military Communications 1984*, (Jane's Publishing Company Limited, London, 5th Edition, 1984), p.791.

early warning satellite ground station at Nurrungar, South Australia, transmitted to the continental United States (CONUS) via the narrow coverage DSCS EPAC satellite system and relayed through the DSCS WPAC Net Control Facilities (NCFs) at either Wahiawa, Hawaii, or Camp Roberts, California, could be monitored by Soviet SATCOM intercept systems aboard ships stationed within some 800 km of Hawaii or the California coast - or, in the case of communications relayed through the Camp Roberts NCF, by SATCOM receiving systems installed in the Soviet Consulate in San Francisco, some 240 km to the northwest.

The DSCS III satellites weigh some 1040 kg; the central structure is 110 inches in length, and extends to 457.7 inches with the solar array fully deployed; it is 76 inches wide and 77 inches deep. The solar power system is capable of producing 1240 watts at the beginning of each mission and 980 watts at the end of the projected 10-year satellite lifetime. A monoprepellant hydrazine propulsion sub-system, with 600 lbs of fuel, is used for attitude control and stationkeeping.

The DSCS III satellite communications system consists of a six-channel SHF transponder, with each channel powered by its own travelling wave-tube amplifier (TWTA) to allow the most efficient use of the available frequency spectrum and power, and ten flexibly interconnected antenna systems. Two of the channels (1 and 2) have a power output of 40 watts, while the other four (3-6) have a power output of 10 watts; one channel (No.6) has a bandwidth of 50 MHz, one (No.3) a bandwidth of 85 MHz, and the other four have bandwidths of 60 MHz.

The 10 communications antennae consist of four Earth-coverage horn systems (two each for reception and transmission); a 61-beam waveguide lens reception antenna, with an associated beam-forming network, which provides anti-jamming protection and a selective coverage capability; two 19-beam waveguide lens transmission antennae with beam-forming networks to rapidly produce selective coverage patterns tailored to the network of ground receiving terminals; a high-gain (3° beam) gimballed dish transmission antenna for spot-beam fixed coverage; and two UHF antennae, one a bow-tie reception system and the other a cross-dipole transmission system, for use by the Single Channel Transponder (SCT). The SCT is integrated into the spacecraft to provide secure and reliable dissemination of the Emergency Action Message (EAM) and Single Integrated Operational Plan (SIOP) communications for the US strategic nuclear forces and command systems. In addition, there is dual-frequency (UHF/S-band and SHF/X- band) Telemetry, Tracking and Control (TT & C) system for spacecraft control, tracking, positioning, and housekeeping.[33]

The 3° beamwidth high-gain gimballed dish transmission antenna provides a spot coverage of some 1,885 km diameter on the ground, while the two 19-beam waveguide lens transmission antenna provide spot coverages of 1°, or some 630 km diameter on the ground. Hence, for example, digital imagery from the KH-11 Kennan PHOTINT satellite transmitted via DSCS III satellite to the KH-11 ground station at Fort Belvoir, Virginia, or SIGINT transmitted to NSA headquarters at Fort Meade, Maryland, could be intercepted by SATCOM receiving systems located in various Soviet diplomatic establishments in the Washington, D.C., area, or by SATCOM intercept systems aboard Soviet ships stationed within 200-300 km of the coast.

In 1982, the Space Division of the US Air Force Systems Command limited development of the Military Strategic/Tactical and Relay (MILSTAR) system, a joint service program designed to provide a highly survivable, jam-resistant, secure, extremely high frequency (EHF) satellite communications system for worldwide use during all levels of conflict including general nuclear war. It will be used to control both strategic and tactical forces, and to relay intelligence information from intelligence satellites and other sources. The first MILSTAR satellite is unlikely to be launched before February 1990.[34]

The total weight of each MILSTAR satellite is expected to be 5,000 to 8,000 lbs. The key features are the use of higher frequencies than those used by the DSCS satellites, band-spreading, on-board signal processing, end-to-end encryption, nulling antennae, hardening

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33 Material on DSCS III satellites provided by Space Systems Division, General Electric, Valley Forge Space Centre, Philadelphia, Pennsylvania.

34 'MILSTAR Satellite Communications System', in Floyd C. Painter (Executive Editor), *The C³I Handbook*, (EW Communications Inc., Palo Alto, California, 3rd Edition, 1988), pp.63-65.

FIGURE 18
DSCS III SATELLITE

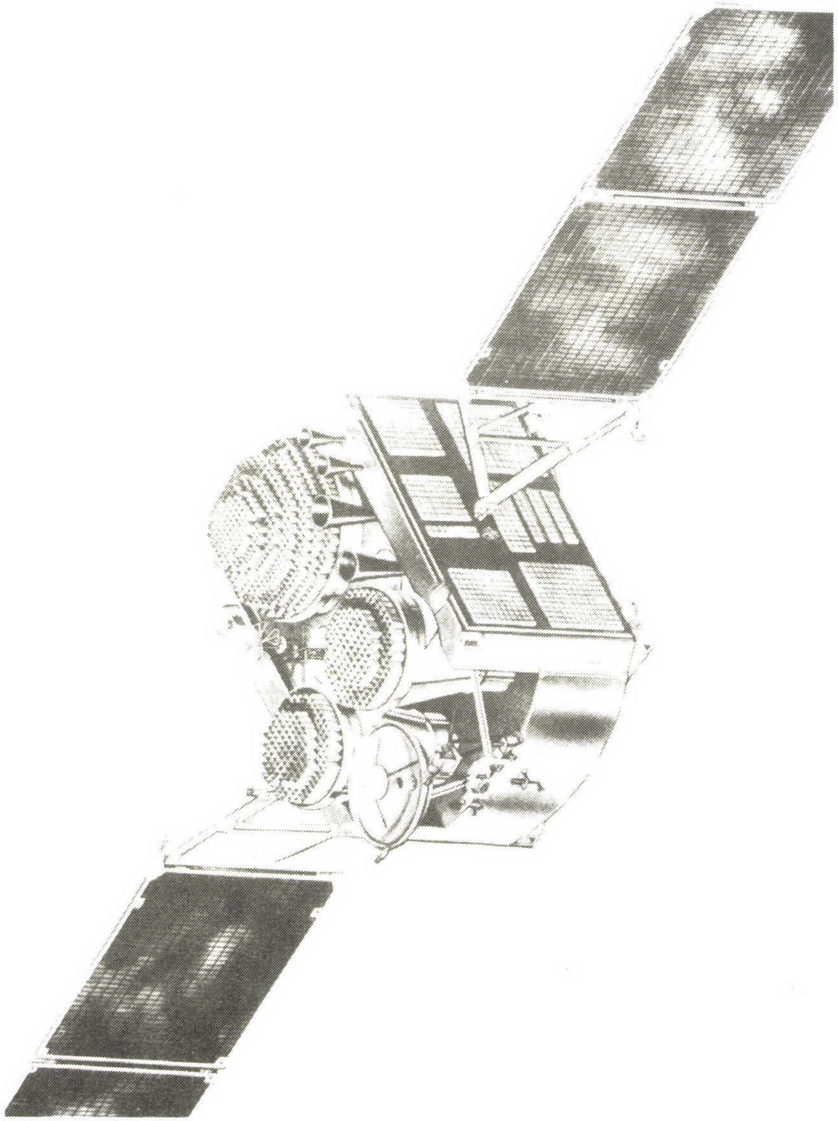

FIGURE 19

DSCS III FREQUENCY PLAN

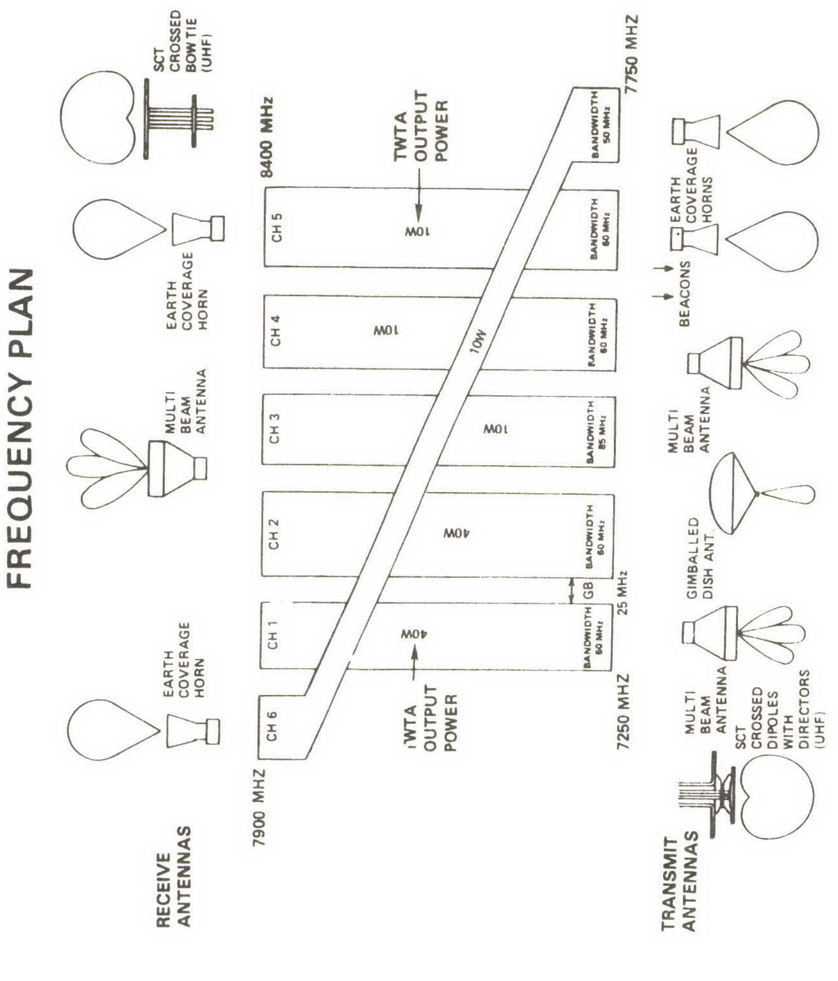

FIGURE 20

DSCS III RECEIVE AND TRANSMIT PLAN

FREQUENCY ALLOCATION FOR EFFICIENT SPECTRUM USE

Spectrum	SHF from 7250–8400 MHz UHF (SCT) from 225 to 260 MHz Transmit 300 to 400 MHz Receive SHF (SCT) Channel 1
Channels 1-5	725 MHz Up-Down Translation
Channel 6	200 MHz Up-Down Translation
Guard Bands	25 MHz Maximum

RECEIVE PLAN

ANTENNA / CHANNEL	MULTI BEAM	EARTH COVERAGE HORN	UHF BOW TIE
CH 1	X	X	–
CH 2	X	X	–
CH 3	X	X	–
CH 4	X	X	–
CH 5	–	X	–
CH 6	–	X	–
SCT	X	X	X

TRANSMIT PLAN

ANTENNA / CHANNEL	MULTI BEAM	EARTH COVERAGE	GIMBALLED DISH	UHF CROSS DIPOLE
CH 1 (40W)	X	–	X	–
CH 2 (40W)	X	–	X	–
CH 3 (10W)	X	X	–	–
CH 4 (10W)	X	X	X	–
CH 5 (10W)	–	X	–	–
CH 6 (10W)	–	X	–	–
SCT	X	–	X	X

FIGURE 21
SPOT BEAM (1°) OF DSCS III SATELLITE FOCUSSED ON FORT BELVOIR, VIRGINIA

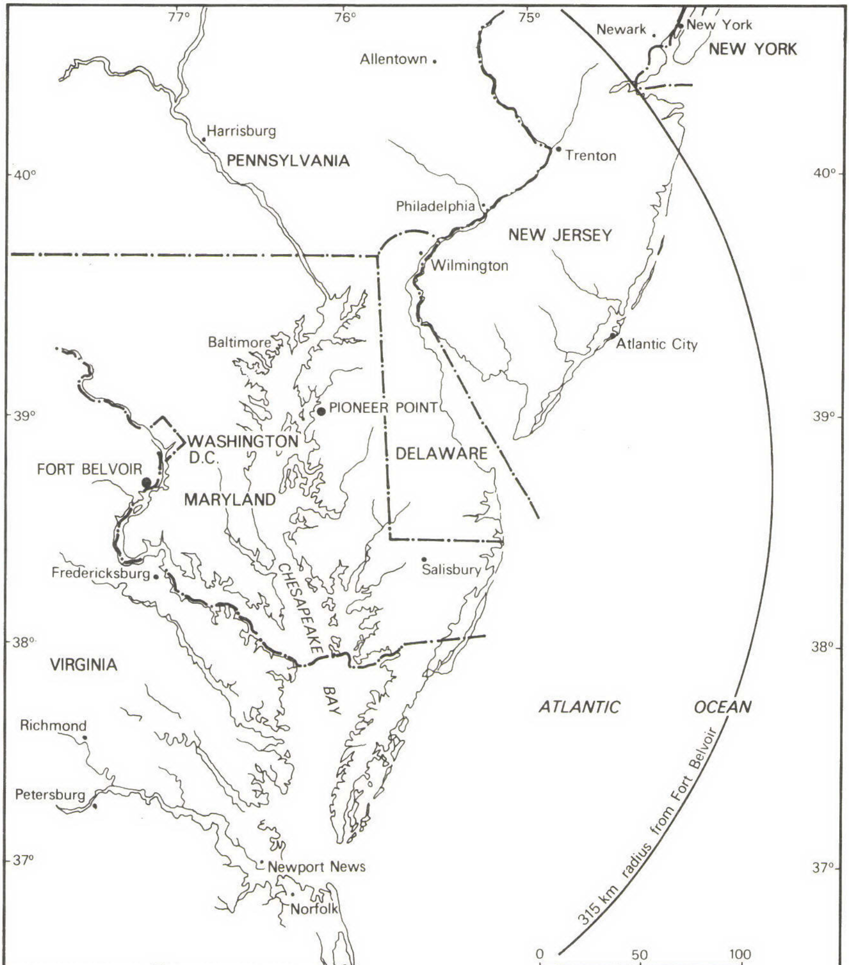

FIGURE 22

SPOT BEAM (1°) OF DSCS III SATELLITE FOCUSSED ON FORT MEADE, MARYLAND

(against both nuclear effects and laser illumination), on-board signal storage, and a high degree of autonomy from ground control.[35] Although the primary communications suite will operate in the EHF band, with uplink and down-link frequencies around 44 GHz and 20 GHz respectively, the MILSTAR satellites will also retain a UHF capability to avoid making obsolete some $2 billion worth of UHF terminals currently in service. The EHF band allows highly directional transmissions with relatively small antenna arrays, thus making interception more difficult. The 44 GHz uplink antenna, for example, could be as small as 1-metre in diameter. In addition to being highly directional, an EHF signal can be spread over a 1 GHz bandwidth, which is too large to permit effective broadband jamming. Rapid frequency-hopping will further enhance MILSTAR's security and anti-jam characteristics.[36]

(The US Navy's FLTSATCOM-7 satellite, launched on 5 December 1986, carried a 44 GHz uplink and 20 GHz down-link EHF package designed to evaluate pre-production MILSTAR EHF terminals.[37])

The 20 GHz MILSTAR down-link is likely to be transmitted by a 4-foot diameter dish and form a beam less than one degree,[38] covering an area about 410 km in diameter. Figure 23 shows the spot coverage of a MILSTAR down-link focussed directly on the Pentagon. It is believed that the Soviet Military Office (SMO) at 2552 Belmont

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35 Defense Market Service (DMS), 'MILSTAR', *DMS Market Intelligence Report*, (DMS Inc., Greenwich, Connecticut, 1984), p.1.

36 'MILSTAR Satellite Communications System', in Floyd C. Painter (Executive Editor), *The C³I Handbook*, p.64.

37 *Aviation Week and Space Technology*, 10 November 1986, p.87; 'FLTSATCOM Follow-On Considered', *Defense Electronics*, March 1985, p.26; and 'Fleet Satellite Communications System', in Floyd C. Painter (Executive Editor), *The C³I Handbook*, (EW Communications Inc., Palo Alto, California, 2nd Edition, 1987), pp.71-72.

38 Albert D. Wheelon, Roger W. Clapp and Barney Krinsky, 'EHF Satellite Communications', (Space and Communications Group, Hughes Aircraft Company, Los Angeles, California, 15 October 1982), p.4.

FIGURE 23

SPOT BEAM OF MILSTAR FOCUSSED ON THE PENTAGON

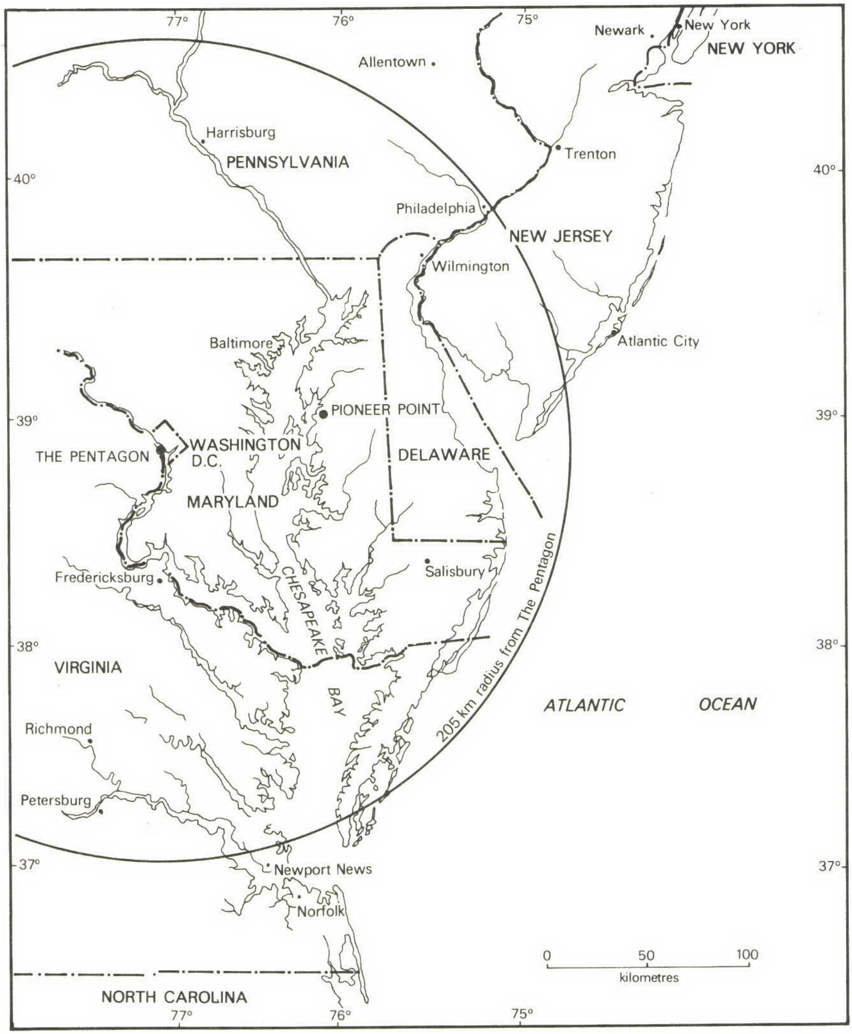

FIGURE 24

EHF ANTENNA, SOVIET MILITARY OFFICE (SMO), WASHINGTON, D.C.

Road NW in Washington, D.C., was equipped with an EHF SATCOM antenna in 1987-88.[39] (See Figure 24.)

The US intelligence community maintains a complex and diverse architecture for down-linking intelligence collected by the various US intelligence satellites. The most secret US intelligence collection program is the geostationary SIGINT satellite program, with satellites code-named Rhyolite, Aquacade, Argus, Chalet, Vortex and, most recently Magnum. The down-link ground stations for these satellites are at Pine Gap in central Australia, Menwith Hill in Yorkshire, England, and Bad Aibling in Bavaria in southern Germany. Assuming that these geostationary SIGINT satellites transmit the collected SIGINT to the ground at a frequency of about 24 GHz, with a down-link antenna about 2.5 metres in diameter, the ground spot would be about 160 km in diameter. Given the interior locations of the down-link stations, it is reasonable to assume that the down-links from these satellites are secure from Soviet interception.[40]

On the other hand, the NSA's low altitude ELINT satellites, code-named Brigitte, Marilyn, Raquel, Farrah, etc., transmit the ELINT to the ground at much lower frequencies and with smaller antennas - probably similar to those of the US Navy's Classic Wizard/WhiteCloud ELINT satellites, which use a down-link frequency of around 1.4 GHz and an antenna of about 1.2 metres in diameter. The NSA ELINT satellites typically orbit at altitudes of around either 500 km or 1,400 km, which would give ground spot diameters of about 90 km and 250 km respectively. The down-link ground stations for these ELINT satellites are those of the US Air Force's Satellite Control Facility (SCF) - i.e. Sunnyvale, California; Vandenberg, California; New Boston, New Hampshire; Thule, Greenland; Mahe in the Seychelle Islands; Guam; Kaena Point in Hawaii; and Oakhanger in England. The Sunnyvale station is 60 km southeast of the Soviet Consulate in San Francisco, and hence down-links from the ELINT satellites to Sunnyvale could be intercepted by SATCOM receivers in the Consulate. (See Figure 25.)

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39 Personal observation, 16 October 1988.

40 Desmond Ball, *Pine Gap: Australia and the US Geostationary Signals Intelligence Satellite Program*, (Allen & Unwin, Sydney, 1988), p.90.

FIGURE 25
ELINT SATELLITE SPOT BEAM COVERAGE, SUNNYVALE, CALIFORNIA

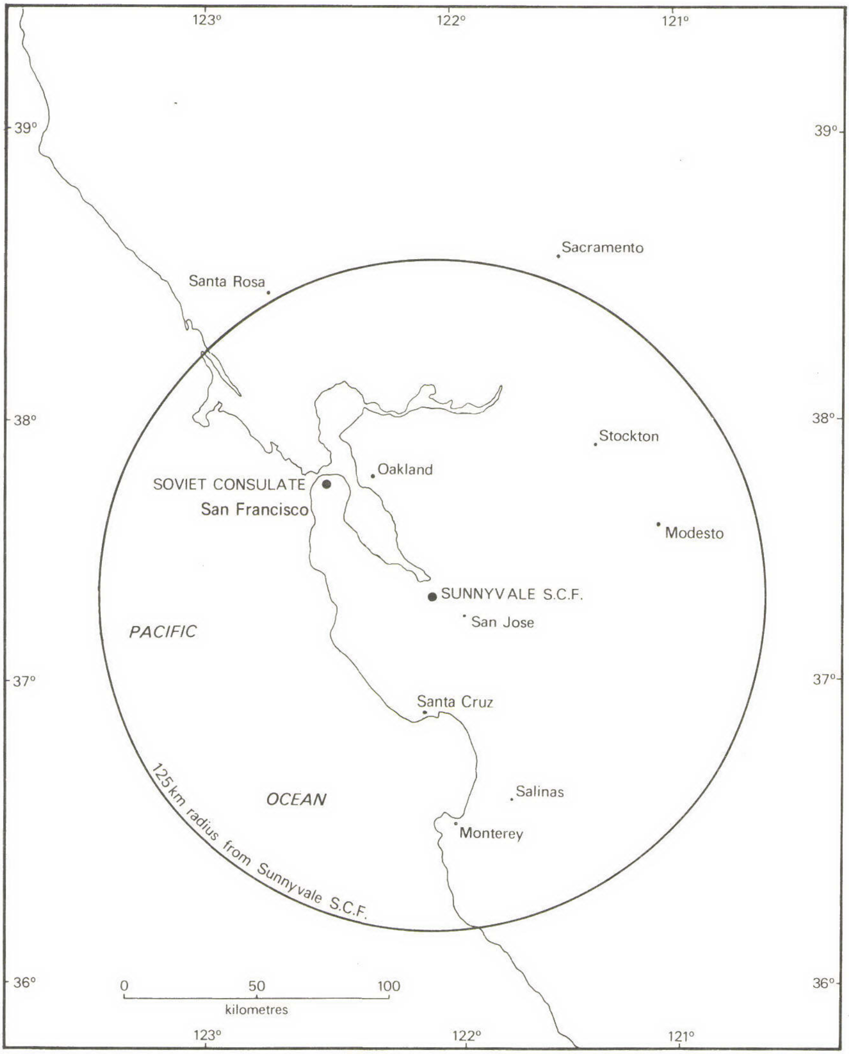
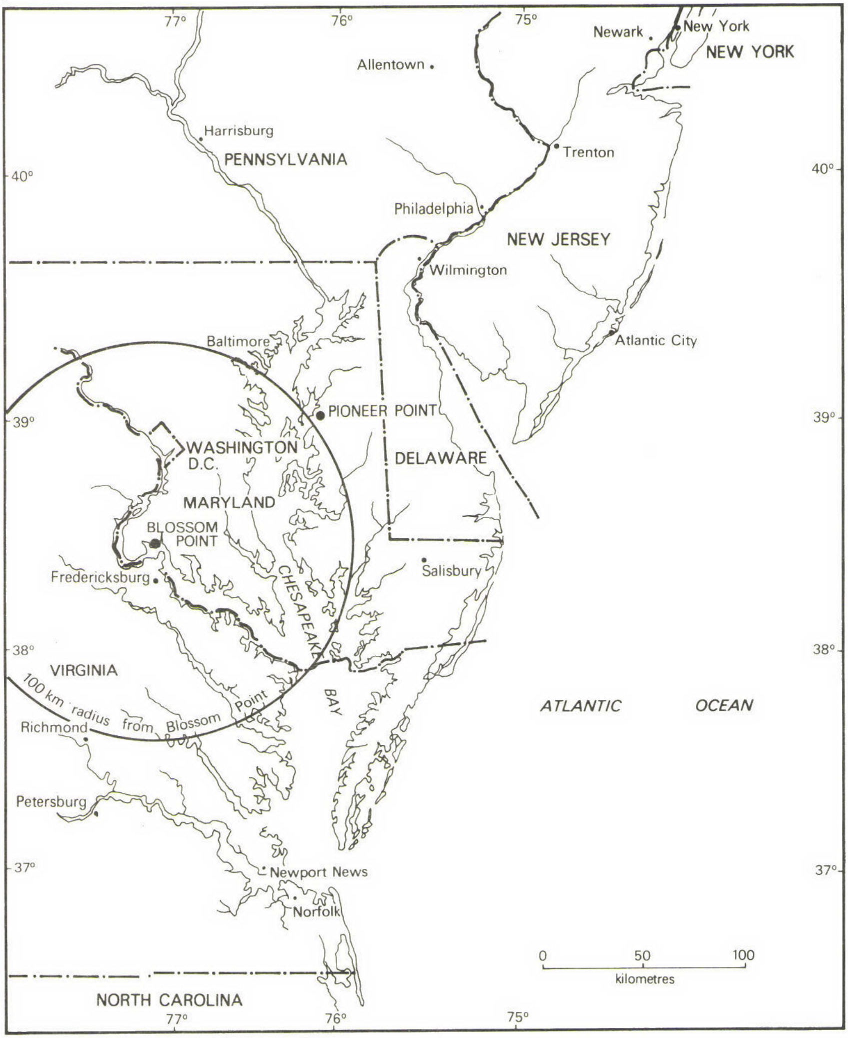


FIGURE 26

WHITE CLOUD ELINT OCEAN SURVEILLANCE SATELLITE SPOT BEAM COVERAGE, BLOSSOM POINT, MARYLAND



The US Navy's Classic Wizard/White Cloud Ocean Surveillance satellite system consists of about three clusters of a 'mother' satellite with three sub-satellites equipped with ELINT receivers and infra-red and microwave radiometers.[41] The sub-satellites are quite small, measuring 90x240x30 cm (3 x 8 x 1 feet). The collected intelligence is transmitted to the ground by each of the sub-satellites at slightly different frequencies - 1.4302 GHz, 1.4322 GHz, and 1.4343 GHz, using approximately 1 MHz of bandwidth.[42] The satellites orbit at an altitude of about 1100 km. Assuring a down-link antenna of 1.2 metres diameter, the ground spot would be about 200 km in diameter. The ground component of the Classic Wizard/White Cloud system consists of stations at Guam, Diego Garcia, Adak (Alaska), Winter Harbor (Maine) and Edzell (Scotland), with the master control station at Blossom Point in Maryland, some 55 km south of Washington, D.C. The White Cloud down-links to Blossom Point could be monitored by SATCOM systems in the Soviet diplomatic establishments in Washington, D.C. or the Soviet 'recreational' facility at Pioneer Point on the eastern shore of Maryland.

The US Keyhole (KH) photographic intelligence (PHOTINT) and imaging intelligence (IMINT) program has used three different techniques for the recovery of collected PHOTINT and IMINT. The first involved the return to earth of undeveloped film in capsules which were recovered by the 6594 Test Group at Hickam Air Force Base in Hawaii. The film was then sent to the CIA's National Photographic Interpretation Center (NPIC) in Building 213 in the Washington Navy Yard at 1st and M Streets SE in Washington, D.C. This technique was employed in the KH-4 Corona, KH-6, KH-8 Gambit and KH-9 Hexagon programs, but is evidently no longer

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41 Jeffrey T. Richelson and Desmond Ball, *The Ties That Bind: Intelligence Cooperation between the UKUSA Countries - the United Kingdom, the United States of America, Canada, Australia and New Zealand*, (Allen & Unwin, Boston, London and Sydney, 1985), pp.214-217.

42 *Aviation Week and Space Technology*, 10 July 1978, p.23; and 'Interference With Radio Astronomy', *Science*, (Vol.1950), 11 March 1977, p.932-933.

used.[43] The second technique involved the radio transmission to the SCF ground stations of photographs processed on board the satellites and converted into electrical signals, which were reconstructed into photographs at NPIC. This technique was employed in the KH-1 , KH-5, KH-7 and KH-9 programs. The KH-9 satellites typically had orbital perigees of about 160 km and apogees around 260 km, and used a 20-foot (6.5m) Space-Ground Link Sub-system (SGLS) for transmission of the photographs to the SCF ground stations.[44] Assuming the SGLS used a frequency of 2.2 GHz, the down-link ground spot would have a diameter of only 4.5 km.

The third technique, used with the KH-11 Kennan real-time digital imaging satellite system, involves an electro-optical system employing a 2-metre array of charge-coupled devices (CCDs). Visible light radiation collected by the CCDs is amplified, digitized, encrypted, and transmitted via satellite relay to the satellite ground station at Fort Belvoir, Virginia, some 16 km southwest of Washington D.C.[45] Three satellite relay systems are available for relay of the KH-11 digital images to the Fort Belvoir station - the Satellite Data System (SDS) satellites, which are deployed in highly elliptical orbits withapogees of about 39500 km, and which are used when the KH-11s are over high northern latitudes; the DSCS satellites, which were first used to relay imagery data transmitted to the SCF stations by the KH-7 radio transmission PHOTINT satellites in the late-1960s; and the NASA Tracking and Data Relay Satellite System (TDRSS). The TDRSS satellites, the first of which was successfully launched into geostationary orbit from the **Challenger** space shuttle on 5 April 1983 (1983-26B) and positioned at 41°W longitude, have seven antennas - two 16-foot (4.9 metre) steerable parabolic antennas for K- and S- band high-speed (100-300 bits per second) communication with other spacecraft (such as the KH-11s); a 28-element S-band antenna and an S-band omni antenna; two C-band transponders; and a 2-metre K-band

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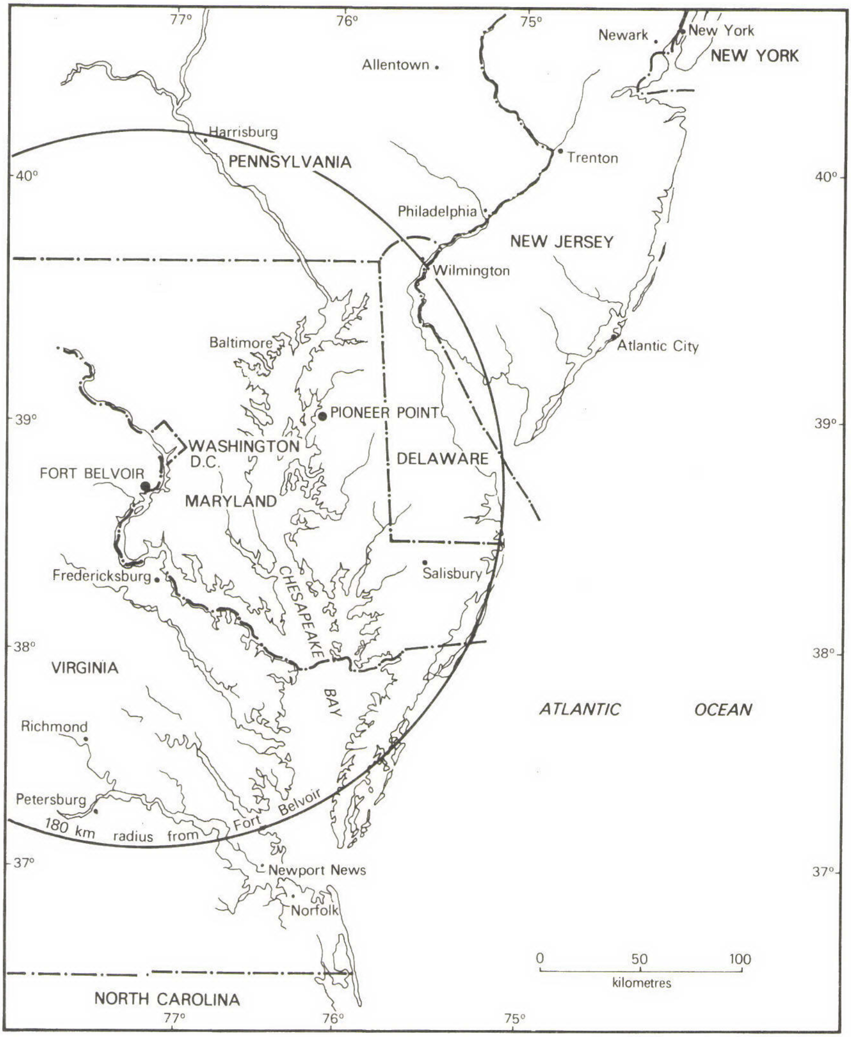
43 Jeffrey Richelson, 'The Keyhole Satellite Program', *The Journal of Strategic Studies*, (Vol.7, No.2, June 1984), pp.121-153.

44 Ted Greenwood, 'Reconnaissance and Arms Control', *Scientific American*, (Vol.228, No.2, February 1973), p.20.

45 William E. Burrows, *Deep Black: Space Espionage and National Security*, (Random House, New York, 1986), pp.243-246.

FIGURE 27
TDRSS SPOT BEAM FOR KH-11 DIGITAL IMAGERY DOWN-LINK, FORT BELVOIR, VIRGINIA



steerable dish for space-to-ground communications.[46] The ground spot for this down-link antenna would be about 360 km in diameter. Digital images transmitted to Fort Belvoir via TDRSS could be intercepted by SATCOM systems installed in Soviet diplomatic establishments in Washington, D.C., or in the Soviet 'recreational' facility at Pioneer Point, Maryland.

46 'TRW Exhibits Model of Fully Deployed TDRS', *Aviation Week and Space Technology*, 18 February 1985, p.130; 'First Space-to-Space Communications Link Between Satellites', *Defense Electronics*, October 1983, p.49; Donald Dickerson, 'Technical Data Relay Satellites', *Popular Communications*, April 1988, pp.54-55; and Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, pp.259-261, 444-445.

CHAPTER 4

THE LOURDES SIGINT COMPLEX

The most important Soviet SIGINT complex outside the Soviet Union itself is at Lourdes, some 60 miles south of Havana, Cuba. In March 1983, President Reagan stated that

> This Soviet intelligence collection facility less than 100 miles from our coast is the largest of its kind in the world. The acres and acres of antennae fields and intelligence monitors are targeted on key U.S. military installations and sensitive activities. The installation, in Lourdes, Cuba, is manned by 1,500 Soviet technicians, and the satellite ground station allows instant communications with Moscow. This 28-square mile facility has grown by more than 60 percent in size and capability during the past decade.[1]

The Lourdes complex has continued to expand since 1983. According to a report released jointly by the Department of State and the Department of Defense in March 1985, there were then 'about 2,100 [Soviet] technicians at the Lourdes electronic intelligence facility'[2] - a growth of 40 per cent since March 1983. The complex has cost some $2-3 billion to construct and equip.

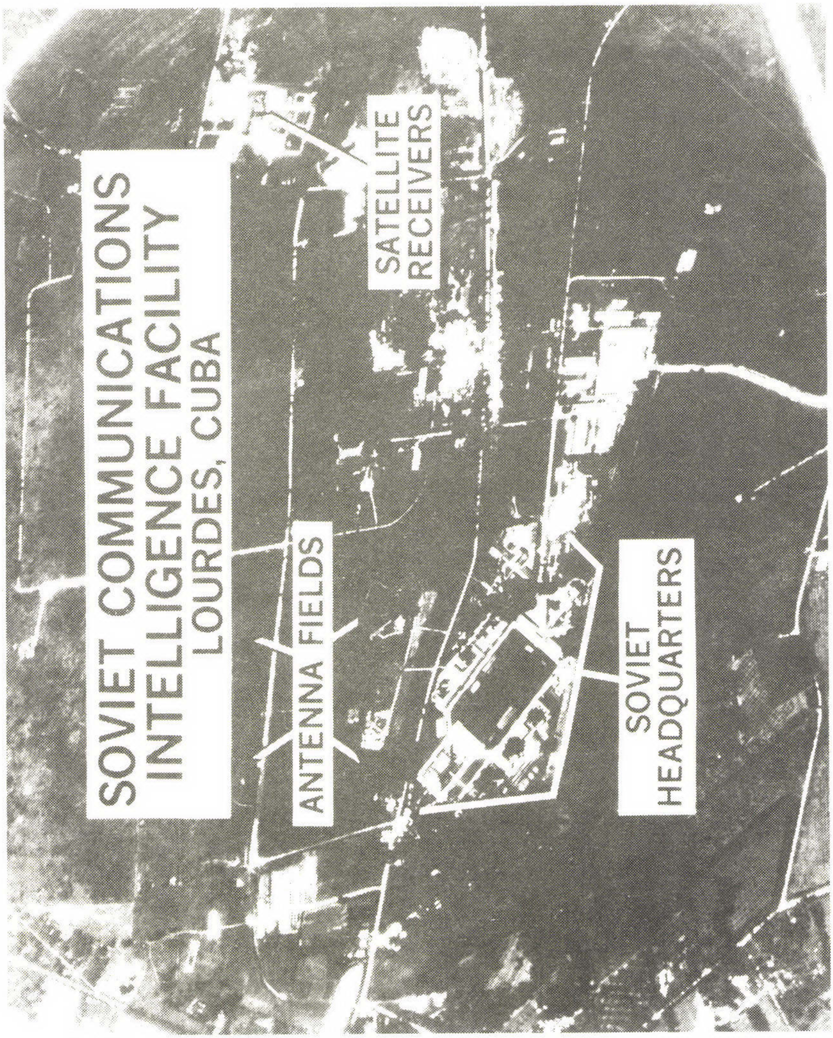
The State Department/Defense Department report of March 1985 provides the most comprehensive official public description of the Lourdes SIGINT complex:

> Cuba's strategic location makes it an ideal site for an intelligence facility directed against the United States. The Soviet Union established such a site at Lourdes near Havana in the mid-1960s. Lourdes today is themost sophisticated Soviet [SIGINT] collection

1 *Text of President Reagan's Address on National Security*, Washington, D.C., 23 March 1983, p.4.

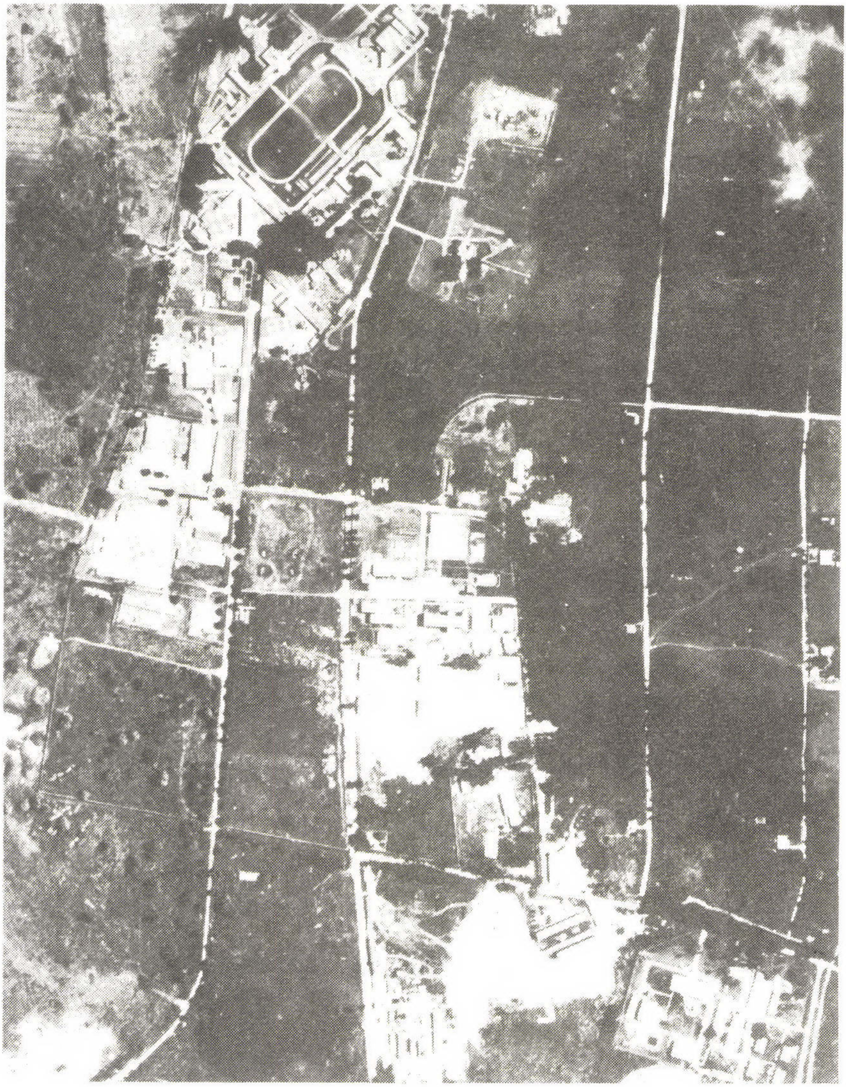
2 Department of State and Department of Defense, *The Soviet-Cuban Connection in Central America and the Caribbean*, (U.S. Government Printing Office, Washington, D.C., March 1985), p.3.

FIGURE 28
SOVIET SIGINT STATION, LOURDES, CUBA



Source: US Department of Defense.

FIGURE 29
SOVIET SIGINT STATION, LOURDES, CUBA



Source: US Department of Defense.

> facility outside the Soviet Union itself. From this key listening post, the Soviets monitor U.S. commercial satellites, U.S. military and merchant shipping communications, and NASA space program activities at Cape Canaveral. Lourdes also enables the Soviets to eavesdrop on telephone conversations in the United States.[3]

And according to a report by the Department of Defense published in April 1985,

> The Soviets ... have extensive signal intelligence facilities in Cuba. At the Lourdes complex near Havana, the Soviets have three separate sites dedicated to signals intelligence collection. These sites are targeted primarily against US commercial satellites.[4]

Major-General George J. Keegan, former Chief of Air Force Intelligence, has described the SIGINT facilities at Lourdes as consisting of 'vast antenna farms, big dish satellite receiver terminals and multi-channel high-speed microwave relay systems'.[5] The antenna field is actually located at Los Paliacios,[6] while the satellite ground terminals are nearby at Torrens, near Pinar del Rio.[7] There are about 50 buildings at Lourdes which contain the monitoring, processing and analysis equipment.[8] Installation of the first large satellite receiving antennas was completed in early 1974, just three months before the first Hughes/Western Union WESTAR satellite (1974-22A, launched on 13 April 1974) became operational. Additional

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3 *Ibid.*, pp.3-4.

4 Department of Defense, *Soviet Military Power 1985*, (U.S. Government Printing Office, Washington, D.C., Fourth Edition, April 1985), p.120.

5 David Binder, 'Senate Panel Calls a Hearing on Intelligence on Cuba', *New York Times*, 7 September 1979, p.A6.

6 Gloria Duffy, 'Crisis Mangling and the Cuban Brigade', *International Security*, (Vol.8, No.1), Summer 1983, p.80.

7 C.A. Robinson, 'USSR Cuba Force Clouds Debate on SALT', *Aviation Week and Space Technology*, 10 September 1979, p.16.

8 Joe Trento, 'Cuba Crisis Tied to US Laser Gun', *News Journal*, 8 September 1979, p.1.

satellite receiving antennas for COMSAT monitoring were reported in December 1977 to have 'recently' become operational.[9] The SATCOM antenna and support complex identified by the Defense Intelligence Agency (DIA) as Space Associated Electronics Area North, which is just west of the Lourdes Soviet Headquarters, has at least five SATCOM antennas, and the complex identified as Space Associated Electronics Area South, which is some distance southwest of the Headquarters, has at least two such antennas.[10] (See Figure 30.) Two Orbita ground terminals are used to transmit bulk-encrypted communications intelligence (COMINT) to the GRU's main radio receiving centre at Vatutinki (some 35 miles southwest of Moscow), via Molniya 1 satellites in highly elliptical orbits over the northern hemisphere, in near real-time.

According to Lieutenant Colonel Oliver North,

> At Lourdes, Cuba, is the largest signals-intelligence site in the world ... They have a direct dial-tone indicator code and a computer down there which they stole from the United States, and that computer shunts telephone messages in the Pentagon, White House and CIA prefixes directly into the earphones of a Soviet linguist who translates it and immediately broadcasts it back to the Soviet Union for action.[11]

The Lourdes complex is ideally located for the interception of an extremely wide range of communications and other electromagnetic signals transmitted over the south-eastern part of the United States. When the SIGINT facilities were established in the mid-1960s, the primary targets were US HF communications in general and US Navy Fleet communications in particular. Since 1974, however, the interception of satellite communications and data links has become a higher priority. There is also a highly secret cell of Soviet civilian

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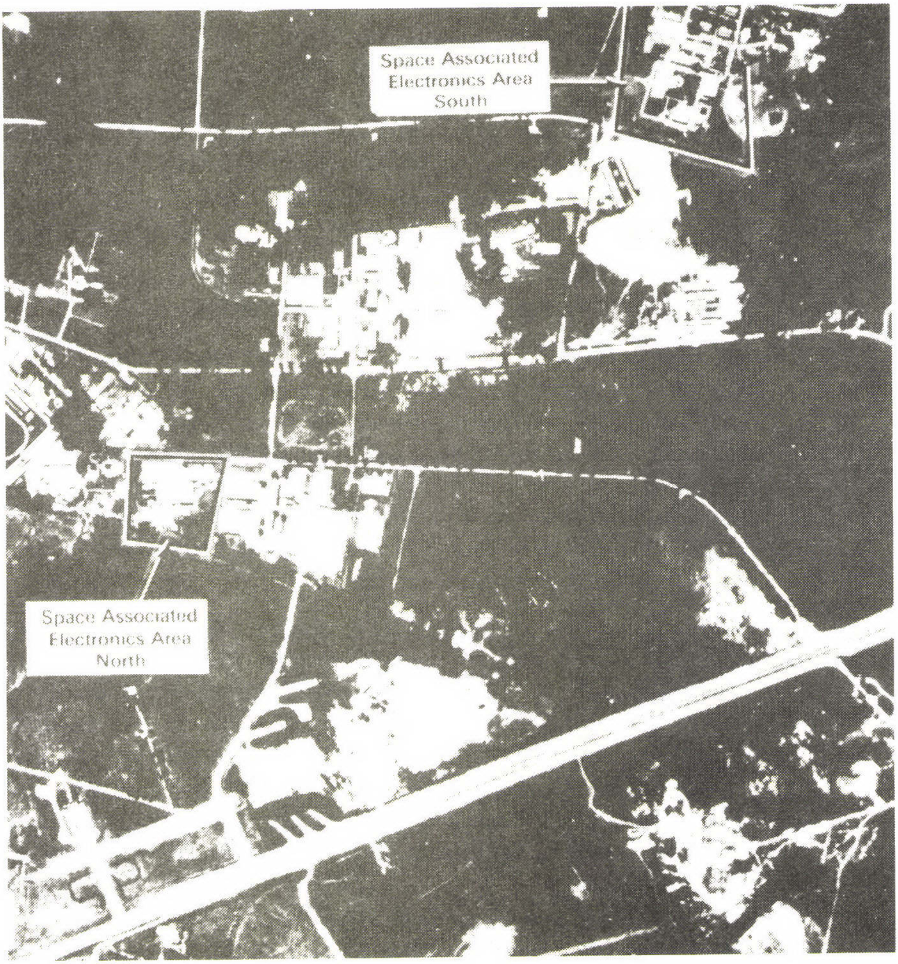
9 George C. Wilson, 'Soviets Place Antennas in Cuba to Intercept U.S. Messages', *Washington Post*, 23 December 1977, p.A22.

10 Defense Intelligence Agency (DIA), *Handbook on the Cuban Armed Forces*, (Defense Intelligence Agency, Washington, D.C., DDB-2680-62-86, 1986), p.8-3.

11 Cited in Ben Bradlee Jnr., *Guts and Glory: The Rise and Fall of Oliver North*, (Grafton Books, London, 1988), pp.241-242.

FIGURE 30
SATCOM INTERCEPT FACILITIES, LOURDES, CUBA



Source: US Defense Intelligence Agency (DIA).

SIGINT processors and analysts at Lourdes who are specifically concerned with the collection of political and economic information.

The various large dish antennas are designed to intercept satellite communications - and, more specifically, the communications and other signals transmitted from satellites stationed in geostationary orbits (i.e. approximately 36,000 km altitude) above the Atlantic and eastern Pacific Oceans. For satellites at this altitude, the purview of the Lourdes station extends across some 150° from about 8°W to about 158°W longitudes (Figure 31). As listed in Table 2, there are presently some 217 satellites either operational or proposed for placement in geostationary orbit within this purview - some 70 operational and some 147 proposed.[12] These satellites can be categorised as follows:

1. *US and NATO Defence Intelligence Satellites*

The United States generally maintains more than a dozen defence communications and early warning satellites in the geostationary band within the purview of Lourdes - including some 5-6 Defense Satellite Communications System (DSCS) satellites, stationed mainly around either 12°W or 52.5°W over the Atlantic Ocean, or 135°W over the eastern Pacific Ocean (DSCS EPAC); three Code 647 Defense Support Program (DSP) ballistic missile early warning satellites, stationed around 70°W to provide warning of SLBM launches from the Atlantic Ocean (DSP-W LANT), around 134°W to provide warning of SLBM launches from the eastern Pacific Ocean

12 The data in Table 2 is compiled from Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, (Howard W. Sams & Company, Indianapolis, Indiana, Second Edition, 1987), pp.612-613, and 616-617; Tina D. Thompson (ed.), *TRW Space Log 1957-1987*, (Space and Technology Group, Space and Defense Sector, TRW, Redondo Beach, California, Vol.23, 1988); International Frequency Registration Board (IFRB), International Telecommunication Union (ITU), *List of Geostationary Space Stations (List A/List B)*, (IFRB, ITU, Geneva, 8 December 1988); and lists of planned and existing geostationary satellites issued by Ford Aerospace and Communication Corporation, and Communications Satellite (COMSAT) Corporation.

FIGURE 31
COVERAGE OF LOURDES SATELLITE COMMUNICATIONS INTERCEPT STATION (GEOSTATIONARY SATELLITES)

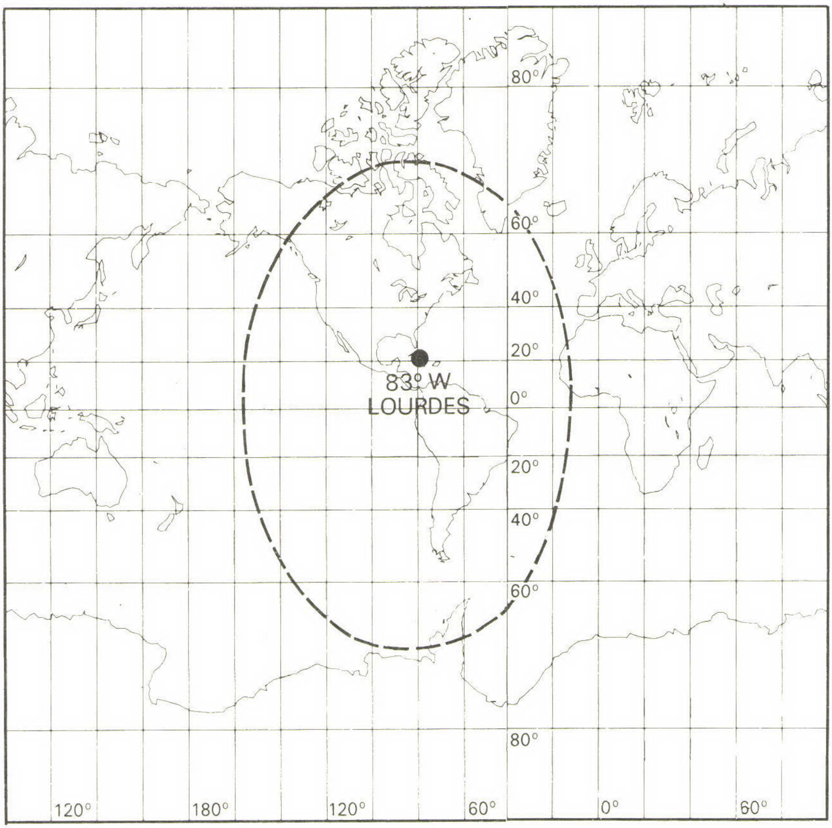


TABLE 2: EXISTING AND PLANNED GEOSTATIONARY SATELLITES WITHIN PURVIEW OF SATELLITE COMMUNICATIONS MONITORING STATION, LOURDES, CUBA

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
1	Telecom-IIA	-	France	1991	8°W	Proposed French domestic communications
2	Telecom-IA	1984-81B	France	4 Aug.1984	8.4°W	French domestic and military communications
3	Skynet 4A	-	UK	-	10°W	Proposed UK/NATO military COMSAT
4	Statsionar-11	-	USSR	-	11°W	Proposed
5	F-Sat-2	-	France	-	11°W	Proposed
6	DSCS 14	1979-98B	US	21 Nov.1979	12°W	May have ceased operations with launch of DSCS III B-4 (1985-92B)
7	Marots B	-	France	-	12.5°W	Proposed
8	Gorizont-04	1980-49A	USSR	14 June 1980	13.1°W	Domestic communications
9	Potok-1	-	USSR	-	13.5°W	Domestic communications
10	Gorizont-07	1983-66A	USSR	1 July 1983	13.7°W	Domestic communications
11	Gorizont-12	1986-44A	USSR	10 June 1986	14°W	Domestic communications
12	More-14	-	USSR	-	14°W	Maritime communications
13	Statsionar-04	-	USSR	-	14°W	Domestic communications
14	Loutch-01	-	USSR	-	14°W	Domestic communications
15	Kosmos 1738	1986-27A	USSR	4 April 1986	14°W	Communications relay
16	DSCS III B-4	1985-92B	US	3 Oct.1985	14°W	DSCS III satellite, provides coverage over the Atlantic Ocean (DSCS LANT)
17	Marisat-Atlantic-101	-	International	1976	14.6°W	Maritime communications
18	Inmarsat-2F 1	-	International	1988	15°W	Maritime communications
19	Eutelsat 1-2	1984-81A	International	4 Aug.1984	15.8°W	Regional communications
20	LEASAT 1	1984-93C	US	31 Aug.1984	15°W	US Navy leased UHF broadcast satellite. Wideband (500 KHz) channel malfunctioned.
21	MILSTAR 3	-	US	-	16°W	US EHF military strategic and tactical relay satellite system
22	WSDRN-1	-	USSR	-	16°W	Tracking and data relay
23	WSDRN-2	-	USSR	-	16°W	Tracking and data relay
24	ZSSRD-2	-	USSR	-	16°W	Tracking and data relay
25	Intelsat IBS 343.5E	-	International	-	16.5°W	International communications
26	Intelsat IVA 343.5E	-	International	-	16.5°W	International communications
27	Intelsat V 343.5E	-	International	-	16.5°W	International communications
28	Intelsat VA 343.5E	-	International	-	16.5°W	International communications
29	Belgium Satcom 2	-	Belgium	-	18°W	Proposed
30	Belgium Satcom 3	-	Belgium	-	18°W	Proposed
31	Intelsat AO-Maj-2	-	International	-	18.5°W	International maritime communications
32	Intelsat IBS 341.5E	-	International	-	18.5°W	International communications

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
33	Intelsat V-F6	1983-47A	International	19 May 1983	18.6°W	International communications
34	Luxsat	-	Luxembourg	-	19°W	Proposed
35	Helvesat-1	-	Switzerland	1990	19°W	Proposed broadcast satellite
36	Helvesat-2	-	Switzerland	1991	19°W	Proposed broadcast satellite
37	Olympus-1	-	International	1989	19°W	Proposed broadcast satellite
38	Olympus-2	-	International	-	19°W	Proposed broadcast satellite
39	Sarit	-	Italy	1989	19°W	Proposed broadcast satellite
40	TDF-1A	-	France	1988	19°W	Proposed broadcast satellite
41	TDF-1B	-	France	1989	19°W	Proposed broadcast satellite
42	TDF-2	-	France	-	19°W	Proposed broadcast satellite
43	TV-Sat F1	-	W.Germany	1989	19°W	Proposed broadcast satellite
44	TV-Sat A5	-	W.Germany	-	19°W	Proposed broadcast satellite
45	Intelsat AO-Dom&MCS	-	International	-	21.5°W	International and maritime communications
46	Intelsat IVA-F4	1977-41A	International	26 May 1977	21.5°W	International communications
47	Intelsat VA 338.5E	-	International	-	21.5°W	International communications
48	Avsat AM	-	US	-	22°W	Aeronautical communications
49	Marecs 2	-	ESA	-	23°W	Proposed European Space Agency maritime communications satellite
50	FLTSATCOM 3	1980-4A	US	17 Jan.1980	23°W	US Navy fleet broadcast satellite
51	Intelsat V-F10	1985-25A	International	22 March 1985	24.4°W	International communications
52	Intelsat VI 335.5E	-	International	-	24.5°W	International communications
53	Raduga-07	1980-81A	USSR	5 Oct.1980	24.7°W	Domestic and government communications. Also known as Statsionar-3
54	Statsionar-08	-	USSR	-	25°W	Domestic communications
55	Kosmos 1546	1984-31A	USSR	29 March 1984	25°W	No mission characterisation provided
56	Kosmos 1629	1985-16A	USSR	21 Feb.1985	25°W	No mission characterisation provided
57	Marecs 1	-	ESA	-	26°W	Proposed European Space Agency maritime communications satellite
58	Inmarsat-2F2	-	International	1989	26°W	Maritime communications
59	Statsionar-D01	-	USSR	-	26.5°W	Diplomatic communications
60	Intelsat AO-Spare 2	-	International	-	27.5°W	International and maritime communications
61	Intelsat VA-F11	1985-55A	International	30 June 1985	27.5°W	International communications
62	Intelsat V-F3	1981-119A	International	15 Dec.1981	27.5°W	International communications
63	Intelsat VA Alt 2	-	International	-	27.5°W	International communications
64	Intelsat VI 332.5E	-	International	-	27.5°W	International communications
65	Marecs I	1981-122A	International	20 Dec.1981	27.9°W	Maritime communications. Leased by INMARSAT from the European Space Agency

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
66	Intelsat AO-Spare 1	-	International	-	31°W	International communications
67	Intelsat VA Alt 6	-	International	-	31°W	International communications
68	Intelsat V Alt 6	-	International	-	31°W	International communications
69	Falklands	-	UK	-	31°W	Proposed
70	British Sat.B/C-1	-	UK	1989	31°W	Proposed
71	British Sat.B/C-2	-	UK	1990	31°W	Proposed
72	Intelsat IVA-F1	1975-91A	International	26 Sept.1975	31.1°W	International communications
73	Atlantic Sat.	-	Ireland	1990	32°W	Domestic and broadcast communications
74	Guyana & Jamaica	-	Guyana & Jamaica		34°W	Proposed
75	Intelsat V-F4	1982-17A	International	5 March 1982	34.4°W	International communications
76	Intelsat AO-Maj-1	-	International	-	34.5°W	International communications
77	Orion-1	-	International	1988	37.5°W	International communications
78	Videosat-2	-	France	-	37.5°W	Proposed
79	Intelsat IBS 319.5E	-	International	-	40.5°W	International communications
80	Intelsat VA319.5E	-	International	-	40.5°W	International communications
81	TDRSS 1	1983-26B	US	5 April 1983	41°W	Tracking and data relay satellite. Coverage extends from the central Pacific eastward to the central Indian Ocean. Operating with steadily diminishing capability.
82	Grenada	-	Grenada	-	42°W	Proposed
83	Videosat-3	-	France	-	43.5°W	Proposed
84	Brazil	-	Brazil	-	45°W	Proposed
85	Simon Bolivar	-	International	1988	45°W	International communications
86	Orion-2	-	International	1988	47°W	International communications
87	Finansat-1	-	International	1990	47°W	International communications
88	NATO 3C	1978-106A	NATO	19 Nov.1978	50°W	Launched on 19 Nov.1978 and positioned at 50°W between Africa and South America as a spare. Remained in orbital storage for nearly 8 years. Reactivated in late 1986
89	Intelsat IBS 310E	-	International	-	50°W	International communications
90	Intelsat IBS 307E	-	International	-	53°W	International communications
91	Intelsat AO-Spare 3	-	International	-	53°W	International communications
92	Intelsat VA Cont.1	-	International	-	53°W	International communications
93	Argentina	-	Argentina	-	55°W	Proposed broadcast satellite
94	Intelsat IBS 304E	-	International	-	56°W	International communications
95	Intelsat VA 304E	-	International	-	56°W	International communications
96	ISI-1	-	International	-	56°W	International communications

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
97	Panamsat-2	-	International	1988	57°W	International communications
98	Falklands	-	Argentina	-	57°W	Proposed broadcast satellite
99	Avsat BM	-	US	-	58°W	Aeronautical communications
100	ISI-2	-	International	-	58°W	International communications
101	Intelsat IBS 300E	-	International	-	60°W	International communications
102	Intelsat VA 300E	-	International	-	60°W	International communications
103	USA-BSS	-	US	-	61.5°W	Proposed broadcast satellite
104	Satcom VII	-	US	-	62°W	Domestic communications
105	SBS-6	-	US	-	62°W	Domestic communications
106	ASC-3	-	US	1990	64°W	Domestic communications
107	ASC-4	-	US	1992	64°W	Domestic communications
108	Brazil	-	Brazil	-	64°W	Proposed broadcast satellite
109	Brazilsat-1	1985-15B	Brazil	8 Feb.1985	65°W	Domestic communications
110	Spacenet II	1984-114A	US	10 Nov.1984	69°W	Domestic communications
111	DSP 10	1982-19A	US	6 March 1982	70°W	US ballistic missile early warning satellite. Provides warning of SLBM launches from the western Atlantic Ocean
112	Brazilsat-2	1986-26B	Brazil	28 March 1986	70°W	Domestic communications
113	Canada-BSS	-	Canada	-	70.5°W	Proposed broadcast satellite
114	Galaxy K1	-	US	1989	71°W	Domestic communications
115	Uruguay	-	Uruguay	-	71.5°W	Proposed broadcast communications
116	Satcom IIR	1983-94A	US	8 Sept.1983	72°W	Domestic communications. RCA
117	Canada-BSS	-	Canada	-	72.5°W	Proposed broadcast satellite
118	Westar A	-	US	-	73°W	Domestic communications
119	Galaxy II	1983-98A	US	22 Sept.1983	74°W	Domestic communications
120	Brazil	-	Brazil	-	74°W	Proposed broadcast satellite
121	Satcol II	-	Colombia	-	75°W	Domestic communications
122	Comstar K-1	-	US	1988	75°W	Domestic communications
123	GOES 7	1987-22A	US	26 Feb.1987	75°W	Geostationary Operational Environmental Satellite
124	Satcol IA	-	Colombia	-	75.4°W	Domestic communications
125	Satcol IB	-	Colombia	-	75.4°W	Domestic communications
126	Comstar D4	1981-18A	US	21 Feb.1981	76°W	Domestic communications
127	Comstar D2	1976-73A	US	22 July 1976	76.3°W	Domestic communications
128	Expresstar B	-	US	-	77°W	Domestic communications
129	Amigo 3	-	Mexico	-	78°W	Proposed broadcast satellite
130	TDRSS Central	-	US	-	79°W	US tracking and data relay satellite
131	Nahuel I	-	Argentina	-	80°W	Domestic communications

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
132	Brazil	-	Brazil	-	81°W	Proposed broadcast satellite
133	Satcom K-2	1985-109D	US	28 Nov.1985	81°W	Domestic communications
134	Canada-BSS	-	Canada	-	82°W	Proposed broadcast satellite
135	ASC-2	-	US	-	83°W	Domestic communications
136	RCA Satcom IV	1982-4A	US	16 Jan.1982	83°W	Domestic communications
137	STSC-1	-	Cuba	-	83°W	Regional communications
138	Haiti & Dominican Rep.	-	Haiti & Dominican R.		83.5°W	Proposed broadcast satellite
139	NE South America	-	Guyana/Trinidad/ Surinam		84.5°W	Proposed broadcast satellite
140	Nahuel II	-	Argentina	-	85°W	Domestic communications
141	Satcom K-1	1986-3B	US	12 Jan.1986	85°W	Domestic communications
142	Satcom K-3	-	US	1989	85°W	Domestic communications
143	Satcom K-4	-	US	1990	85°W	Domestic communications
144	DSP 8	1979-53A	US	10 June 1979	85°W	US ballistic missile early warning satellite. Provides warning of SLBM launches from the Pacific Ocean
145	Telstar 3C	1984-93D	US	1 Sept.1984	86°W	Domestic communications
146	Peru	-	Peru	-	86°W	Proposed broadcast satellite
147	Spacenet IV(III')	-	US	1988	87°W	Domestic communications
148	Cuba	-	Cuba	-	89°W	Proposed broadcast satellite
149	Canada-BSS	-	Canada	-	91°W	Proposed broadcast satellite
150	SBS-4	1984-93B	US	31 Aug.1984	91°W	Domestic communications
151	Westar VI-S	-	US	1988	91°W	Domestic communications
152	Westar III	1979-72A	US	10 Aug.1979	91°W	Domestic communications. Owned by Western Union. Also used for US defence and intelligence communications (e.g. DMSP)
153	Caribbean	-	International	-	92.5°W	Proposed broadcast satellite
154	Galaxy III	1984-101A	US	21 Sept.1984	93.5°W	Domestic communications
155	Argentina	-	Argentina	-	94°W	Proposed broadcast satellite
156	Ecuador	-	Ecuador	-	95°W	Proposed broadcast satellite
157	SBS-3	1982-110B	US	11 Nov.1982	95°W	Domestic communications. Provides all-digital transmission of telephone, computer, electronic mail, and video conferencing to Satellite Business Systems clients
158	Bermuda	-	Bermuda	-	96°W	Proposed broadcast satellite
159	Telstar 3A	1983-77A	US	28 July1983	96°W	AT&T domestic communications

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
160	SBS-2	1981-96A	US	24 Sept.1981	97°W	Domestic communications for Satellite Business Systems Corp.
161	STSC-2	-	Cuba	1989	97°W	Regional communications
162	Paraguay	-	Paraguay	-	99°W	Proposed broadcast satellite
163	Westar IV	1982-14A	US	26 Feb.1982	99°W	Domestic communications. TV, voice and facsimile data.
164	USA-BSS	-	US	-	101°W	Proposed broadcast satellite
165	SBS-1	1980-91A	US	15 Nov.1980	101°W	Domestic communications for Satellite Business Systems clients
166	Brazil	-	Brazil	-	102°W	Proposed broadcast satellite
167	Colombia	-	Colombia	-	103°W	Proposed broadcast satellite
168	Gstar I	1985-35A	US	8 May 1985	103°W	Domestic communications
169	LEASAT 2	1984-113C	US	10 Nov.1984	105°W	US Navy leased UHF fleet broadcast satellite
170	Venezuela	-	Venezuela	-	104°W	Proposed broadcast satellite
171	Anik D-1	1982-82A	Canada	26 Aug.1982	104.5°W	Canadian domestic communications. Also known as Telesat G.
172	Gstar II	1986-26A	US	28 March 1986	105°W	Domestic communications
173	Chile	-	Chile	-	106°W	Proposed broadcast satellite
174	Msat	-	Canada	-	106.5°W	Maritime communications
175	Anik C-1	1985-28B	Canada	12 April1985	107.5°W	Canadian domestic communications
176	Anik C-2	1983-59B	Canada	18 June1983	110°W	Canadian domestic communications. Also known as Telesat 7
177	FLTSATCOM 1	1978-16A	US	9 Feb.1978	110°W	US Navy fleet broadcast satellite
178	FLTSATCOM 7	1986-96A	US	10 Dec.1986	110°W	US Navy fleet broadcast satellite. Equipped with EHF test payload.
179	Anik D-2	1984-113B	Canada	9 Nov.1984	110.5°W	Domestic communications
180	Morelos-1	1985-48B	Mexico	18 June 1985	113.5°W	Domestic communications. Also known as Ilhuicahua 1
181	Avsat 3	-	US	1988	114°W	Aeronautical communications
182	Andean BSS	-		-	115°W	Proposed broadcast satellite. Venezuela, Colombia, Peru, Ecuador and Bolivia
183	Morelos-2	1985-109B	Mexico	27 Nov.1985	116.5°W	Domestic communications. Also known as Ilhuicahua 2
184	Anik C-3	1982-110C	Canada	12 Nov.1982	117.5°W	Domestic communications. Also known as Telesat E
185	USA-BSS	-	US	-	119°W	Proposed broadcast satellite
186	MILSTAR 6		US	-	120°W	US EHF military strategic and tactical relay satellite system
187	Spacenet I	1984-49A	US	23 May 1984	120°W	Domestic communications
188	Galaxy IV	-	US	1993	122°W	Domestic communications
189	SBS-5	-	US	-	122°W	Domestic communications

	Satellite	Designation	Country	Date of Launch	Station Longitude	Comments
190	Westar V	1982-58A	US	9 June1982	122.5°W	Domestic communications. Owned by Western Union. Used to relay voice, data, video and facsimile to CONUS, Hawaii, Alaska, Puerto Rico and Virgin Islands.
191	Expresstar A	-	US	-	124°W	Domestic communications
192	Gstar III (Initial)	-	US	1987	124°W	Domestic communications
193	DSCS II	1978-113A	US	13 Dec.1978	124°W	DSCS satellite. Provides coverage over the eastern Pacific Ocean (EPAC)
194	Telstar 3C	1984-93D	US	1 Sept.1985	125°W	Domestic communications
195	Amigo 4	-	Mexico	-	127°W	Proposed broadcast satellite
196	ASC-1	1985-76C	US	27 Aug.1985	128°W	Domestic communications. CONTEL Corp.
197	Canada-BSS	-	Canada	-	129°W	Proposed broadcast satellite
198	Galaxy K-2	-	US	-	130°W	Domestic communications
199	DSCS 13	1979-98A	US	21 Nov.1979	130°W	DSCS III satellite. Provides coverage over Western Pacific Ocean (WPAC). May have been superceded by 1982-106B.
200	Satcom IIIR	1981-114A	US	19 Nov.1981	131°W	Domestic communications
201	Westar B	-	US	-	132°W	Domestic communications
202	Galaxy I	1983-65A	US	28 June 1983	133.9°W	Domestic communications. Hughes TV.
203	Comstar K-2	-	US	-	134°W	Domestic communications
204	DSP 9	1981-25A	US	16 March 1981	134°W	US ballistic missile early warning satellite
205	DSCS 3-A1	1982-106B	US	30 Oct.1982	135°W	DSCS III satellite, provides coverage over the Western Pacific Ocean (WPAC)
206	GOES W	-	US	-	135°W	Geostationary Operational Environmental Satellite
207	Amigo I	-	Mexico	-	136°W	Proposed broadcast satellite
208	Gstar III (Final)	-	US	-	136°W	Domestic communications
209	Canada-BSS	-	Canada	-	138°W	Proposed broadcast satellite
210	NATO 3D	1984-115A	NATO	14 Nov.1984	138°W	Military communications
211	Satcom IR	1983-30A	US	11 April 1983	139°W	Domestic communications. Also known as RCA Satcom VI. First completely solid-state domestic COMSAT. Provides coverage of CONUS, Alaska and Hawaii
212	Aurora I	1982-105A	US	28 Oct.1982	143°W	Domestic communications. Also known as RAC Satcom V. Provides telephony, video and high speed data to all 50 US states.
213	Aurora IR	-	US	-	143°W	Domestic communications
214	Amigo 2	-	Mexico	-	146°W	Proposed broadcast satellite
215	USA-BSS	-	US	-	148°W	Proposed broadcast satellite
216	MILSTAR 12	-	US	-	148°W	US EHF military strategic and tactical relay satellite system
217	USA-BSS	-	US	-	157°W	Proposed broadcast satellite

(DSP-W PAC), and around 85°W as an in-orbit back-up station to the primary pair; two or three US Navy Fleet Satellite Communications (FLTSATCOM) satellites, stationed around 23°W and 110°W; and two US Navy LEASATs, stationed at 15°W and 105°W.

In addition, there are two NATO SATCOMs stationed within the purview of Lourdes. NATO-3C (1978-106A) was launched on 19 November 1978 and placed at 50°W between Africa and South America as an in-orbit spare. It remained in orbital storage for nearly eight years, and was reactivated by a signal from the US Satellite Control Facility (SCF) station at Oniszuka Air Force Station at Sunnyvale in California, transmitted via the SCF station at New Boston in New Hampshire, in late 1986. NATO-3D (1984-115A) was launched on 14 November 1984 and stationed at 138°W. The NATO satellites are inter-operable with the DSCS system, and used for military and diplomatic communications between the US and the other NATO countries.[13]

The defence satellites proposed for placement in the relevant geostationary band are three MILSTAR EHF COMSATs (16°W, 120°W and 148°W) and the British Skynet-4A satellite (10°W).

The satellite receiving antennas at Lourdes are able to intercept the communications and data transmitted through the DSCS, NATO, FLTSATCOM and LEASAT systems. Major DSCS terminals in the south-eastern part of the United States include the DSCS Net Control Facilities (NCFs) at Fort Detrick in Maryland, Fort Meade in Maryland and Northwest in Virginia, as well as stations at Brandywine in Maryland, Fort Dix and Fort Monmouth in New Jersey, and Fort Gordon in Georgia. There are also DSCS ground terminals at Guantanamo in Cuba and Howard Air Force Base in Panama. A master control station for the Navy's FLTSATCOM and LEASAT satellites is located at Norfolk in Virginia.

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13 Reginald Turnill (ed.), *Jane's Spaceflight Directory 1987*, (Jane's Publishing Company Limited, London, Third Edition, 1988), p.349.

2. *Other US Geostationary Satellites*

There are some 61 US commercial and other non-military geostationary satellites either operational (29) or proposed for placement (32) within the purview of Lourdes. The 29 currently operational satellites include the Hughes/Western Union WESTAR satellites controlled from the WESTAR Control Center at Glenwood in New Jersey and known to be a primary interest of the Lourdes operation; the Satellite Business Systems (SBS) communications satellites; the SATCOM system operated by Radio Corporation of America (RCA); CONTEL Corporation's ASC-1 (1985-76C); COMSAT Corporation's COMSTAR satellites; and the American Telephone and Telegraph (AT&T) TELSTAR satellites.

According to the Department of Defense,

> The importance of the facility [at Lourdes] is that it provides the Soviets, together with similar facilities in the USSR, complete coverage of the global beams of all US geosynchronous communications satellites.[14]

As described in Chapter 3, almost 10 per cent of all channels carried on US commercial COMSATs - more than 1,100 circuits - are dedicated to use by the US Department of Defense. The Hughes/Western Union WESTAR system, for example, provides critical communications services for the Defense Meteorological Satellite Program (DMSP) and the CIA's covert satellite communications system. The RCA SATCOM system provides communications between important air defence and intelligence activities in Alaska and the continental US (CONUS), and also comprises part of the NSA's Maroon Shield system for SIGINT communications.

In addition to these dedicated Department of Defense circuits, US COMSATs are also used for communications between Defense facilities and defence contractors and for communications generally within the defence industrial community. These communications are also of major interest to the Lourdes station. For example, it has been reported that in 1978 Lourdes obtained two secret identification codes which served as passwords to the Cray supercomputer at Lockheed in

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14 Department of Defense, *Soviet Military Power 1984*, (U.S. Government Printing Office, Washington, D.C., Third Edition, April 1984), p.126.

California, and that between 1978 and 1982 the station was able to monitor data traffic involving the Cray system.[15] This would have enabled the KGB to glean almost all of Lockheed's aircraft designs during this period - including the F-117A Stealth fighter, the SR-71 reconnaissance aircraft, and the C-5A transport aircraft.

Although telephone and data transmissions are the highest priority target at Lourdes, there is also an interest in video transmissions. For example, in November and December 1988, the Soviets 'almost certainly' monitored three particularly interesting video transmissions - video of the roll-out of the Northrop Stealth bomber on 22 November 1988 transmitted via the RCA/GE Americom SATCOM VI (1982-4A) stationed at 83°W (which would have been especially helpful to the Soviets since there was no Soviet photographic intelligence satellite in space at the time); video of the launch of the Shuttle **Atlantis**, with the secret **Lacrosse** radar imaging satellite, on 2 December 1988, transmitted by NASA via the SATCOM 11R (1983-94A) at 72°W; and video of the F-117A Stealth fighter flying in formation with a MiG-21 over the Nevada desert, transmitted over the SATCOM K-2 (1985-109D) satellite stationed at 81°W.[16]

3. *Regional Geostationary Satellites*

There are some nine operational and 41 proposed non-US regional COMSATs stationed within the purview of Lourdes. The operational satellites consist of two owned by Brazil, two by Mexico, and five by Canada. These satellites carry a wide range of military and other government telecommunications in addition to commercial and private telecommunications. For example, the Telesat Canada Anik D-2 (1984-113B), launched on 9 November 1984 and activated at 110.5°W in November 1985 (as a replacement for Anik B, launched on 16 December 1978), is used to carry early warning intelligence from the North American Air Defense (NORAD) North Warning System deployed across northern Canada to the Satellite Control Facility (SCF) at Oniszuka Air Force Station at Sunnyvale in California and from

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15 Charlie Nordblom, *Industrispionage*, (Timbro, Stockholm, 1984), pp.262-264.

16 Information provided by Robert Windrem, NBC Nightly News, New York.

there to the NORAD headquarters under Cheyenne Mountain in Colorado.[17]

4. *International Geostationary Satellites*

There are currently 10 operational and 60 proposed international COMSATs stationed in the geostationary band within the purview of Lourdes. The operational satellites are the French Telecom-1A (1984-81B), the European Telecommunications Satellite Organisation (ETSO) Eutelsat 1-2 (1984-81A), the European Space Agency (ESA)/INMARSAT Marecs I (1981-122A), and seven INTELSATs -- IVA-FI (1975-91A), IVA-F4 (1977-41A), V-F3 (1981-119A), V-F4 (1982-17A), V-F6 (1983-47A), V-F10 (1985-25A), and VA-F11 (1985-55A).

The French Telecom-1A (1984-81B), stationed at 8.4°W, is used for both civil and military telecommunications, with an X-band transponder carried specifically for military telecommunications.[18] The ETSO Eutelsat, at 15.8°W, is designed to complement the terrestrial public telecommunications network throughout Western Europe, and provides telephone and high-speed data services for both military and other governmental agencies as well as commercial and private users. The Marecs 1 (1981-122A) satellite, at 27.9°W, is part of the INMARSAT system, and provides telephone, telex, data and facsimile transmissions. Although it is operated primarily for non-military maritime agencies and ships, it is used by the US Navy and other Western Navies.

The seven INTELSAT satellites, controlled from ground stations at Andover in Maine and Etam in West Virginia, carry more than 100 million international telephone calls across the Atlantic each year, in addition to teletype data messages and computer data links. This traffic is reportedly of major interest to the Lourdes station.[19]

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17 *Ibid.*.

18 Tina D. Thompson (ed.), *TRW Space Log 1957-1987*, p.214; and Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, p.174.

19 George C. Wilson, 'Soviets Place Antennas in Cuba to Intercept U.S. Messages', *Washington Post*, 23 December 1977, p.A22.

5. *Soviet Geostationary Satellites*

The Soviet Union currently maintains seven geostationary satellites and has proposed placement of a further 10 within the purview of its station at Lourdes. The operational satellites consist of Gorizont-04 (1980-49A) at 13.1°W, Gorizont-07 (1983-66A) at 13.7°W, Gorizont-012 (1986-44A) at 14°W, Raduga-7 (1980-81A) at 24.7°W, Kosmos 1738 (1986-27A) at 14°W, Kosmos 1546 (1984-31A) at 25°W, and Kosmos 1629 (1985-16A) also at 25°W.

The Gorizont COMSATs are used for a variety of purposes, including the provision of telecommunications relay for the INTERSPUTNIK international communications network. Gorizont-012 at 14°W also serves as a node in the Direct Communications Link (DCL) or Hotline between Washington and Moscow.[20] The Raduga-7 satellite (1980-81A) at 24.7°W is used for Soviet military and other governmental communications. The three Kosmos satellites are used for unspecified purposes, which are likely to include SIGINT operations. It is reasonable to assume that transmissions from these satellites are monitored by the Lourdes station for communications security (COMSEC) purposes.

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20 Nicholas L. Johnson, *The Soviet Year in Space 1986*, (Teledyne Brown Engineering, Colorado Springs, Colorado, 1987), p.24.

CHAPTER 5

SATCOM SYSTEMS AT SOVIET DIPLOMATIC ESTABLISHMENTS

SATCOM antennas have been installed at more than a dozen Soviet diplomatic establishments. These include establishments in Tokyo, New Delhi (2), Kathmandu, London, Ankara, Milan, Paris, Amsterdam (2), Copenhagen, Gothenburg and Reykjavik. (See Figure 32.) However, the size and capabilities of these SATCOM facilities are severely constrained by various physical and political considerations. Most diplomatic establishments lack sufficient ground space for large SATCOM antennas; and, at least in many capital cities, surrounding high-rise buildings constrict azimuth or low-horizon line-of-sight access to particular satellites. The size and weight of roof-mounted terminals is limited by the structural design of the supporting buildings, particularly in high-wind areas. Local building codes frequently impose further restrictions. Politically, the requirement for host country permission generally also limits terminals to smaller, lower-capacity systems. Terminals assembled covertly in attics or shacks without host country permission are necessarily small. Hence, in practice, SATCOM terminals installed in diplomatic establishments tend to be no larger than three or four metres in diameter and are frequently only about a metre in diameter.

The Soviet Embassy in Tokyo has a 12-foot diameter SATCOM dish oriented almost directly south. It is able to monitor transmissions from at least four different geostationary SATCOM systems. First, it is able to receive transmissions from the Japanese Sakura CS-2 communications satellites, operated by the Nippon Telegraph and Telephone Public Corporation (NTT), and stationed at 132°E (1983-6A) and 135°-136°E (1983-81A). These satellites were designed to provide communications with the remote islands of Japanese territory; to establish domestic public telecommunications services for national disasters or emergencies; and to provide telecommunication networks for business corporations and government agencies.[1] In August 1983,

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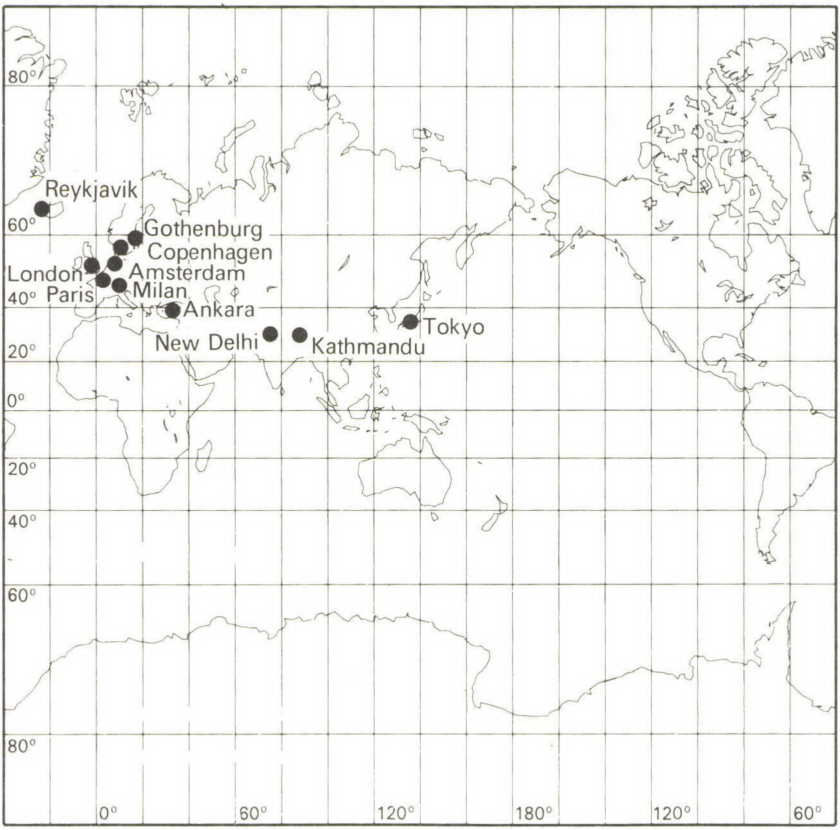
1 Madeline W. Sherman (ed.), *TRW Space Log 1982-1983*, (Electronics and Defense Sector, TRW, Redondo Beach, California, 1984), p.5.

FIGURE 32

SOVIET DIPLOMATIC ESTABLISHMENTS WITH SATCOM ANTENNAS



the Japanese Government approved the use of the Sakura CS-2 system by the Japanese Self Defence Force (JSDF) for telecommunication transmission between the main islands and the outlying Ogasawa Islands[2] - or, more specifically, Iwo Jima Island, where contingents of both the Maritime Self Defense Force (MSDF) and the Air Self Defense Force (ASDF) are based. In March 1985, the network became operational with two Sakura C-2 circuits - a general subscriber line type and an exclusively leased line type - linking Iwo Jima and the headquarters of the Japan Defense Agency (JDA) in Hinoki-cho in downtown Tokyo.[3] (The JDA headquarters is about 0.4 km north of the Soviet Embassy). Second, the Soviet SATCOM terminal is able to monitor transmissions from the US Fleet Satellite Communications (FLTSATCOM) system, which is being increasingly used by the MSDF. In Fiscal Year 1985, for example, the MSDF introduced five sets of FLTSATCOM receivers on destroyers, and it currently plans to develop an exclusive transmitter-receiver station to utilise the FLTSATCOM system.[4] Third, the MSDF uses the MARISAT/ INMARSAT system for communications between the Tokyo headquarters and the fleet,[5] and these communications are accessible to the Soviet Embassy. (The Network Control Station for the MARISAT/INMARSAT Indian Ocean satellite is located at Yamaguchi, about 750 km southwest of Tokyo.[6]) And, fourth, the Soviet SATCOM terminal can be used to communicate through Soviet GORIZONT geostationary COMSATs stationed at 140°E.

The Soviet Embassy in New Dehli has two Ekran SATCOM arrays designed to receive television and radio broadcasts from the

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2 'Defense Forces Want Reconnaissance Satellite', *Asahi Evening News*, 4 January 1984, p.3.

3 Japan Defense Agency, *Defense of Japan 1985*, (Japan Defense Agency, Tokyo, 1986), pp.116-119.

4 *Ibid.*, p.119.

5 *Ibid.*, p.119.

6 Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, (Howard W. Sams & Company, Indianapolis, Indiana, Second Edition, 1987), p.109; and R.J. Raggett (ed.), *Jane's Military Communications 1986*, (Jane's Publishing Company Limited, London, Seventh Edition, 1986), p.347.

FIGURE 33
SOVIET EMBASSY, TOKYO, JAPAN

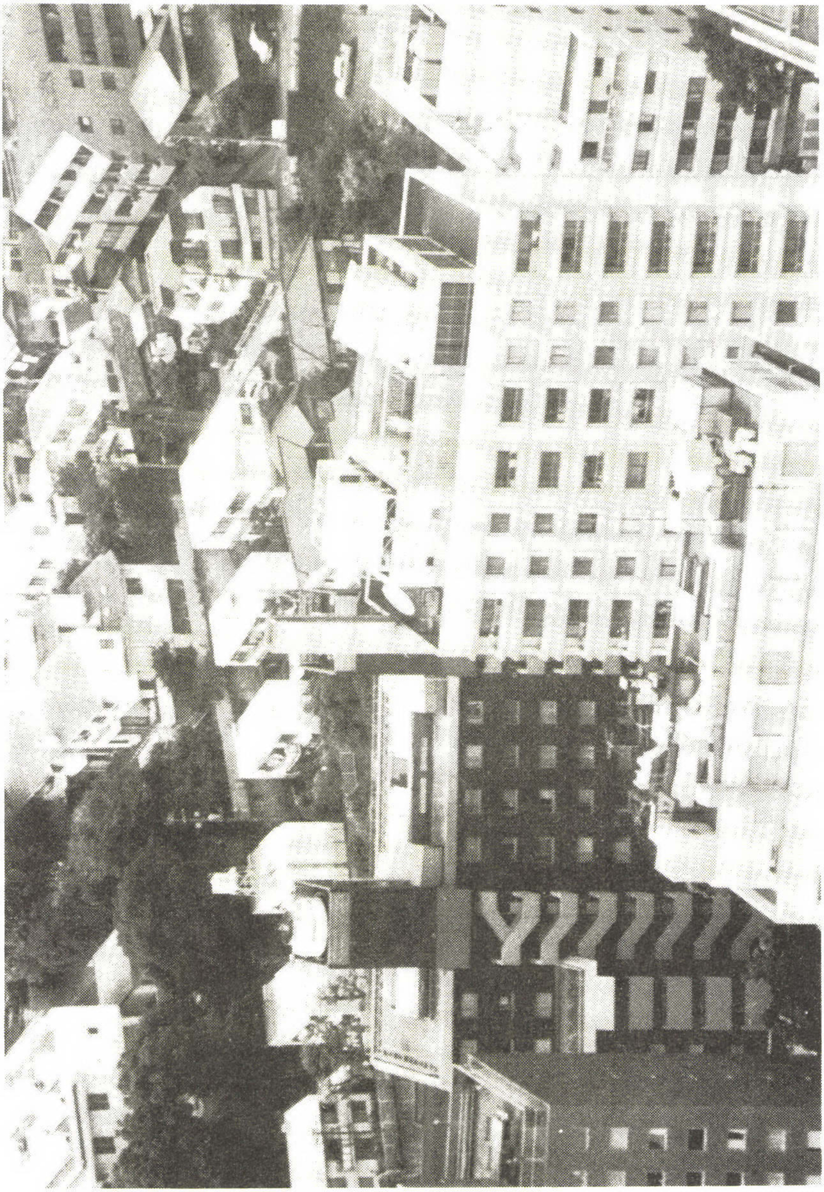


FIGURE 34
SOVIET EMBASSY, PARIS, FRANCE

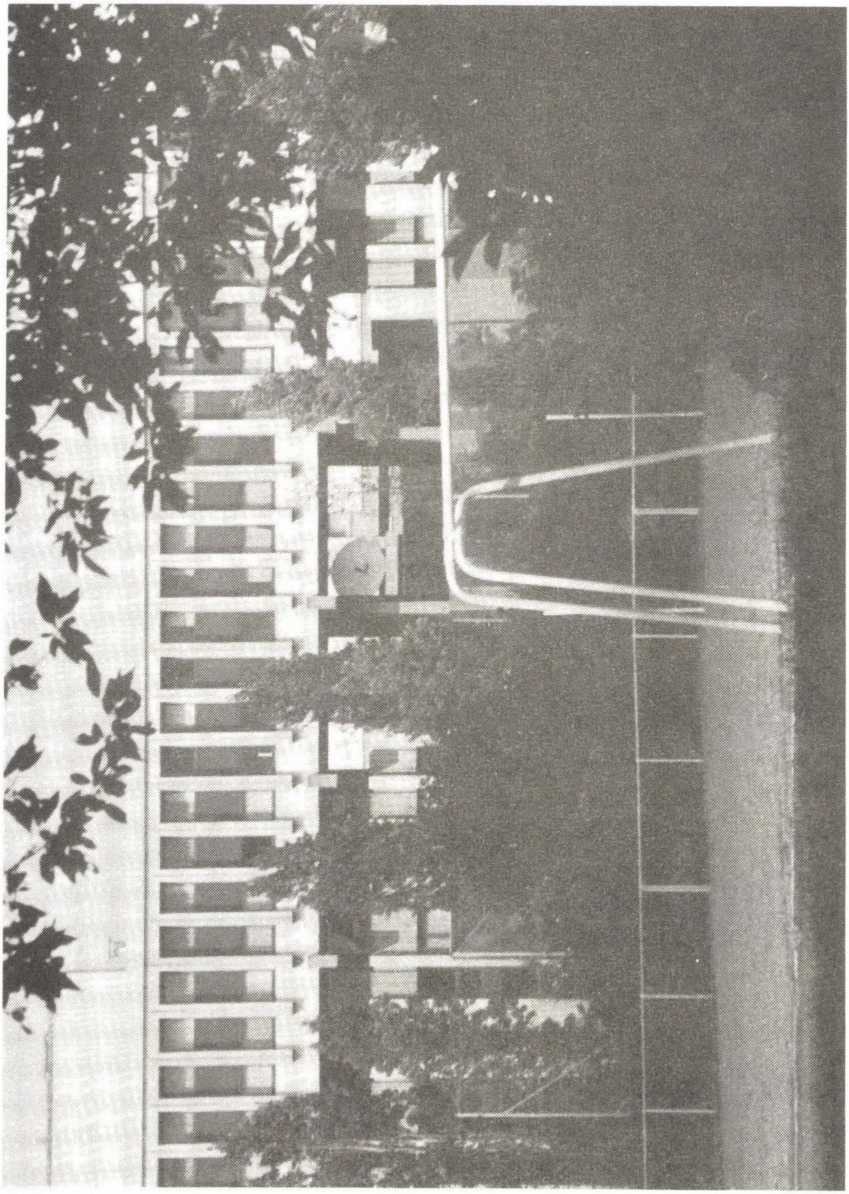
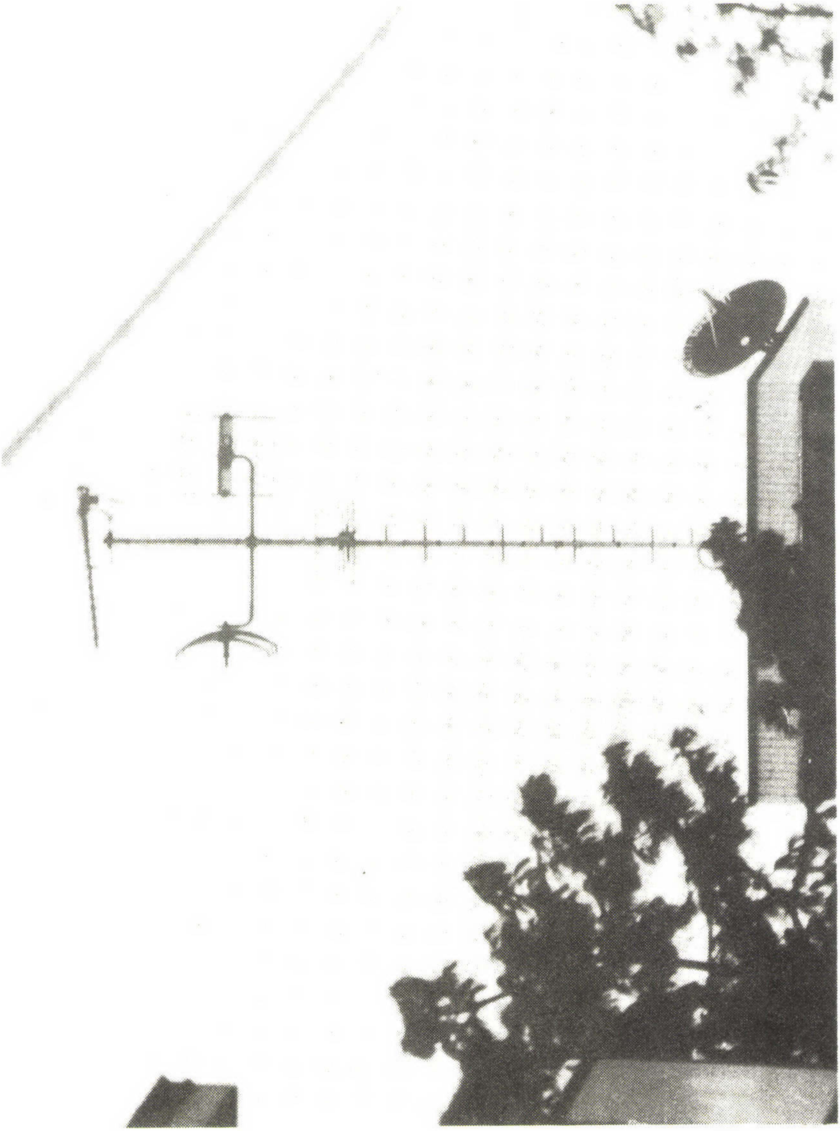


FIGURE 35
SOVIET CONSULATE, MILAN, ITALY



Source: Fabrizio Tonello, Milan, November 1987.

FIGURE 36
SOVIET EMBASSY, LONDON, ENGLAND

FIGURE 37
SOVIET TRADE MISSION, AMSTERDAM, THE NETHERLANDS

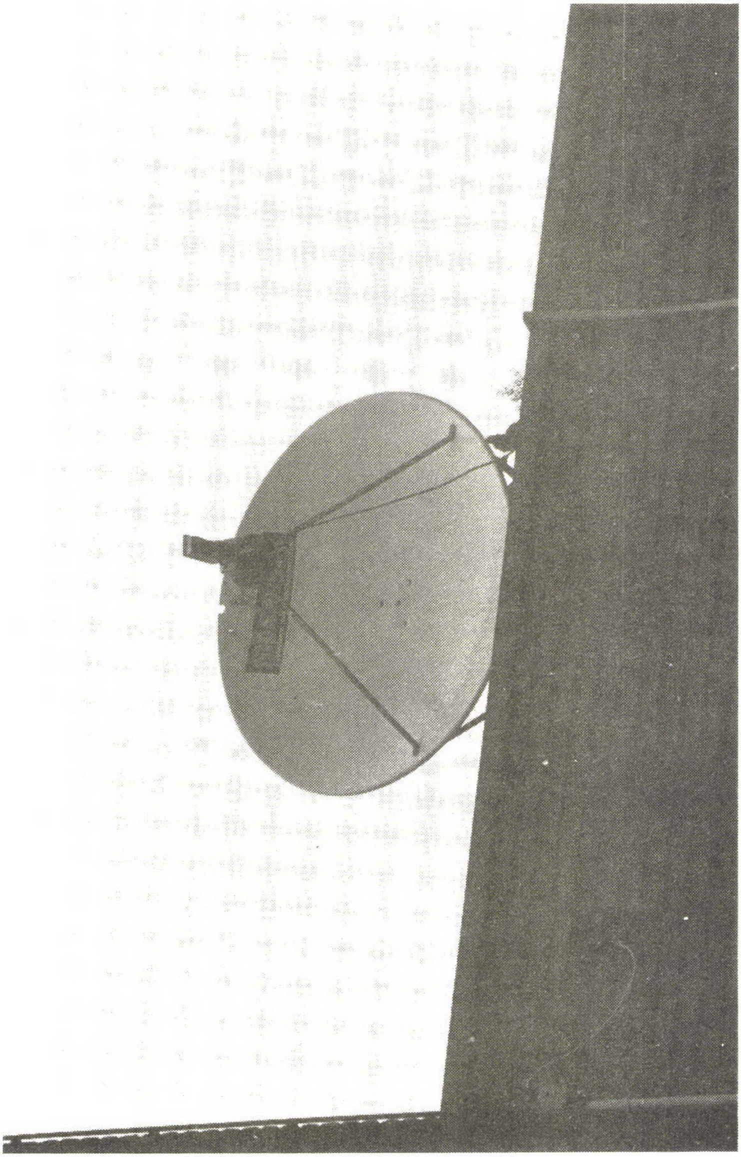


FIGURE 38

SOVIET TRADE MISSION, AMSTERDAM, THE NETHERLANDS

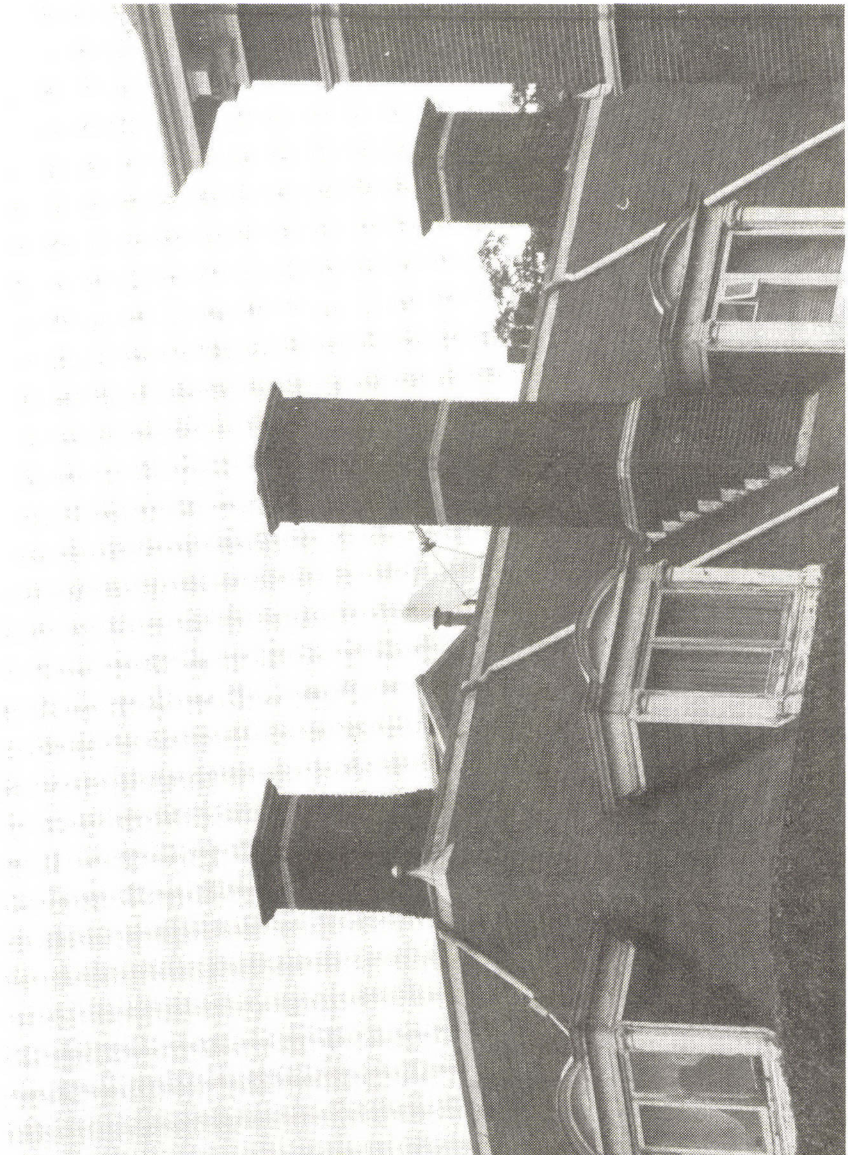


FIGURE 39
SOVIET EMBASSY, COPENHAGEN, DENMARK

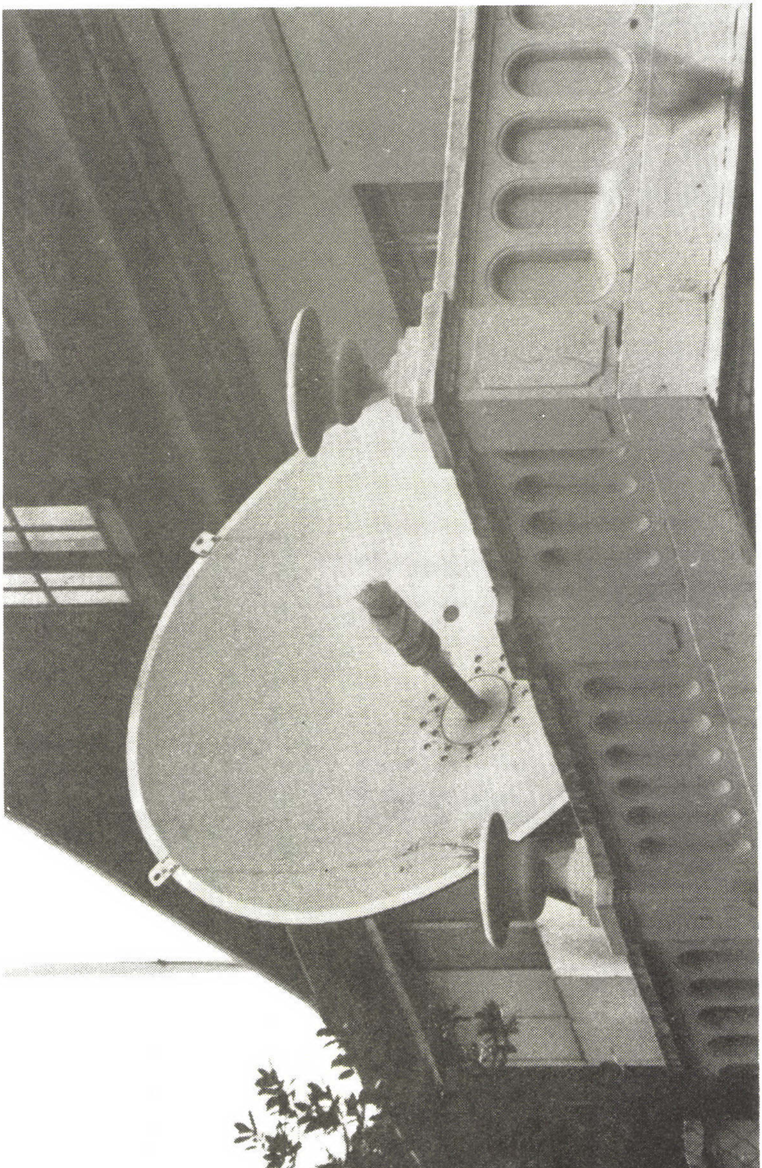


FIGURE 40
SOVIET CONSULATE, GOTHENBURG, SWEDEN

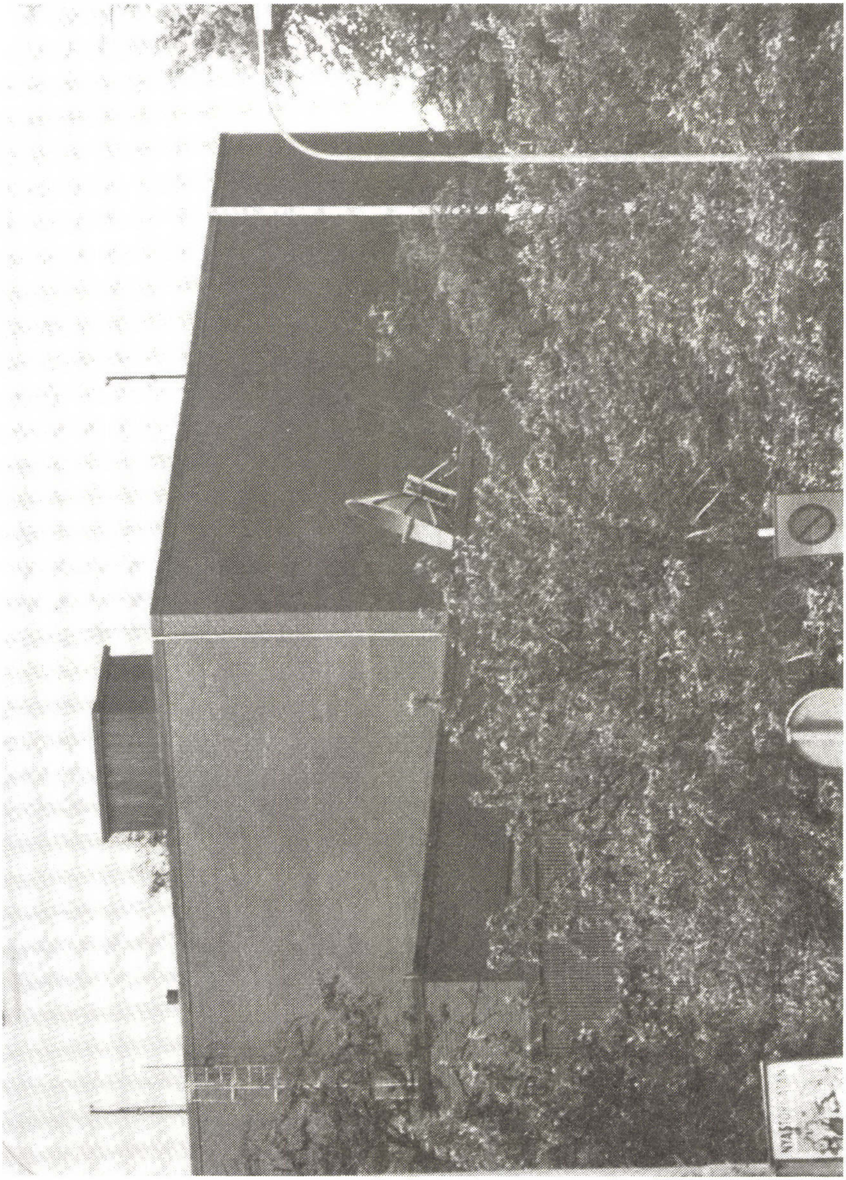
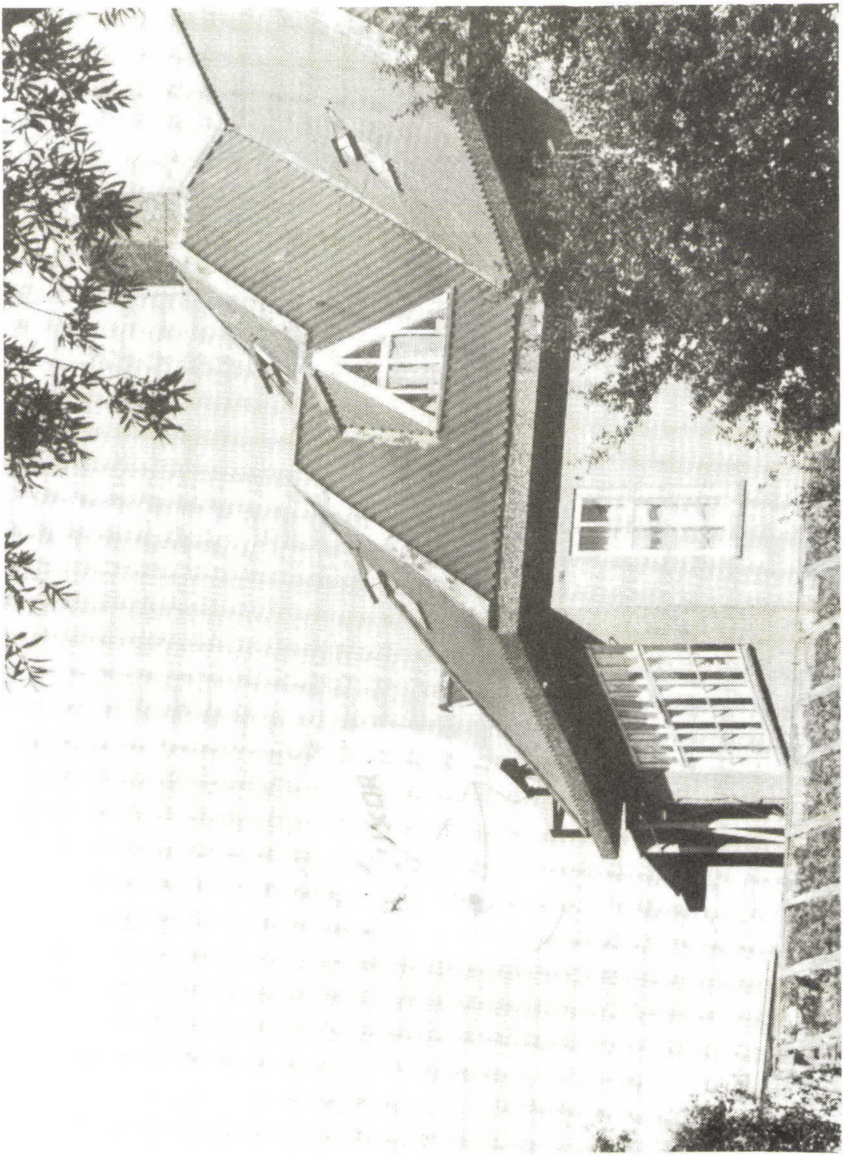
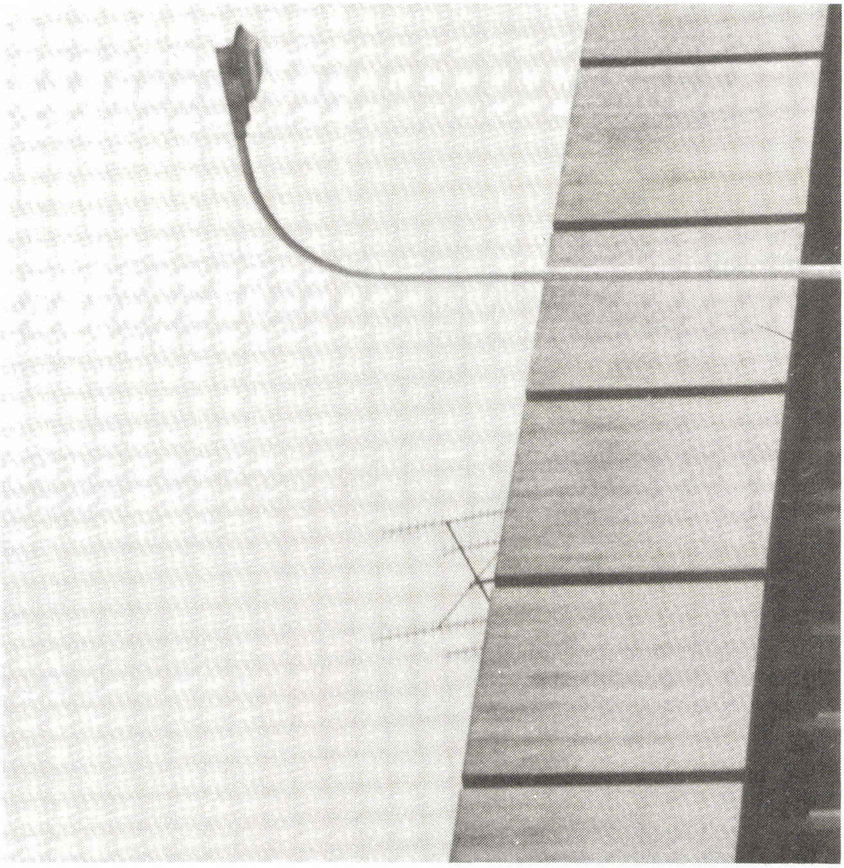


FIGURE 41
SOVIET EMBASSY, REYKJAVIK, ICELAND



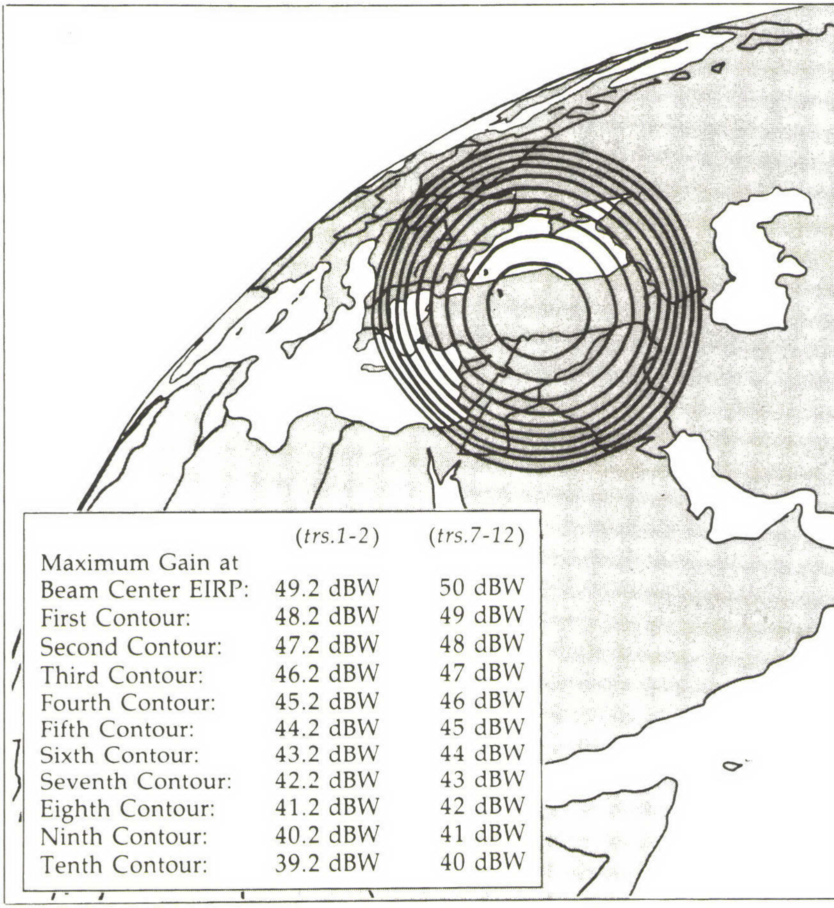
Source: Bjorn Bjarnason, Reykjavik, September 1988.

FIGURE 42
SOVIET EMBASSY, KATHMANDU, NEPAL



Source: Andrew Mack, February 1989.

FIGURE 43
INTELSAT V F7 BEAM ON TURKEY



	(trs.1-2)	*(trs.7-12)*
Maximum Gain at Beam Center EIRP:	49.2 dBW	50 dBW
First Contour:	48.2 dBW	49 dBW
Second Contour:	47.2 dBW	48 dBW
Third Contour:	46.2 dBW	47 dBW
Fourth Contour:	45.2 dBW	46 dBW
Fifth Contour:	44.2 dBW	45 dBW
Sixth Contour:	43.2 dBW	44 dBW
Seventh Contour:	42.2 dBW	43 dBW
Eighth Contour:	41.2 dBW	42 dBW
Ninth Contour:	40.2 dBW	41 dBW
Tenth Contour:	39.2 dBW	40 dBW

Source: Mark Long, *World Satellite Almanac: The Complete Guide to Satellite Transmission and Technology*, (Howard W. Sams & Company, Indianapolis, Indiana, Second Edition, 1987), p.517.

Ekran COMSATs. These satellites operate in the UHF band, and the arrays in the Embassy would be able to monitor certain transmissions from the MARISAT/INMARSAT and US Navy Fleet Satellite Communications (FLTSATCOM) UHF satellites. The Soviet Embassy in Kathmandu has a single Ekran SATCOM array (Figure 42).

In Western Europe, there are at least nine Soviet diplomatic establishments equipped with SATCOM facilities. The primary objectives of the SATCOM intercept activities are evidently general US/NATO defence satellite communications, naval satellite communications, and national or international commercial satellite communications. In Ankara, the SATCOM facility in the Soviet Embassy is most likely concerned with monitoring transmissions from the Defense Satellite Communications System (DSCS) satellites to DSCS stations at Diyarbakir, Pirinclik and Incirlik, and/or communications from the INTELSAT V F7 satellite, the west spot beam of which is directed to 39.1°N 36.3°E, just 300 km southeast of Ankara. The INTELSAT V F7 satellite is used by Turkey to transmit domestic television, voice, and data traffic.[7] In December 1988, the US Defense Communications Agency (DCA) reached agreement with the Turkish Post, Telegraph and Telephone Authority to lease SATCOM services from the Authority and to install six satellite ground terminals at US bases in Turkey.[8] The SATCOM antenna at the Soviet Embassy in Paris is about 2-metres in diameter and points almost directly south. The dish on the roof of the Soviet Consulate in Milan is about 1-metre in diameter, and is pointed towards the southwest. The dish on the roof of the Soviet Embassy in London is also about 1-metre in diameter, and points south-southwest. The Soviet Trade Mission in Amsterdam occupies two buildings, which have identical 1-metre dishes pointing to the southeast.

In Scandinavia, the SATCOM terminals at Copenhagen, Gothenburg and Reykjavik are each three metres in diameter. The Copenhagen dish points southwest while that at Gothenburg points southeast. It is likely that these monitor both the UHF and the S through X bands. This would provide the Soviet facilities with access

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7 Mark Long, *World Satellite Almanac*, pp.516-520.

8 'U.S. To Transmit on Turkish Lines', *Defense News*, 31 October 1988, p.2; and 'Turkey, US to Modify Audio Systems at Bases', *Journal of Commerce*, 16 December 1988, p.5.

to the US/NATO UHF FLTSATCOM and MARISAT/INMARSAT communications concerning naval movements through the Skagerrak and in the North Sea and Norwegian Sea, as well as commercial satellite communications. In Reykjavik, for example, the 3-metre Luxor dish at the Soviet Ambassador's residence would easily be able to acquire COMSAT signals transmitted down to the Post and Telegraph SATCOM station located some 15 km away.

CHAPTER 6

SOVIET SHIP-BASED SATCOM MONITORING SYSTEMS

The Soviet Union maintains more than two dozen ships which are well equipped for intercepting satellite communications. These include the four Balzam-class intelligence collection ships (AGIs), which were purpose-built for SIGINT collection (including the collection of satellite communications), and the Soviet Missile Range Instrumentation Ships and Space Event Support Ships which have secondary SATCOM SIGINT missions. These ships, and the Soviet naval SATCOM antennas, are identified in Tables 3 and 4.

Soviet SATCOM Intelligence Collection Ships (AGIs)

The Balzam-class intelligence collection ships (AGIs) were the first class of AGIs to be specifically designed to intercept satellite communications along with other radio and radar signals. The first of the class (the Balzam SSV 516) was completed in 1980, the second (SSV 493) in 1981, the third (SSV 80) in 1984, and the fourth (SSV 443) in 1986. These ships have a displacement of some 5000 tons, and measure 346 feet (105.5 metres) in length, 51 feet (15.5m) across the beam, and 19 feet (5.8m) in draft.[1] They have two large, spherical radomes, approximately 10 metres in diameter, which reportedly 'house antennas for interception of satellite communications'.[2] The Balzams have considerable space for on-board SIGINT processing and analysis equipment and work stations. Communications with Moscow and the Fleet Headquarters is maintained by COMSAT and HF radio through a central relay station at Khiva in Uzbekistan.[3]

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1 Norman Polmar, *Guide to the Soviet Navy*, (US Naval Institute Press, Washington, D.C., Fourth Edition, 1987), pp.327-328.

2 *International Defense Review*, No.8, 1980, p.1187.

3 Harry Caul, 'Eavesdropping on the Soviet Navy', *Popular Communications*, March 1986, pp.28-31.

TABLE 3
SOVIET SATCOM MONITORING SHIPS

	Ship	Class and Type	Comments
1	Balzam SSV 516	Balzam-class intelligence collector (AG1).	Two large radomes house antennas for interception of satellite communications. Based in the Pacific.
2	SSV 493	Balzam-class AG1.	Two large radomes house antennas for interception of satellite communications. Based with the Northern Fleet.
3	SSV 80	Balzam-class AG1.	Two large radomes house antennas for interception of satellite communications. Based in the Pacific.
4	SSV 443	Balzam-class AG1	
5	Chazhma	Desna-class Missile Range Instrumentation Ship.	Equipped with one Ship Globe dish/radome. Based in the Pacific.
6	Chumikan	Desna-class Missile Range Instrumentation Ship.	Equipped with one Ship Globe dish/radome. Based in the Pacific.
7	Chukotka	Sibir-class Missile Range Ship.	Two small SATCOM dishes. Based in the Pacific.
8	Sakhalin	Sibir-class Missile Range Ship.	Three radomes. Based in the Pacific.
9	Sibir	Sibir-class Missile Range Ship.	Three radomes. Based in the Pacific.
10	Spassk	Sibir-class Missile Range Ship.	Based in the Pacific.
11	Marshal Nedelin	Marshal Nedelin-class Missile Range Ship.	One Ship Globe and three Quad Ring systems.
12	Marshal Krylov	Marshal Nedelin-class Missile Range Ship.	One Ship Globe and three Quad Ring systems.
13	Kamchatka SSV 391	Bambuk-class.	Based in the Pacific.
14	SSV 33 (Bal-Aux 2)		Currently undergoing sea trials in the Baltic.

	Ship	Class and Type	Comments
15	Kosmonaut Yuri Gagarin	Gagarin-class Space Event Support Ship (SESS).	Two Ship Shell, two Ship Bowl, and five Quad Ring systems. Based in the Black Sea (Odessa).
16	Kosmonaut Vladimir Komarov	Komarov-class SESS.	Two Ship Globe, one Ship Wheel and three Quad Ring systems. Based in the Black Sea (Odessa).
17	Akademik Sergey Korolev	Korolev-class SESS.	One radome (about 12 m in diameter), two Ship Bowls, five Quad Rings and one INMARSAT SATCOM terminal. Based in the Far East.
18	Kosmonaut Vladimir Volkov	Kosmonaut Pavel Belyayev-class SESS.	One Quad Spring, three Quad Rings, and a 2.5 m Molniya SATCOM dish. Based in Leningrad.
19	Kosmonaut Georgy Dobrovolsky	Kosmonaut Pavel Belyayev-class SESS.	One Quad Spring, three Quad Rings, and a 2.5 m Molniya SATCOM dish. Based in Leningrad.
20	Kosmonaut Pavel Belyayev	Kosmonaut Pavel Belyayev-class SESS.	One Quad Spring, three Quad Rings, and a 2.5 m Molniya SATCOM dish.
21	Kosmonaut Viktor Patsayev	Kosmonaut Pavel Belyayev-class SESS.	One Quad Spring, three Quad Rings, and a 2.5 m Molniya SATCOM dish. Based in Leningrad.
22	Borovichi	Vytegrales- or Morzhovets-class SESS.	One Quad Ring and one Quint Ring.
23	Kegostrov	Vytegrales- or Morzhovets-class SESS.	Three Quad Rings.
24	Morzhovets	Vytegrales- or Morzhovets-class SESS.	Three Quad Rings.
25	Nevel	Vytegrales- or Morzhovets-class SESS.	Five Quad Rings, with one 143 MHz VHF and four 922 MHz UHF arrays.

TABLE 4
SOVIET NAVAL SATCOM ANTENNAS

	Antenna Designation	Description	Comments
1	Ship Shell	25-26 m diameter parabolic dish antennas.	Installed on Kosmonaut Yuri Gagarin Space Event Support Ship (SESS).
2	Ship Globe	8 m diameter parabolic dish, normally housed in 18-19.5 m radome.	
3	Ship Bowl	12 m diameter dish.	Installed on Kosmonaut Yuri Gagarin and Akademic Sergey Korolev Space Event Support Ships. Used, *inter alia*, for Molniya communications.
4	Ship Wheel	2 m dish housed in 7.5 m radome.	
5	Big Ball	4 m radome houses 2.5 m dish.	Communications with Molniya and Raduga COMSATs.
6	Punch Bowl	3 m radome.	SATCOM terminal for reception of targeting data from ocean surveillance satellites.
7	Pert Spring		SATCOM terminal installed on Sierra and Victor III SSNs.
8	Quad Spring	9 m diameter, 4-dish clover-leaf alt-azimuth array.	Telemetry reception. Installed on Kosmonaut Pavel Belyayev class SESSs and SSV 33.
9	Quad Ring	4-element 143 MHz helical array or 922 MHz Yagi.	Telemetry reception. Used, *inter alia*, for Salyut and Mir telemetry.
10	Quint Ring	5-element helical array.	Telemetry reception.

In September 1980, the Balzam SSV 516 monitored the NATO *Teamwork* exercise in the Atlantic Ocean as part of its sea trials.[4] It was assigned to the Pacific Fleet in 1982, and generally operates off the west coast of the United States, where it accords particular attention to the Western Missile Test Range off southern California. In September 1983, it was stationed about 20 miles south of the island of Oahu in Hawaii.[5] In February 1984, it was patrolling off Alaska.[6] It then moved south and lingered off the Trident submarine base at Bangor, near Seattle, before cruising further down the west coast of the United States.[7] In mid-March 1984, it was observed off Point Delagada, about 250 miles north of San Francisco.[8] In late March 1984, it was observed 32 nautical miles west of San Clemente monitoring US Navy and civilian communications.[9] In April 1984, it patrolled for several days off the coast from San Diego.[10] It then turned north again, and in May 1984 was stationed off the Western Test Range where it monitored missile tests being conducted from the US Navy's Pacific Missile Test

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4 *International Defense Review*, No.8, 1980, p.1187; and 'Soviet Spy Ship on the Prowl', *Sydney Morning Herald*, 1 October 1980, p.19.

5 'Special Soviet Spy Ship Prowls Coast', *San Diego Union*, 26 March 1984, p.A-9.

6 Robert Dietrich, 'Navy Monitors Armed Soviet Spy Ship Spotted Steaming Off County Coastline', *San Diego Tribune*, 7 April 1984, p.C-1.

7 'Special Soviet Spy Ship Prowls Coast', *San Diego Union*, 26 March 1984, p.A-9.

8 'Navy Keeping Eye on Soviet Ship: Vessel Spotted 250 Miles North of San Francisco', *San Diego Tribune*, 20 March 1984, p.A-3.

9 'Special Soviet Spy Ship Prowls Coast', *San Diego Union*, 26 March 1984, p.A-9; and 'Soviet Spy Ship Near US Coast', *Canberra Times*, 27 March 1984, p.4.

10 Robert Dietrich, 'Navy Monitors Armed Soviet Spy Ship Spotted Steaming Off County Coastline', *San Diego Tribune*, 7 April 1984, p.C-1; and 'Navy Watches Soviet Vessels', *San Diego Union*, 7 April 1984, p.B-4.

FIGURE 44
BALZAM SSV 516 AGI

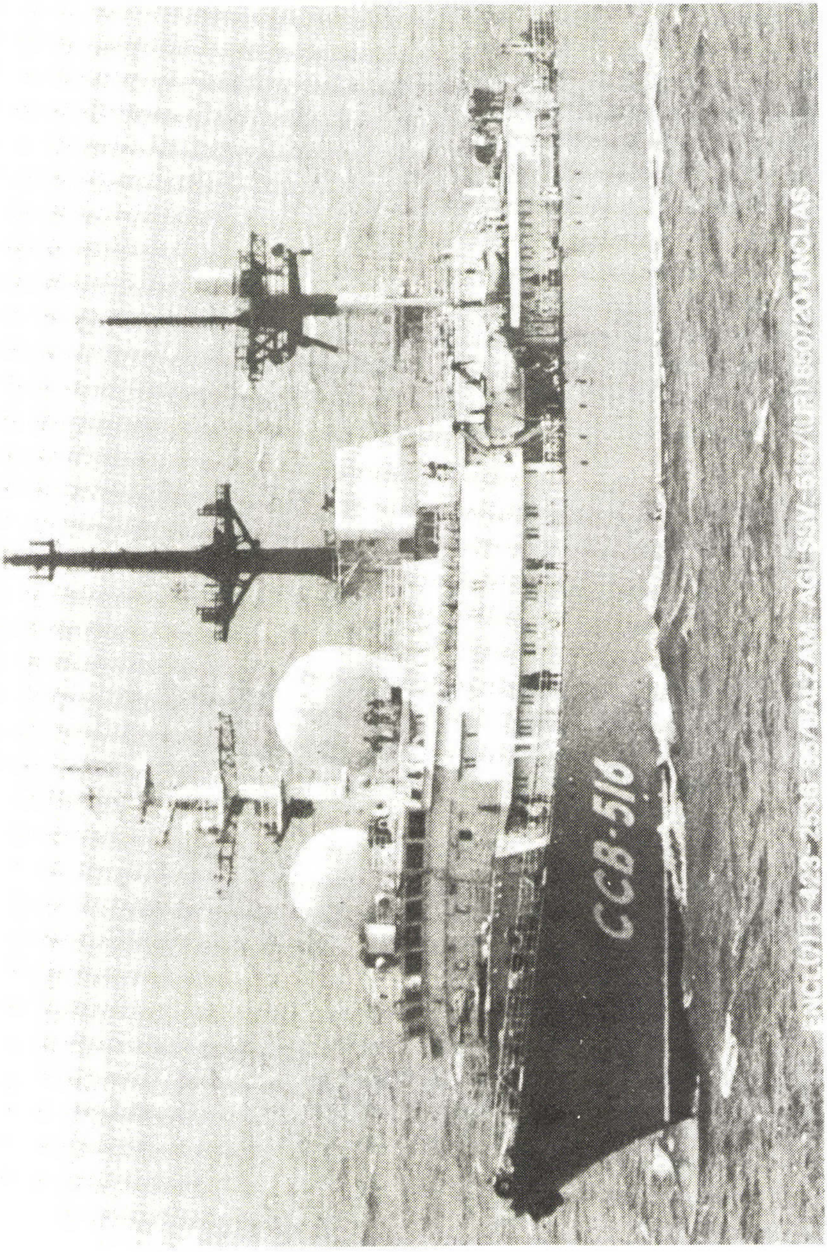
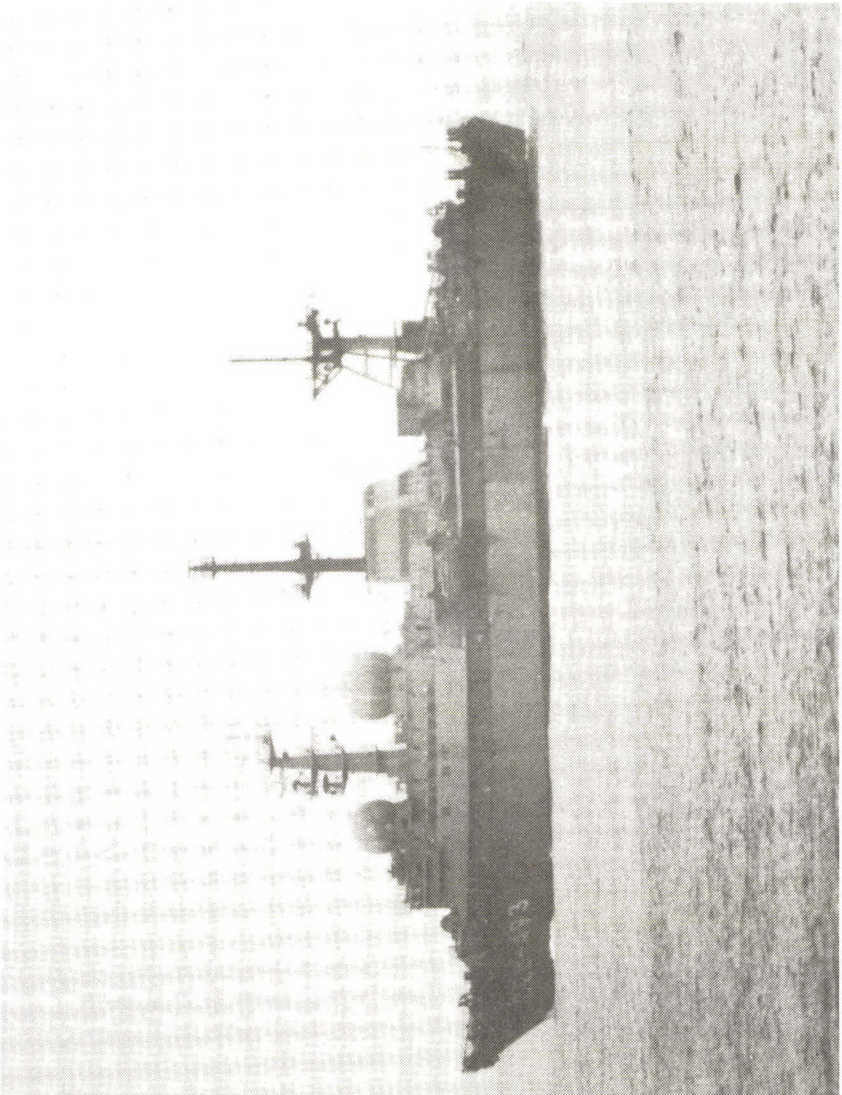


FIGURE 45
BALZAM-CLASS SSV 493 AGI



Source: US Navy.

Center at Point Mugu.[11] In November 1987, the Balzam monitored the US Navy's *NORPACEX* exercise in the Gulf of Alaska.[12]

The second Balzam-class AGI, the SSV 493, operates in the Atlantic Ocean, principally along the east coast of the United States. The fourth ship, the SSV 443, has also recently begun operations in the Atlantic. In September 1986, it monitored the NATO Exercise *Northern Wedding 86*, which involved amphibious landings on the Norwegian coast.[13]

The third Balzam-class vessel, the SSV 80, constructed in 1984, has been assigned to the Pacific Fleet and evidently operates primarily off Japanese waters. In August 1985, it was sighted 230 km west of Okinawa.[14] It was sighted at various points off Japan from September to December 1987, where it was reportedly monitoring signals relating to Japan's new Base Air Defense Ground Environment (BADGE) system.[15]

The most recent class of AGI is the Vishnya, four of which have now been produced - the SSV 520, SSV 535, SSV 169, and SSV 201. The first of this class made its maiden voyage in July 1986, and monitored the NATO Exercise *Northern Wedding 86* in September

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11 'Soviets Return U.S. Target Drone', *Chicago Tribune*, 11 May 1984, p.4; Joseph Volz, 'OK, Take Your Drone', *New York News*, 11 May 1984, p.6; 'Soviet Ship Holds U.S. Target Drone 24 Hours', *Aviation Week and Space Technology*, 21 May 1984, p.20; and Kip Cooper, 'Soviet Spy Ship's Study of Navy Drone is Hinted', *San Diego Union*, 2 June 1984, pp.A-1, A-14.

12 Tom Burgess, 'Soviet Spy Ship Surprises Enterprise During War Games', *San Diego Union*, 17 November 1987, p.A-4; and Dean Fosdick, 'Soviets Shadow Navy Drill in Aleutians', *Washington Times*, 18 November 1987, p.3.

13 Peter Almond, 'Marines in Huge NATO Drill Have Hearts in Middle East', *Washington Times*, 10 September 1986, p.9B.

14 'Latest Soviet Intelligence Ship Sighted in South China Sea', *Defense Electronics*, September 1985, p.17.

15 'Japan/Soviet Spy Ship', *Current News*, 3 December 1987, p.6; and Robert Horiguchi, 'Soviet Snooper Finds a Sting in the Air', *Pacific Defence Reporter*, (Vol.XVI, No.9), March 1988, p.34.

1986.[16] Although no SATCOM systems have yet been installed on these vessels, there are two large mounts or plinths forward of the mainmast which are likely to be fitted with twin radomes similar to those on the Balzam class.[17]

Soviet Missile Range Instrumentation Ships (MRISs)

The Soviet Navy maintains in the Pacific a fleet of 8-10 space and missile tracking ships, most frequently designated Missile Range Instrumentation Ships (MRISs), which are equipped with a variety of sophisticated SATCOM systems. The requirement for ships of this sort was evidently determined around 1957, when plans were developed for the full-range testing of intercontinental ballistic missiles from the Tyuratam Missile Test Center across Kamchatka into the Pacific. In 1958-59, four Sibir-class bulk ore carriers were rebuilt to serve as MSIRs and deployed in the Pacific - the Chukotka, Sakhalin, Sibir and Spassk. The antenna arrays and arrangements differ on these ships. The Sakhalin and the Sibir have three radomes.[18] The Chukotka has two small SATCOM dishes.[19] In September 1987, the Chukotka was involved in an incident near the Hawaiian Islands, during which it directed laser illumination at US P-3 and WC-135 aircraft monitoring Soviet ICBM test launches into the Pacific near Hawaii.[20]

In 1963, the two Desna class MRISs - Chazhma and Chumikan - became operational. These are larger and faster than the Sibir class

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16 Peter Almond, 'Marines in Huge NATO Drill Have Hearts in Middle East', *Washington Times*, 10 September 1986, p.9B.

17 Captain Richard Sharpe (ed.), *Jane's Fighting Ships 1988-89*, (Jane's Publishing Company Limited, London, 91st Edition, 1988), p.611.

18 *Ibid.*, p.621; and US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87. Piloted Space Activities, Launch Vehicles, Launch Sites, and Tracking Support*, (U.S. Government Printing Office, Washington, D.C., 1988), Part 1, p.264.

19 Norman Polmar, *Guide to the Soviet Navy*, (Naval Institute Press, Annapolis, Maryland, Third Edition, 1983), p.307.

20 Michael R. Gordon, 'Russian Lasers Reported Aimed at U.S. Planes', *New York Times*, 3 October 1987, p.1.

ships, and each is equipped with a single large Ship Globe SATCOM system.[21] In April 1970, during the recovery of the aborted Apollo 13 flight, the Chumikan was in the recovery area around 21°S 165°W in the South Pacific - a remote area which, as a report by the Congressional Research Service noted, is 'not near known Soviet test areas'.[22] According to the Congressional Research Service report, 'undoubtedly its reason for being there was the collection of intelligence by studying the Apollo reentry ablation phase'.[23] The Chumikan would have been able to monitor all the communications and telemetry transmissions associated with the recovery of the Apollo 13 spacecraft.

In June 1982, the Chumikan was in the Indian Ocean, with the Kosmonaut Georgy Dobrovolsky, to support the recovery of the Kosmos 1374 sub-scale space plane about 300 miles south of the Cocos Islands;[24] and in March 1983 it was again on hand in the Indian Ocean, with the Kosmonaut Pavel Belyayev, to support the recovery of the similar Kosmos 1445 spacecraft.[25] In March 1987, the Chumikan was observed conducting monitoring operations near the Cook Islands.[26]

A new MRIS, the Marshal Nedelin, was completed in 1983 and made its maiden voyage directly from Leningrad to Vladivostok in

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21 Norman Polmar, *Guide to the Soviet Navy,* (Third Edition), pp.305-306.

22 US Congress, Senate Committee on Aeronautical and Space Sciences, *Soviet Space Programs, 1971-75: Overview, Facilities and Hardware, Manned and Unmanned Flight Programs, Bioastronautics, Civil and Military Applications, Projections of Future Plans,* (U.S. Government Printing Office, Washington, D.C., 1976), Volume 1, p.72.

23 *Ibid.*.

24 Frank Cranston, 'Soviet Ships Under Surveillance', *Canberra Times,* 7 June 1982, p.1; *Aviation Week and Space Technology,* 14 June 1982, p.18; and US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87,* Part 1, p.264.

25 *Ibid.*.

26 'Soviet Missile Ship Spotted', *Canberra Times,* 22 March 1987, p.5; and 'NZ Forces Locate Soviet Ship', *Newcastle Herald,* 25 March 1987, p.15.

FIGURE 46

CHUMIKAN MISSILE RANGE INSTRUMENTATION SHIP

Source: US Navy.

1984. The ship displaces some 25,000 tons and measures some 214 x 27.1 x 7.7 metres (701.9 x 88.9 x 25.3 feet). It is fitted with a variety of space and missile associated electronic systems, including an 18-metre Ship Globe radome housing a SATCOM terminal and three Quad Ring antenna arrays for telemetry reception.[27] A second Marshal Nedelin class MRIS, the Marshal Krylov, was completed in 1987.[28]

The Kamchatka SSV 391, which was launched in Leningrad and began trials in the Baltic in September 1987, was deployed to the Pacific in December 1987.[29] It was observed off Okinawa in mid-December 1987.[30] Its pennant number indicates intelligence collection and its electronics fit suggests that its primary mission is the collection of space and missile communications and other signals.[31]

A new Soviet MRIS/SIGINT vessel, which carries the pennant number SSV 33 and which NATO has temporarily designated Bal-Aux 2, began sea trials in the Baltic in 1987. It has a displacement of approximately 40,000 tons, measures 265 x 30.5 x 10 metres (869.4 x 100 x 32.8 feet), and is nuclear powered. It has an extensive space-associated electronics fit, including a large phased-array radar, a 4-dish clover-leaf Quad Spring alt-azimuth array, a large (approximately 23.5 metre diameter) Ship Globe radome, and more than half a dozen smaller radomes.[32]

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27 'Marshal Nedelin - Soviets' Latest AGM', *Jane's Defence Weekly*, 26 October 1985, pp.919-920; and US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, p.264.

28 Captain Richard Sharpe (ed.), *Jane's Fighting Ships 1988-89*, p.622.

29 *Ibid.*.

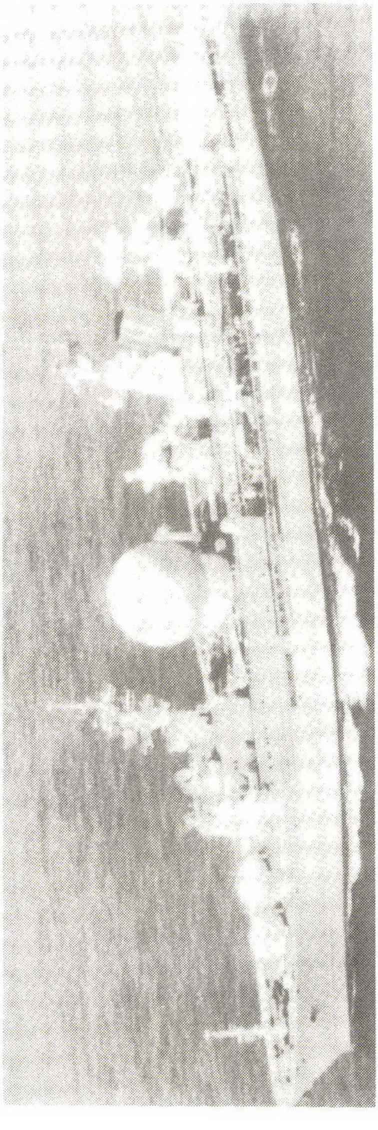
30 'New Soviet Spy Ship Spotted Off Okinawa', *Washington Times*, 15 December 1987, p.2.

31 Sharpe (ed.), *Jane's Fighting Ships 1988-89*, p.622.

32 Siegfried Bryer, 'New Soviet EW Vessel in the Baltic', *International Defense Review*, (Vol.20, No.12), 1987, pp.1592-1593; and Sharpe (ed.), *Jane's Fighting Ships 1988-89*, p.622.

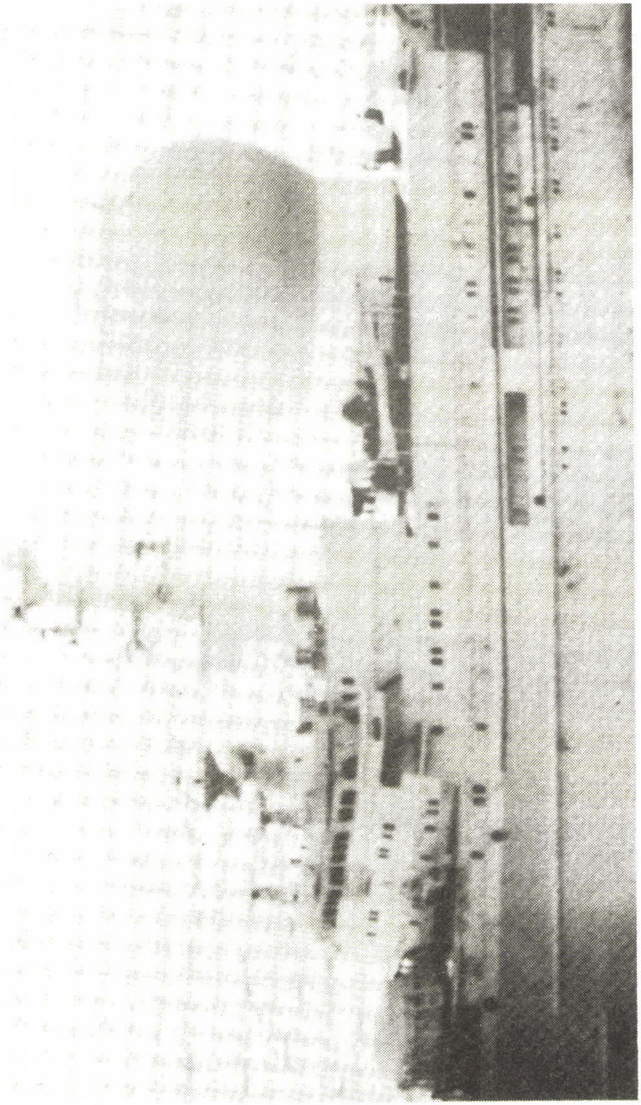
FIGURE 47

MARSHAL NEDELIN MISSILE RANGE INSTRUMENTATION SHIP



Source: US Navy.

FIGURE 48
18-METRE SHIP GLOBE RADOME ON MARSHAL NEDELIN MISSILE RANGE INSTRUMENTATION SHIP



Source: *Jane's Defence Weekly*, 26 October 1985, p.919.

Space Event Support Ships (SESSs)

The Soviet Union currently maintains eleven Space Event Support Ships (SESSs), the primary mission of which is to provide world-wide satellite tracking and recovery capabilities, but which also have significant 'secondary intelligence collection ... capabilities'.[33]

The oldest of these SESSs still in service are four vessels of the Borovichi or Vytegrales class, which were completed in 1965-66 - the Borovichi (callsign UVAU), Kegostrov (UKBH), Morzhovets (UUYG) and Nevel (UUYZ). These ships have a displacement of about 4,900 tons and measure 122.1 x 16.8 x 6.8 metres (400.3 x 55.1 x 22.3 feet), with slightly different electronic fits. The Borovichi has two alt-azimuth mounts on its deck, one carrying a 143 MHz VHF Quad Ring helical array and the other a five-element Quint Ring helical array for telemetry reception. The Kegostrov and the Morzhovets have three 143 MHz VHF Quad Ring helical arrays.[34] The Nevel has a VHF Quad Ring and four 922 MHz UHF Yagi arrays.[35] The Morzhovets made news in the early 1970s when it 'was put under temporary arrest in a Brazilian port for violating territorial waters'.[36] In September 1968, the Zond 5 spacecraft, which had completed a circumlunar flight, was recovered in the Indian Ocean by the Borovichi.[37] During the 1970s, these Borovichi class vessels played major roles in support of the Soyuz manned space flights. In June 1970, for example, the Morzhovets and the Kegostrov operated in the South Atlantic in support of the Soyuz 9 mission.[38] The general locations of these

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33 Director of Naval Intelligence and Chief of Information (US Navy), *Soviet Naval Developments*, (The Nautical and Aviation Publishing Company of America, Annapolis, Maryland, Second Edition, 1981), p.67.

34 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, p.272.

35 'Varied Gear Seen on Russian Command, Tracking Ships', *Aviation Week and Space Technology*, 5 February 1968, pp.66-67.

36 US Congress, Senate Committee on Aeronautical and Space Sciences, *Soviet Space Programs, 1971-75*, p.72.

37 *Ibid.*.

38 *Ibid.*.

vessels during manned spaceflight missions in the 1980s, together with that of the other SESSs, is shown in Table 5.[39]

The four Kosmonaut Pavel Belyayev vessels - the Kosmonaut Vladislav Volkov (callsign UIVZ), Kosmonaut Viktor Patsayev (UZYY), Kosmonaut Pavel Belyayev (UTDX), and Kosmonaut Georgy Dobrovolsky (UZZV) - entered service as SESSs in 1977-78 following conversion from Vytegrales class merchant ships. They are similar to the Borovichi class vessels in displacement and dimensions, but have more extensive and more sophisticated electronic suites. In particular, they each carry amidships a large (9 meter diameter), four-dish clover-leaf alt-azimuth Quad Spring array for satellite tracking and telemetry reception. The four dishes, with independent electrical feeds, provide wide-band coverage from the VHF and UHF ranges through the microwave band, and are rotatable across 180°. They each also carry three 143 MHz VHF Quad Ring helical arrays, a 2.5 metre diameter SATCOM dish for Molniya communications, and numerous other MF, HF and VHF communications and direction finding (DF) systems.[40] According to a report by the Congressional Research Service, the prime function of these vessels is to receive signals from Soyuz spacecraft and to transmit commands to them, while they are out of range of tracking stations on Soviet territory, acting as a relay between the crew in space and flight controllers on the ground.[41] However, they also provide more general support to the Soviet space program. For example, the Kosmonaut Georgy Dobrovolsky and the Kosmonaut Pavel Belyayev supported the recovery of the Kosmos 1374 and 1445

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39 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, p.280.

40 'Kosmonaut Pavel Belyayev Space Monitoring Ships', *Jane's Defence Weekly*, 7 September 1985, pp.466-471; US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part I, p.271; and US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1976-80. Supporting Vehicles and Launch Vehicles, Political Goals and Purposes, International Cooperation in Space, Administration, Resource Burden, Future Outlook*, (U.S. Government Printing Office, Washington, D.C., 1982), p.130.

41 *Ibid.*.

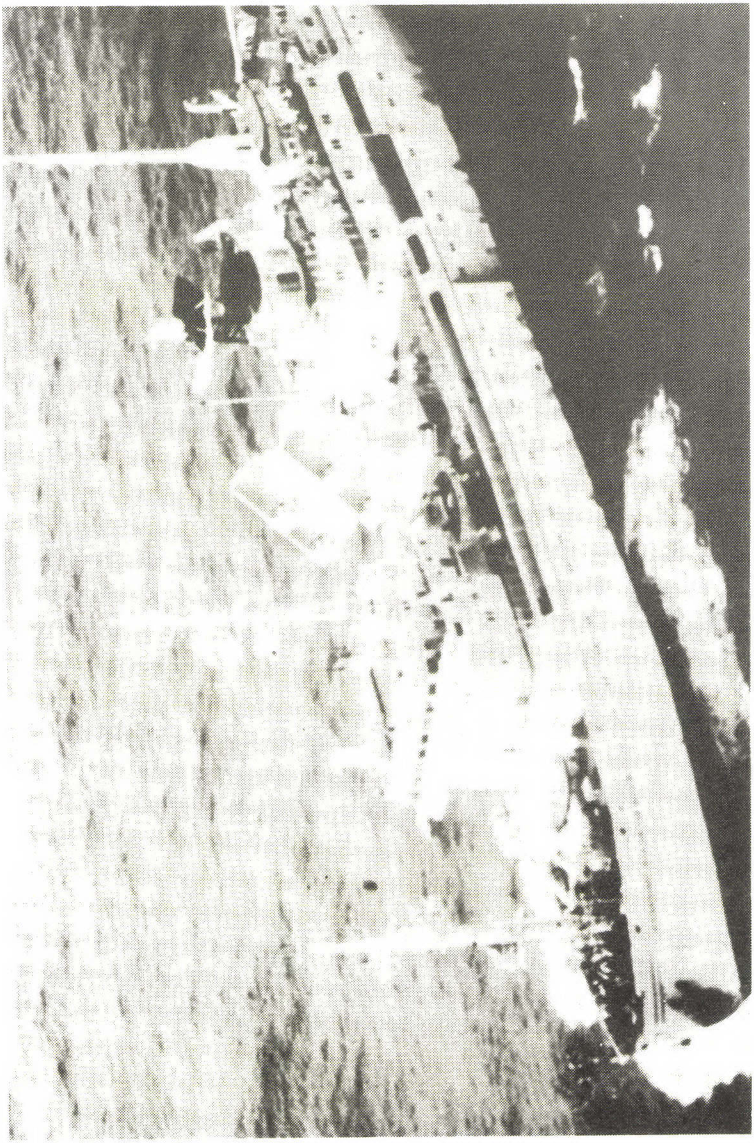
TABLE 5
SPACE EVENT SUPPORT SHIP (SESS) DEPLOYMENT DURING PILOTED SPACEFLIGHT MISSIONS, 1981-1987*

Mission	Nova Scotia	Atlantic	Gibraltar	West Africa	South Atlantic	Caribbean	Mediterranean
Salyut 6/T-4 Soyuz 39/40 1981			Gagarin	Komarov	Kegostrov Morzhovets	Dobrovolsky	
Salyut 6/T-5/T-6/T-7 1982		Komarov	Komarov Gagarin	Gagarin Volkov Borovichi	Morzhovets Nevel Borovichi	Korolev Patsayev Dobrovolsky	Komarov
Salyut 7/T-8/T-9 1983	Korolev Gagarin		Komarov	Patsayev Morzhovets Kegostrov	Belyayev Nevel Borovichi	Korolev Patsayev Dobrovolsky	
Salyut 7/T-10/T-11/T-12 1984	Gagarin	Korolev	Komarov	Volkov Patsayev Dobrovolsky Belyayev Morzhovets	Volkov Nevel Kegostrov	Korolev Volkov Patsayev Borovichi	
Salyut 7/T-13/T-14 1985	Gagarin	Komarov	Komarov	Patsayev Belyayev	Volkov Dobrovolsky Nevel Borovichi Kegostrov	Morzhovets	
Mir/Salyut 7/T-15 1986	Korolev		Komarov	Volkov Kegostrov	Dobrovolsky Nevel	Morzhovets	Gagarin
Mir/TM-2/TM-3 (to Sept.30 1987) 1987	Gagarin Korolev	Gagarin	Komarov	Komarov Patsayev Dobrovolsky Belyayev	Volkov Dobrovolsky Borovichi Morzhovets	Nevel	Patsayev

* Prepared for the Congressional Research Service by Max White.

FIGURE 49

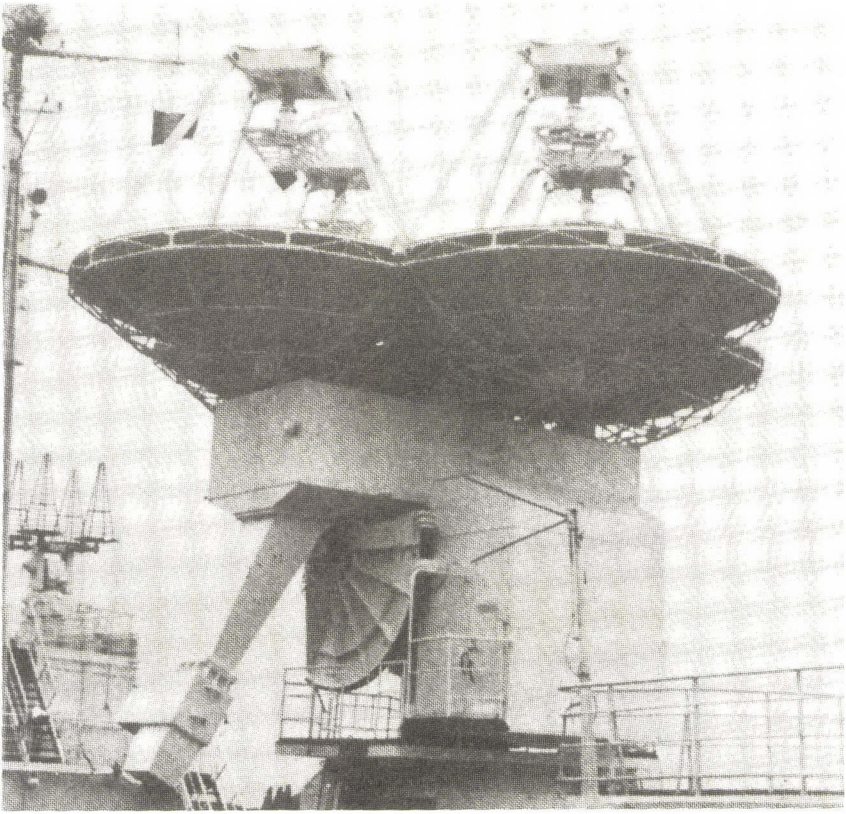
COSMONAUT VLADISLAV VOLKOV SPACE EVENT SUPPORT SHIP



Source: US Navy.

FIGURE 50

QUAD SPRING (9 METRE) ARRAY INSTALLED ON KOSMONAUT PAVEL BELYAYEV CLASS SESSS AND SSV 33



Source: *International Defense Review*, 12/1987, p.1592.

sub-scale space planes in the Indian Ocean in June 1982 and March 1983 respectively.[42]

In September 1988, the Kosmonaut Georgy Dobrovolsky sought permission to berth in Wellington, New Zealand, but was redirected by the New Zealand Ministry of Foreign Affairs to Bluff, near Invercargill, at the southern tip of the South Island of New Zealand. The Dobrovolsky had entered the Pacific on or about 26 September, and according to the ship's senior officers, was providing communications support to the Soviet Mir manned space station. However, permission to berth in Wellington was reportedly refused because the ship was equipped with 'communication interception equipment that would enable it to monitor government and embassy communications in Wellington'.[43] The ship berthed at Bluff from 3 to 5 October 1988.

The Kosmonaut Vladimir Komarov (callsign UUVO) was the first of three progressively larger and even more capable additions to the SESS fleet. It was completed in 1967, has a standard displacement of 11,090 tons and 17,500 tons with a full load, and measures 155.7 x 23.3 x 9.1 metres (514 x 77 x 30 feet).[44] Its SATCOM systems include two large (18 metre) Ship Globe radomes (housing 8 metre dishes), a 7.5 metre radome housing a 2 metre Ship Wheel dish, a 143 MHz VHF Quad Ring array, and two 922 MHz UHF 10-element Yagi arrays for

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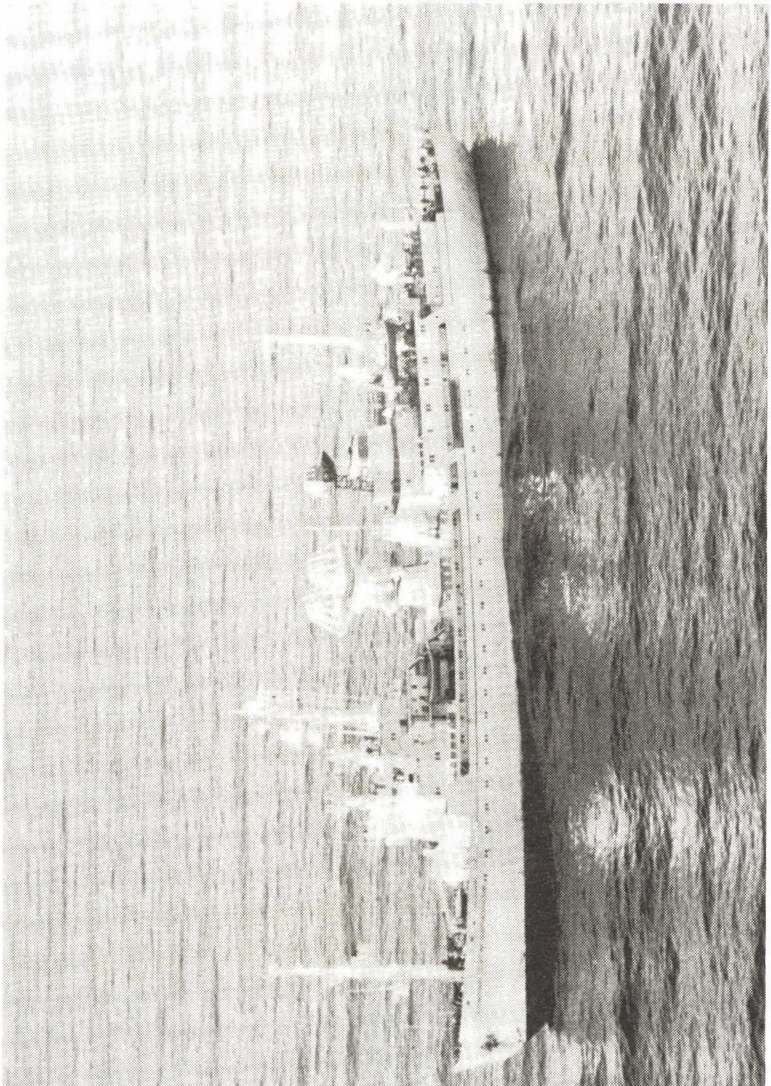
42 Frank Cranston, 'Soviet Ships Under Surveillance', *Canberra Times*, 7 June 1982, p.1; *Aviation Week and Space Technology*, 14 June 1982, p.18; and US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, p.264.

43 Nadya Kooznetzoff and James Gardiner, 'Russian Tracking Ship Denied Port Entry', *The Dominion* (Wellington), 30 September 1988, p.1; 'Soviet Ship Banished to Bluff?', *Taranaki Herald*, 30 September 1988, p.3; 'Soviet Missile Ship Forbidden Entry', *New Zealand Herald*, 1 October 1988, p.5; 'Soviet Ship's Berth Bid A First', *The Dominion*, 1 October 1988, p.1; and 'Soviet Ship Not Able to Eavesdrop, Says Captain', *The Dominion*, 4 October 1988, p.3.

44 Polmar, *Guide to the Soviet Navy*, (Third Edition), pp.310-311.

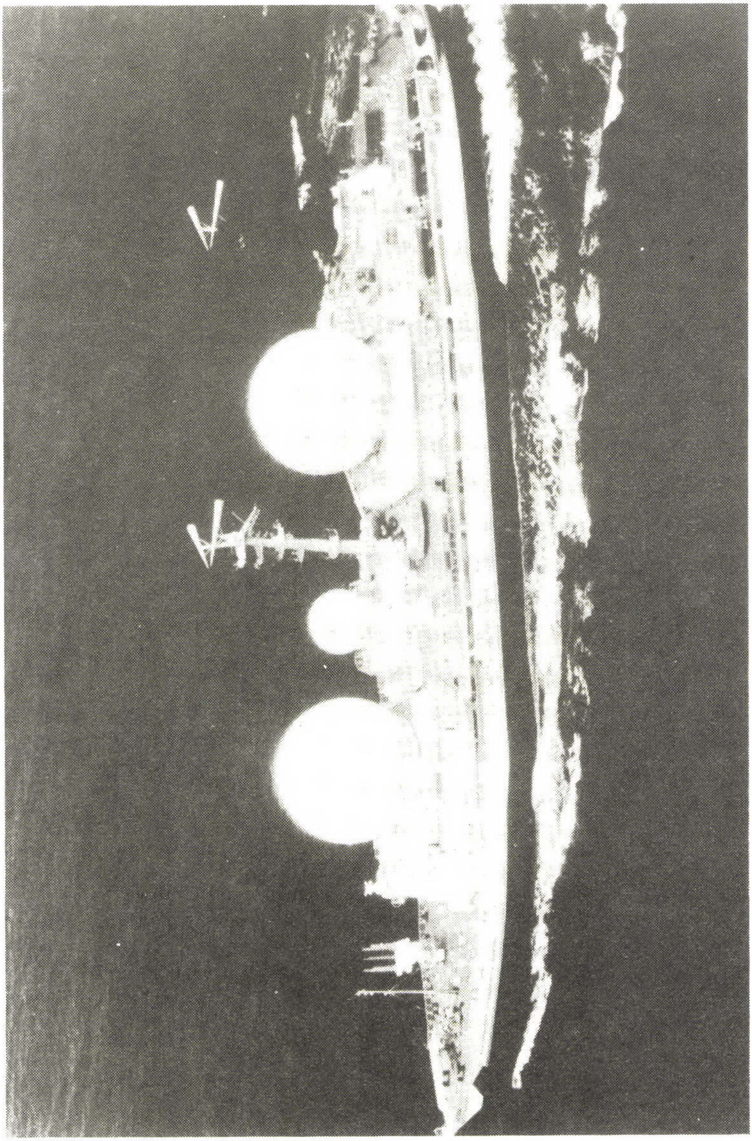
FIGURE 51
KOSMONAUT GEORGY DOBROVOLSKY



Source: Royal New Zealand Air Force.

FIGURE 52

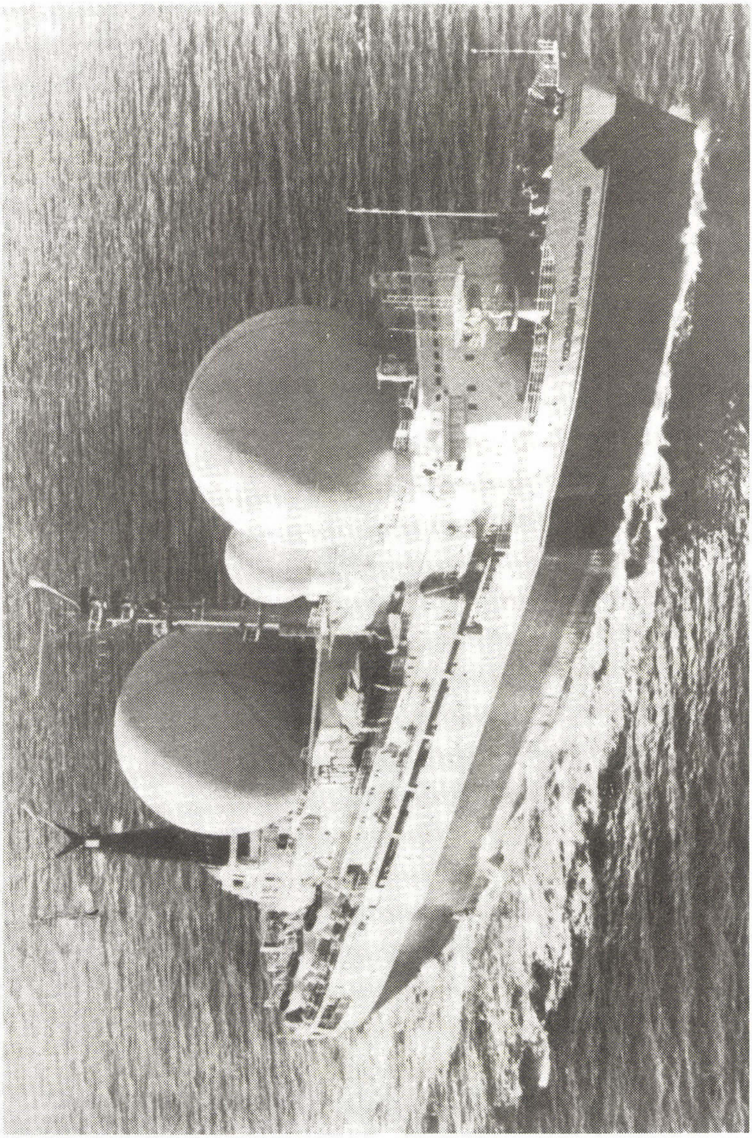
COSMONAUT VLADIMIR KOMAROV SPACE EVENT SUPPORT SHIP



Source: US Navy.

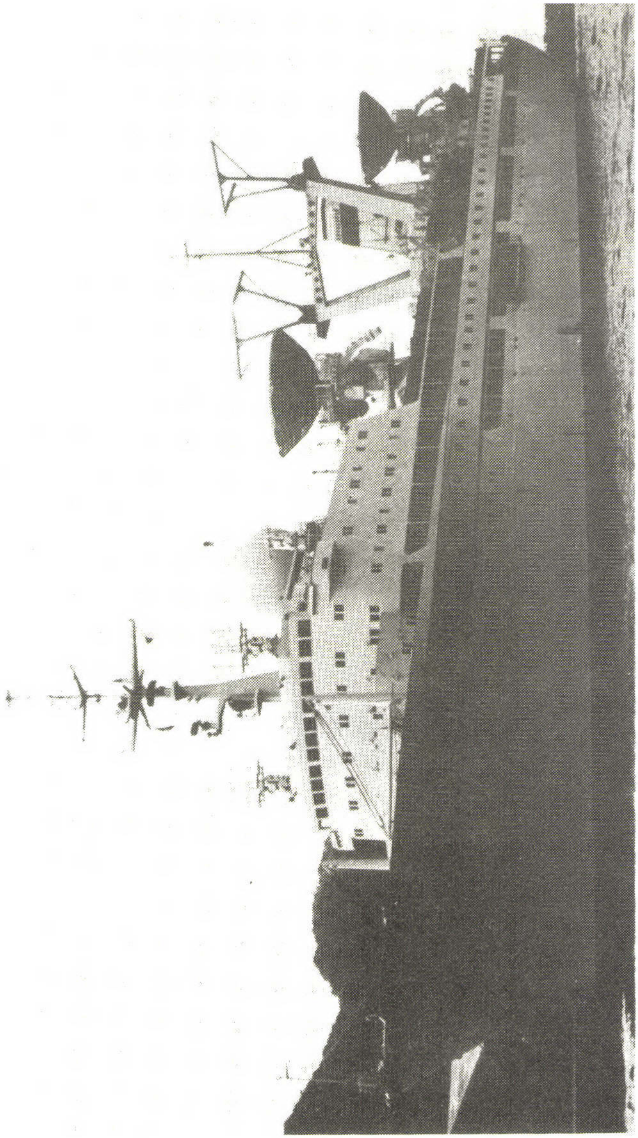
FIGURE 53

COSMONAUT VLADIMIR KOMAROV SPACE EVENT SUPPORT SHIP



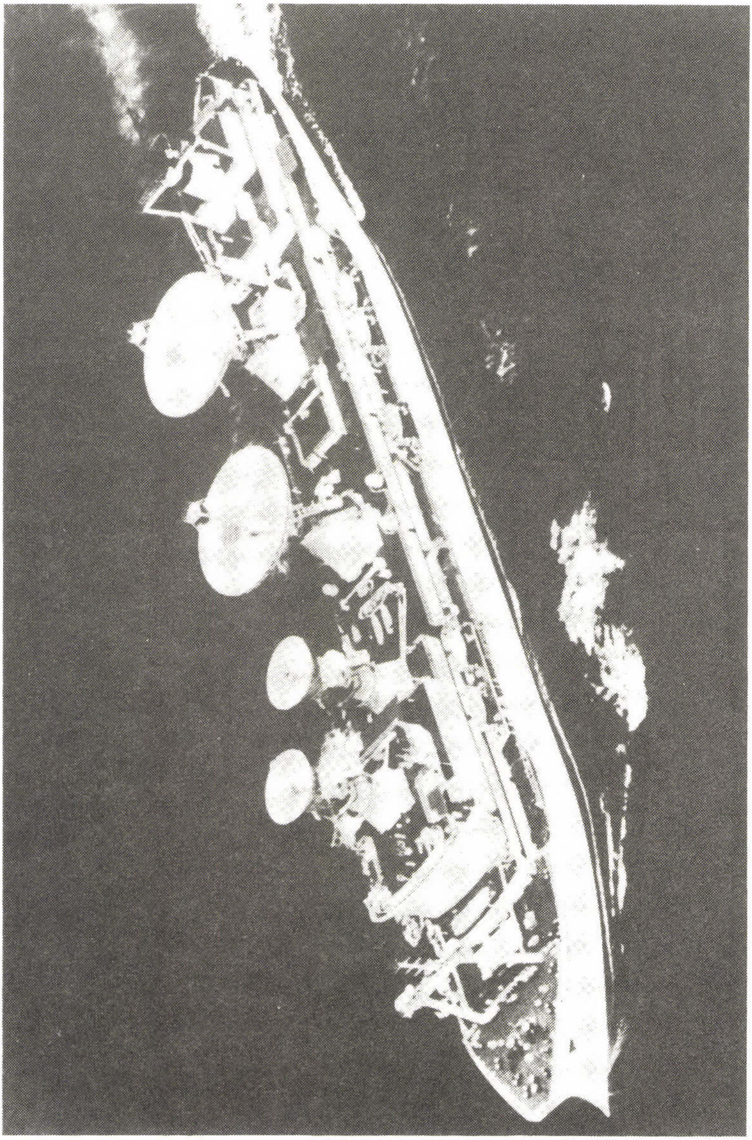
Source: US Navy.

FIGURE 54
AKADEMIK SERGEI KOROLEV SPACE EVENT SUPPORT SHIP



Source: US Navy.

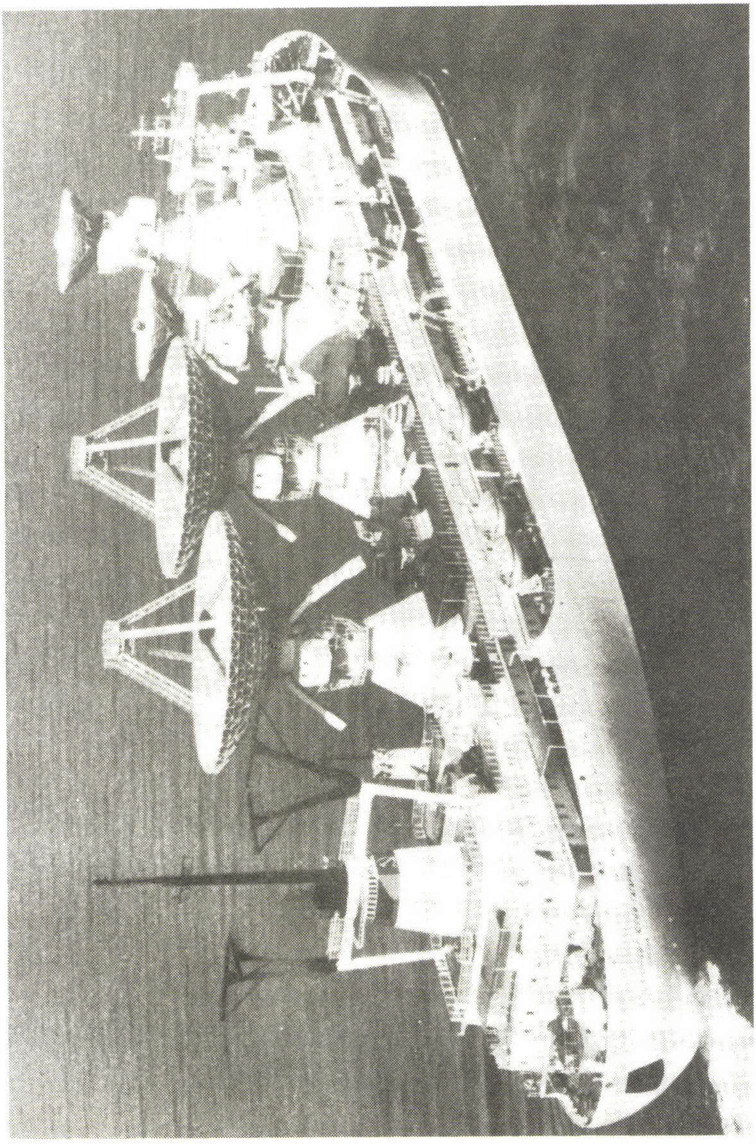
FIGURE 55
KOSMONAUT YURI GAGARIN SPACE EVENT SUPPORT SHIP



Source: US Navy.

FIGURE 56

KOSMONAUT YURI GAGARIN SPACE EVENT SUPPORT SHIP



Source: US Navy.

he reception of telemetry from Salyut and Mir spacecraft.[45] During the 1970s, it frequently operated out of Havana, Cuba,[46] but during the 1980s it has most frequently operated near Gibralter.[47]

The Akademic Sergei Korolev (callsign UISZ), completed in 1970, was the first ship designed from the keel up specifically for the space support mission. It has a standard displacement of 17.115 tons and 21,250 tons with a full load, and measures 181.9 x 25.1 x 7.9 metres (600 x 83 x 26 feet).[48] Its principal SATCOM systems include one dish housed in a radome (about 12 metres in diameter), two 12 metre Ship Bowl dishes (one used for communications via the Molniya COMSAT network), five Quad Ring mounts (for both 143 MHz VHF helical and 922 MHz UHF Yagi arrays), and an INMARSAT SATCOM dish housed in a small radome.[49] It also has 'over 80 laboratories' for 'scientific research' activities.[50]

The latest Soviet SESS, the Kosmonaut Yuri Gagarin (callsign UKFI), completed in 1971, is also the largest scientific research/space support ship in the world. It has a displacement of 37,500 tons standard and 45,000 tons with a full load, and measures 231.8 x 31.0 x 10.7 metres (765 x102 x 34 feet).[51] According to Soviet descriptions

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45 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, pp.270-271.

46 US Congress, Senate Committee on Aeronautical and Space Sciences, *Soviet Space Programs, 1971-75*, Vol.1, pp.68-69; and US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1976-80*, Part 1, p.127.

47 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, pp.272-280.

48 Polmar, *Guide to the Soviet Navy*, (Third Edition), p.310.

49 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, p.270.

50 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1976-80*, Part 1, pp.127-128.

51 Polmar, *Guide to the Soviet Navy*, (Third Edition), p.309.

published in 1971, it has 86 laboratories, and 130 antenna systems.[52] It can communicate 'simultaneously with two or more satellites'; via Molniya COMSATS it can 'reach almost any telephone in the Soviet Union around the clock'; and it is 'capable of receiving high data rates from satellites and amplifying weak signals at planetary distances'.[53] Its SATCOM systems include two large 25-26 metre diameter Ship Shell parabolic dishes, two 12 metre Ship Bowl dishes, and five Quad Ring mounts supporting three 143 MHz VHF helical arrays and two 922 MHz UHF Yagi arrays.[54]

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52 Cited in US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1976-80*, Part 1, p.129.

53 *Ibid.*.

54 US Congress, Senate Committee on Commerce, Science, and Transportation, *Soviet Space Programs: 1981-87*, Part 1, pp.269-270.

CHAPTER SEVEN

CONCLUSION

The Soviet Union maintains the largest SIGINT establishment in the world. It is capable of monitoring virtually the whole radio frequency spectrum on an almost global scale. A significant proportion of this effort is directed at satellite communications (SATCOMs).

The Soviet Union is not alone in this activity. The United States, Britain and Australia also maintain extensive SATCOM intercept capabilities. (Cooperation between these countries with respect to SIGINT collection and exchange is institutionalised under the UKUSA arrangements.[1]) In the United States, a large National Security Agency (NSA)/Naval Security Group (NSG) station at Sugar Grove in West Virginia is designed to monitor the telecommunications traffic through the COMSAT Corporation INTELSAT ground station at Etam, less than 60 miles away, through which passes more than half of the non-governmental international satellite communications entering and leaving the United States each day. Other NSA stations at Winter Harbor in Maine, Yakima in Washington, and Skaggs Island in California monitor the other half of the US INTELSAT traffic which passes through the COMSAT ground stations at Andover (Maine), Brewster (Washington) and Jamesburg (California) respectively.[2] NSA also maintains large SATCOM SIGINT stations at Rosman in North Carolina, Misawa in Japan (code-named Ladylove), Bad Aibling in West Germany, and Menwith Hill in Yorkshire, England (codenamed

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1 See Jeffrey T. Richelson and Desmond Ball, *The Ties That Bind: Intelligence Cooperation Between the UKUSA Countries - the United Kingdom, the United States of America, Canada, Australia and New Zealand,* (George Allen & Unwin, Sydney, London and Boston, 1985).

2 James Bamford, T*he Puzzle Palace: Inside the National Security Agency, America's Most Secret Intelligence Organization,* (Penguin Books Ltd., Harmondsworth, Middlesex, 1983), pp.220-225.

Moonpenny).[3] The Moonpenny operation is concerned with both Soviet highly-elliptical Molniya communications satellites and Soviet geostationary COMSATs. The British Government Communications Headquarters (GCHQ) maintains a station at Morwenstow (near Bude in Cornwall), which is designed to monitor the telecommunications traffic which passes through the COMSAT/INTELSAT ground station at Goonhilly Downs, some 60 miles to the south of Morwenstow.[4] GCHQ also operates jointly with the Australian Defence Signals Directorate (DSD) a SATCOM intercept station at Stanley Fort Station in Hong Kong, code-named Project Kittiwake, which is primarily designed to monitor Chinese satellite communications.[5] DSD also maintains a SATCOM SIGINT station at Shoal Bay, near Darwin, code-named Project Larswood, which is designed for the interception of Indonesian satellite communications.[6] A much larger DSD SATCOM SIGINT station is currently under construction near Geraldton in Western Australia, which is designed to monitor Soviet communications satellites and regional COMSATs such as the Japanese CS-2 COMSATs.[7] The New Zealand Government Communications Security Bureau (GCSB) is also currently constructing a SATCOM SIGINT station at Waihopi, near Blenheim.[8]

However, notwithstanding the comprehensiveness of this UKUSA activity, the Soviet SATCOM SIGINT effort must be assessed as even more extensive. The Soviet SIGINT complex at Lourdes in Cuba, which is targeted 'primarily' against satellite communications, is 'the largest of its kind in the world'.[9] Other major SATCOM SIGINT

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3 Duncan Campbell, 'They've Got It Taped', *New Statesman,* 12 August 1988, p.12.

4 James Bamford, *The Puzzle Palace,* pp.420-421.

5 Desmond Ball, *Australia's Secret Space Programs,* (Canberra Papers on Strategy and Defence No.43, Strategic and Defence Studies Centre, Australian National University, Canberra, 1988), pp.7-17.

6 *Ibid.*, pp.18-35.

7 *Ibid.*, pp.36-56.

8 *Ibid.*, pp.71-76.

9 *Text of President Reagan's Address on National Security,* Washington, D.C., 23 March 1983, p.4; and Department of

stations are maintained in South Yemen, Cam Ranh Bay in Vietnam, Eastern Europe, and the USSR itself. SATCOM monitoring capabilities are also maintained in numerous Soviet diplomatic establishments. The US has nothing comparable to the Soviet fleet of more than two dozen ships with sophisticated SATCOM SIGINT capabilities.

The SATCOM SIGINT facilities at Lourdes in Cuba, together with similar facilities in the USSR, provide 'complete coverage of the global beams of all US geosynchronous communications satellites'.[10] These facilities also provide complete coverage of the global beams of all other national and international communications satellites. Hence, as noted by Walter G. Deeley, Deputy Director of NSA for Communications Security (COMSEC) in October 1984,

> If it [i.e. communications] is going via satellite, you can presume the other guy is listening to it.[11]

Soviet SATCOM monitoring facilities also have extensive although less than complete coverage of defence and intelligence SATCOM systems, including many of the spot beams specifically configured to prevent interception.

Much of the US defence, intelligence and other government satellite communications is encrypted to very high standards. However, a substantial proportion of defence SATCOM circuits remain unencrypted or at least encrypted to lower standards. In 1984, for example, only 40 per cent of all channels in the Defense Satellite Communications System (DSCS) were bulk encrypted. This is substantially less than the number of channels required to handle the amount of classified traffic, forcing the SATCOM controllers to choose between transmitting sensitive communications either on time or in secure fashion. In any case, even where the highest encryption standards are employed, the KGB and GRU have still been able to

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Defense, *Soviet Military Power 1985*, (U.S. Government Printing Office, Washington, D.C., Fourth Edition, April 1985), p.120.

10 Department of Defense, *Soviet Military Power 1984*, (U.S. Government Printing Office, Washington, D.C., Third Edition, April 1984), p.126.

11 Cited in David Burnham, '500,000 More Spy-Proof Phones Proposed by Top Security Agency', *New York Times*, 7 October 1984, pp.1,40.

monitor and decrypt certain satellite communications. During 1975-76, for example, Christopher Boyce provided the Soviets 'months in advance' with cryptographic keylists for the KW-7 and KG-13 cryptographic machines,[12] which were used by the CIA for encrypted communications between the CIA headquarters at Langley, Virginia, and other CIA facilities around the world, including the CIA's SIGINT satellite ground station at Pine Gap in central Australia. And in the mid-1970s and early 1980s, John Walker and Jerry Whitworth provided the Soviets with technical manuals and cryptographic keylists for KW-7, KWR-37, KL-47 and KG-36 cryptographic machines used by the US Navy for fleet satellite broadcast communications.[13] The cryptographic material provided by Walker and Whitworth reportedly allowed the Soviets to decipher 'more than a million' US messages[14] - most of them transmitted via satellite communications systems.

Non-government, commercial and private satellite telecommunications remain extremely vulnerable to Soviet SATCOM SIGINT activities. Over the past decade, there has been increasing use of the US Data Encryption Standard (DES) or some equivalent or lesser encryption standard by corporations, banks and other financial institutions, etc. However, it should not be assumed that the DES and other public key standards are beyond Soviet decryption capabilities. Moreover, a large proportion of commercial communications and computer data links, and virtually all private telecommunications, remain unencrypted.

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12 *United States of America versus Christopher John Boyce,* (Reporter's Transcript of Proceedings, US Federal District Court, Los Angeles, 27 April 1977), pp.1995-1996.

13 Howard Blum, *I Pledge Allegiance ... The True Story of the Walkers: An American Spy Family,* (Weidenfeld and Nicolson, London, 1988), pp.90, 92, 98, 124-125, 135, 153, 176-177, 194-95, 207, and 236; Thomas B. Allen and Norman Polmar, *Merchants of Treason: America's Secrets for Sale,* (Delacorte Press, New York, 1988), pp.6-9, 22-23, 111, and 264-265; and John Barron, *Breaking the Ring: The Bizarre Case of the Walker Family Spy Ring,* (Houghton Mifflin Company, Boston, 1987), pp.128, 162-165, 168, 170, 177, 185-186, and 191-192.

14 *Ibid.*, p.148.

The scale and sophistication of the Soviet SATCOM SIGINT activity is generally inadequately appreciated. In the United States, some countermeasures have been adopted. On 7 November 1985, US Secretary of State George Shultz published in the *Federal Register* Public Notice 947 which requires foreign diplomatic missions to seek the approval of the State Department's Office of Foreign Missions before installing certain telecommunications equipment, including 'any parabolic dish antennaes or comparable apparatus',[15] and the State Department subsequently 'denied a Soviet request to install a parabolic dish antenna at their new Embassy site [at Mount Alto in Washington, D.C.] and at their recreational facility at Pioneer Point, Maryland'.[16] It is likely, however, that SATCOM receiving equipment has been covertly installed in some Soviet diplomatic establishments in Washington, D.C. - including the Soviet Military Office (SMO), which reportedly maintains a SATCOM transmitter;[17] and the new Embassy at Mount Alto.[18]

On 17 September 1984, President Reagan signed National Security Decision Directive (NSDD)-145, entitled *National Policy on Telecommunications and Automated Information Systems Security*, which noted that 'telecommunications and automated information processing systems are highly susceptible to interception', and assigned the NSA a major role in the protection of US governmental and industrial communications.[19] In accordance with this Directive, NSA proposed that some 500,000 US government and industry telephones be equipped with the new Secure Telephone Unit (STU)-III to protect

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15 US Congress, Senate Permanent Subcommittee on Investigations of the Committee on Governmental Affairs, *Foreign Missions Act and Espionage Activities in the United States*, (U.S. Government Printing Office, Washington, D.C., 1986), pp.130-131.

16 *Ibid.*, p.224.

17 Ronald Kessler, *Spy vs Spy: Stalking Soviet Spies in America*, (Charles Scribner's Sons, New York, 1988), p.78.

18 *Ibid.*, p.120.

19 US Congress, Senate Select Committee on Intelligence, *Report of the Select Committee on Intelligence, United States Senate, January 1, 1983, to December 31, 1984*, (U.S. Government Printing Office, Washington, D.C., 1985), pp.33-35, and 52-70.

voice and data communications;[20] however, the response has been tardy, and the STU-111 program is well behind schedule. The objectives of NSDD-145 remain unfulfilled expectations.

Moreover, the Soviet threat to SATCOM systems is not merely passive. Soviet SATCOM SIGINT capabilities can readily be employed to support active jamming of particular US and other satellites. According to one report,

> The most menacing Soviet systems now in operation are large fixed-based [SATCOM] jammers with high effective radiated power. Using 30-foot or larger antennas for high gain, the Soviets have created 200-kilowatt devices for jamming UHF signals and 400-kilowatt systems for SHF.[21]

The irony is that Western publics are much more aware of the SATCOM SIGINT activities of their own SIGINT agencies than they are of those of the Soviet Union. Hence, as Walter Deeley observed in October 1984,

> They [i.e. the Soviets] are having us for breakfast. We're hemorrhaging.[22]

This situation can only be redressed through greater public awareness of Soviet SIGINT activities. As the Senate Select Committee on Intelligence reported in September 1986:

> Public awareness of the hostile intelligence threat to domestic communications is essential, because there are real limits to what the U.S. Government can do to provide secure communications for the private

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20 David Burnham, '500,000 More Spy-Proof Phones Proposed by Top Security Agency', *New York Times*, 7 October 1984, pp.1, 40; and Daniel J. Knauf, 'Communications Security and the Problem of Hamlet: To Be or Not to Be', *Signal*, (Vol.39, No.8), April 1985, pp.47-53.

21 James B. Schultz, 'Space System Designs Promote Survival of the Fittest', *Defense Electronics*, June 1985, p.74.

22 Cited in David Burnham, '500,1,000 More Spy-Proof Phones Proposed by Top Security Agency', *New York Times*, 7 October 1984, p.1.

> sector.... The protection [of non-governmental communications] must depend on the willingness of private organisations to invest in secure communications, not only for their immediate self-interest, but for the larger interests of the nation as a whole.[23]

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23 US Congress, Senate Select Committee on Intelligence, *Meeting the Espionage Challenge: A Review of United States Counterintelligence and Security Programs,* (U.S. Government Printing Office, Washington, D.C., 1986), p.34.

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This monograph is concerned with Soviet capabilities and operations with respect to the intercepting of satellite communications (SATCOMs) - both commercial SATCOMs and defence and intelligence SATCOMs. The monograph describes the Soviet SATCOM SIGINT ground station capability and, most particularly, the major SIGINT facility at Lourdes in Cuba; the Soviet use of diplomatic establishments for intercepting SATCOMs; and Soviet ship-based SATCOM monitoring capabilities. The monograph concludes that the scope and sophistication of Soviet SATCOM SIGINT activities is inadequately appreciated by Western publics, and that greater public awareness of the vulnerability of SATCOMs is necessary for the implementation of effective and comprehensive communications security (COMSEC) policies and practices.