

V.S.

SPACE AND FOREIGN POLICY*

S. Dhawan

The foreign policy of nations intrinsically flows from domestic compulsions as influenced by historical and contemporary dispositions of physical, political and economic parameters. In the modern world after World War II, there are two additional factors of importance. The first is the emergence of over a hundred nations freed politically from the colonial yoke and the second the impact of the scientific revolution on the lives of nations.

To be sure the global economic system still contains serious distortions and the continued manipulative dominance of the affluent nations and their military-industrial complexes. Even so the world today presents a remarkable picture of interdependence of the well-being of all nations and peoples.

At the dawn of independence Jawaharlal Nehru had the vision to set India on a path which explicitly acknowledged the intellectual and emotional matrix of science with an essentially humane pattern of social development. This vision covered India as well as the world and sought to harmonize internal and foreign policies. India was fortunate to have K. P. S. Menon, a dedicated intellectual and outstanding diplomat, to further this policy creatively. I am grateful to the K. P. S. Menon Memorial Society for this opportunity to pay my respectful tribute to such a distinguished personality.

In this lecture I propose to touch upon some issues of national and foreign policy posed by the introduction of space technology.

Reactions to the launch of Sputnik-I in October 1957 and subsequent developments in space were a mixture of excitement of exploration and discovery in an atmosphere of rivalry and military competition between the USA and the USSR. Since that time the world's space activities have grown manifold both in magnitude and diversity. Scientific exploration and military use have had to accommodate a significant component of practical civilian utilization of space. Although the USSR and the USA still are the dominant performers they no longer monopolize space. Several other countries have acquired the capabilities of

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independent entry and use of outer space and more are likely to attain access. Space technology has become an important component of technological, industrial and economic activity. Nearly 140 nations now utilize civilian space services in some form or the other. Thus space now actively enters into national and international policies of most nations.

India elected to use space technology in the early sixties with the explicit purpose of using it to enhance the national efforts in providing nation-wide access to education and communications and for the contribution space could make to the survey and management of natural resources.

For the purposes of this lecture it is useful to quickly review some events of the past 30 odd years since the first artificial satellite went into orbit.

Fig. 1 shows a synopsis of space events and indicates the international actions particularly in the UN which attempts to reconcile the often conflicting interests of nations.

1957 The dawn of the space age in an atmosphere which was an amalgam of scientific excitement, national prestige and military competition.

The 1960s The USSR put Yuri Gagarin into space. In the US/USSR race to the moon there were many failures and some triumphs. The USSR sent its Luna spacecraft around the moon and eventually landed them on it. Venus and Mars were also visited. The USA Ranger, Surveyor and Apollo missions culminated with the triumph of Neil Armstrong's landing on the moon and returning. There were also the first space tragedies. The first Apollo mission resulted in a fire with the loss of three lives. The USSR Soyuz I mission ended in the returning pilot's death because of a failure in his landing parachute. Lunar samples were obtained by the US and the USSR and earlier theories about the moon upset by the findings. Great strides were made in applications especially by the deployment of communication and meteorological satellites

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explosions, were tested. Routine deployment of reconnaissance and communication satellites began. These events influenced the negotiations on banning nuclear tests.

Several other countries—Europe led by France, UK, Japan, China and India became active in space.

The 1970s The rapidly expanding and developing space activity of the world saw some significant changes. Scientific exploration continued and science was advanced spectacularly by space probes to the planets Venus, Mars, Jupiter and Saturn. Military applications also expanded significantly. Civilian effort on space applications and use intensified. Commercial and industrial interests of nations forced a pragmatic element in the funding and utilization of space. Many developing countries were exposed to the potential uses of space through discussions in the UN Committee on Outer Space (COPUOS) and other international agencies. The developing world's view of Space was broadly intertwined with the concepts of a New International Economic Order and a New International Information and Communication Order. Overriding everything was the concern of nations for the prevention of nuclear war and the promotion of disarmament.

The 1980s By the early 1980s over 4,000 satellites had been launched—the bulk of them by the Soviet Union and the USA. Over 75 per cent of these were for military purposes and approximately 2/3rds of the space budgets and manpower were being devoted to military space—primarily for communications, navigation and reconnaissance. Space was getting crowded with space debris—the remnants of expired satellites and rocket stages.

Military issues have dominated space because of its close linkage with the Nuclear deterrent issue. Space provides the primary component of the national technical means of verification as well as the essential communications and intelligence to defence services. On the civilian side there is intense competition

growing in providing satellites and services and in the launching of space systems. Led by France, Europe first broke the launch monopoly of the US and USSR. Now Japan and China and India have also grown capabilities of launch. Israel has just launched its first satellite and Brazil is also expected to do so soon. The most ominous event of the 1980s was the announcement of the 'Star Wars' scenario by the US President. Fortunately the opposition of US scientists and people around the world and the wise moves by the Soviet Union have given some hope of peace to the world.

Evolution of Space Policy

It is perhaps worth recording that India's space programme is unique in its origin and premise being wholly peaceful, open and outside the military ambit. Time will tell whether this will remain so.

While the space policy of nations is likely to be determined primarily by their own domestic political compulsions it cannot escape the impact of international politics and technological advances.

In 1958—a year after Sputnik-I was launched—the United Nations constituted an ad hoc committee on outer space with 18 members. In the beginning the UN approach to space was conditioned by disarmament issues and concerns of radioactivity in the environment, especially from nuclear explosions which led to the Nuclear Partial Test Ban Treaty of 1963. The treaty prohibited nuclear explosions in outer space, in the atmosphere and in the oceans. By 1967 COPUOS was seized with the issue of how to expand use and benefits of space to nations other than the USA/USSR. This led to the consideration of the international legal principles necessary to govern the use of space by all nations. By October 1967 the Outer Space Treaty had entered into force. The main principles enunciated were :

- * Space for all mankind.
- * National appropriation of space prohibited.
- * No military bases or weapons of mass destruction in space including nuclear weapons.

However what was 'peaceful' was not fully spelled out. Neither were the boundaries of outer Space demarcated from air Space.

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A complex international network of legal and cooperative organisations with responsibilities for space activities now exists. Each country has to evolve a policy for using space and take part in international bodies to promote use of space according to UN principles while safeguarding its own interests.

Use of Space

Space is an area of strategic activity and space technology can make significant contributions to :

- * Scientific knowledge.
- * Large scale public services.
- * International economic competitiveness.
- * National and international security.
- * International cooperation.

The pattern of integration of space activities into national and international life is strongly influenced by the political and economic determinants of nations.

Man's entry into space is essentially dependent on the use of multistage rockets which overcoming gravity can place instrumented satellites in desired orbits. Once in orbit the laws of celestial mechanics govern the motion of spacecraft. Fig. 2 shows typical orbits around the earth of satellites for various applications :

- LEO** Low Earth Orbits are effective for surveillance and reconnaissance as well as meteorological observation and resource monitoring.
- GEO** 36,000 km above the equator a satellite remains stationary over a location on the Earth and 'sees' 1/3rd of the Earth. Such satellites are effective as communication stations and also as platforms for early warning of cyclones as well as missile launches.
- Elliptical orbits** With apogee approx 35,000 km and perigee around 300 km especially are used by the Soviet Union for communications since most of USSR territory lies in the north latitudes. These are known as Molniya orbits.

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about 1,000 km height and inclined in various orbits so
that at any given instant at least two or three satellites are
visible from points on the globe. Originally launched for
military uses civil organisations can also use them to a
limited degree.

Multistage rockets used for launching satellites are usually launched in an easterly direction to take advantage of the Earth's rotation. Lift off is usually vertical and then the vehicle rapidly turns in flight to follow a pre-determined trajectory to reach orbit. Each stage is discarded as it burns out and arcs back to earth. Safety considerations dictate that the impact zone should be away from habitation and not cause a hazard to life or property. Since the ground trace of the flight may cover several thousand kms the launch ranges have to be located in uninhabited areas, like deserts or coastal zones. They have to be acceptable to national and international shipping and civil aviation. If the space launchers overfly territorial waters and land areas of other nations then acceptability has to be established through diplomatic as well as technical channels.

Practically all satellite launching stations have had to undergo a process of sorting out of internal and external issues. Fig. 3 gives a glimpse of the existing launching stations and the launch corridors in the world. The launch corridor is defined by considerations of range safety and compliance with national and international regulations. Among other elements prior notification of all launches to maritime and civil aviation organisations is mandatory. Clandestine launches may and do take place but not often. Even IRBM and ICBM tests are notified stating the danger zones. In case of space launches the launching state bears absolute responsibility for any damage to property or life. For this, as well as other reasons space launchers are designed with 'command destruct' systems and the entire flight closely monitored from ground tracking and telemetry stations. Since the flight usually overflies territories other than that of the launching nation, the location and operation of the down-range stations also involves negotiation with and agreement of several countries. The major space powers have in the past solved this problem in their own characteristic ways. The US and Western powers often utilize erstwhile colonial territories spread all over the globe including islands in the Indian, Pacific and Atlantic Oceans.

Diego Garcia in the Chagos Archipelago is one of the US tracking and communication stations. The USSR largely overflies its own territory, supplemented by shipborne tracking and telemetry stations which being mobile can be suitably located in international ocean zones. Obviously there are issues of costs and logistics involved.

Some notes about the world's launching stations shown in Fig. 3.

US	Cape Canaveral - Florida and Vandenburg - off the coast of California	Prime land for vacationers. Real estate and environmental issues. Flight corridor - Caribbean countries, Northern region of South America, Venezuela, Guyana Surinam, Brazil, west coast of Africa.
USSR	Kapustan Yar near Volgograd Baikonur (Kazakistan)	Flight corridor south-east launches over Iran, Saudi Arabia, Arabian Sea, Indian Ocean
	Plesetsk near Archangel south of Barents Sea	North over USSR territory and the Arctic.
France Europe	Kourou - French Guiana close to Equator	Flight corridor—south-east and north
Japan	Kagoshima near southern tip of Kyushu Tanegshima	Flight corridor over fishing zones. Restricted by fishing seasons.
China	Jiuquan Gansu Province Xichang Sichuan Province	Flight corridor - over Chinese territory and then over North Pacific Ocean.

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Let us consider some issues about Indian satellite launching and tracking :
Fig 4 is an aerial view of SHAR from the north and shows the Bay of Bengal to
the left. Madras city lies near the horizon. Fig. 5 shows the launching station,
flight trajectories, stage impact points and the neighbouring countries.

National issues (Fig. 4)

- (1) Pulicat Lake and bird sanctuaries—Environmental protection.
- (2) Coastal fishing, shipping and safety of Madras city have to be ensured.
- (3) Displacement and rehabilitation of fishermen from the south tip needs careful handling and planning.

International issues (Fig. 5)

- (4) Flight corridor - safety and territorial waters of Sri Lanka, Malaysia, Indonesia and Australia - these need a dialogue with the countries and the outcome was not always positive.
- (5) Tracking stations : Reactions of Malaysia, Indonesia, negative. Fiji allowed an Indian tracking station which was moved after the launch.

For the Polar Satellite Launch Vehicle (PSLV) a tracking station has been established in Mauritius.

Space Policy Issues

We have noted that space constitutes a strategic sector and impacts both domestic and foreign policy. Typical issues which need consideration of policy makers are :

(a) Domestic

- * Definition of the prime national objectives for the use of space - for example civilian or military? Regulation of the relative emphasis on education, communications, use by the business community etc.
- * Access to the space segment - only for government, Central and State or also public and private use, e.g., newspapers and political parties.
- * Access to remotely sensed data limited to government institutions or regulated for use by newspapers and public interest groups.
- * Sale of 'Value added' and analysed data by commercial interests.

(b) International

- * Regulation of the national space segment use by other countries—especially neighbouring ones.
- * Collection and distribution of remotely sensed data over other countries.
- * Security of satellite communications and data—in peace time and during national emergencies.
- * Transfer of space technology and co-operation with other countries.

The above list is not exhaustive but only illustrative.

The nature of issues which crop up in dealing with space can be illustrated by the following examples :

- (a) Allocation of geostationary orbit positions;
- (b) 'Prior consent' versus 'Open skies' issue relating to direct TV broadcast and data collection through satellite remote sensing; and
- (c) Space debris: pollution of the space environment.

(a) Geo orbit

The question of allocation of geostationary orbit positions for major and other late countries for regional purposes has been argued for a long time, especially those late countries who have advanced allocation of most of the positions in the process which they have chosen. The position of a developing country because of having a large population wants to have the geostationary orbit positions which they deem fit. Such a country has often to tread a fine line between its own interests and the interests of other countries. Over a period of time, negotiations and frequent discussions are required to reach a mutually acceptable arrangement.

(b) DBS and Remote Sensing
'Prior consent'

There has been a growing concern in many countries by remote sensing. The independent space resources and security of space should be freely available to all countries who have the space resources. It should be freely available to all countries without charge for use of space resources of countries who do not acquire independent space resources.

There is also a growing concern about all remote sensing activities. Those who control the space resources should be held responsible. With the advent of space technology, the control of space resources is becoming more and more important.

(a) Geo orbit

The question of access to the geostationary orbit has been the subject of discussion for many years. Fig. 6 shows the crowding. Developing countries and other late comers wishing to use satellite communications for domestic or regional purposes want equitable sharing for this "limited resource" and have been arguing for a planning and allocation process. The advanced countries, especially those led by the USA on the other hand argue that there is no need for advance allocations since according to them advances in technology will take care of most of the problems. This in practice leads to a 'first-come first-served' process which the developing countries do not support. What would be the position of a developing country which currently supports 'prior planning' but because of having made some progress in high frequency communications also wants to have the opportunity to use advanced technology? There are some equatorial developing countries who have been arguing that the portion of the geostationary orbit above their territories belongs permanently to them to use as they deem fit. So far COPUOS and ITU have not agreed to this position. India has often to tread warily as it supports *apriori* planning but not permanent allocation. Over a period of time some advance has been made in allocation of positions and frequencies for the main geographical regions.

(b) DBS and Remote Sensing
'Prior consent' and 'Open skies'

There has been serious debate for many years about data gathering over countries by remote sensing satellites. Many countries—usually those who do not have independent space programmes—feel that such data often relating to their national resources and security have economic and defence implications and should not be freely available to others without their consent. Other nations, especially those who have the space capability and have been exercising it, argue that data should be freely available to every one on an equitable basis—for instance by paying a charge for use of the space system. Again the question arises about the policy of countries who object to 'open skies' and then change their stand when they acquire independent means of satellite remote sensing.

There is also an element of domestic policy to be sorted out. In the past all remote sensing satellites have been launched by government space agencies who control the space segment as well as the acquisition and distribution of data. With the advent of Spot-Image, the French company distributing satellite data

on commercial terms, any one, in particular newspapers, can acquire photos and data, get them interpreted and use them as part of their news services. Governments usually do not like this. The issue of the freedom of the press and what is regarded as confidential by government agencies are under public debate. The USSR has also recently organised commercial sale of satellite imagery.

With the launch and operationalisation of the Indian Remote Sensing Satellite IRS-IA we can expect both types of policy issues to come up for discussion. Should India use it for looking at the neighbour's backyards? What would be the reaction of other nations? Should the Indian newspapers have access to satellite data to arrive at independent assessments relating to a host of national and international issues? Would the information be used wisely? India's domestic space policy as well as its repercussions on the conduct of foreign affairs will need formulation and enunciation on such and similar matters. The 'direct' broadcasting and 'spill over' issues also raise similar questions and need continuous attention.

(c) Space debris

Resulting from the break-up of satellites and upper stages of rockets some 80,000 objects larger than one cm size are orbiting the earth. The explosive force of a piece of debris about one cm in size would be roughly equivalent to one kg of high energy explosive and would destroy an operating spacecraft or seriously damage it. As Fig 7. shows the debris are distributed from about 400 km to the geostationary orbit with maximum concentration around 800 km. The international space community will soon have to devise regulations to prevent further increase as well as means to reduce the existing pollution. All nations will need to cooperate and prevent increase of this serious hazard—this will inevitably mean increased costs of space systems and operations.

We have earlier noted that military use of satellites has been widely prevalent for communications, navigation and reconnaissance purposes especially by the two major space powers. Equipped with manoeuvre capability, day and night vision and active radar, surveillance satellites can obtain high resolution photographs of military installations, equipment, etc., all over the globe. Nations possessing such systems use them not only for their own purposes but also in international situations involving other nations.

Figs. 8 and 9 illustrate typically how the space powers have used space systems for conflict surveillance over areas where they have geopolitical interests

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as well as for keeping tab over each other's military dispositions and manoeuvres. In this form the use of space systems is said to have a 'peace keeping role.' Space systems also constitute the main component of the so-called 'national technical means' which is vital for assuring compliance with nuclear test bans and strategic arms limitation agreements. Given such uses it has been sometimes argued that such vital space assets are vulnerable and need protection. If implemented unilaterally the weaponization of space with all its 'Star Wars' scenarios then follow logically. The alternative is to keep space free of all weapons through international agreements and define the legally permissible uses to which space systems can be put.

Figs. 10 to 15 illustrate some satellite photographs which relate to security and other issues.

Fig. 10 :	LANDSAT : (USA)	Chernobyl. April 1986
Fig 11 :	US/MILSAT :	USSR Nuclear A/c carrier.
Fig 12 :	COSMOS : (USSR)	Columbia river delta—Ships in dock, A/c on runway.
Fig 13 :	LANDSAT : (USA)	Beijing—Forbidden city, Military airfields
Fig 14 :	IRS (INDIA)	New Delhi
Fig 15 :	IRS (INDIA)	Agriculture : Between Samarkand and Bokhara.

It is clear that as the use of space technology grows and more nations acquire launch capabilities this important element will enter into their national defence postures. Nations who do not have and are not likely to make the investments for independent space capabilities would seek to make arrangements with nations with independent space programmes. Interestingly enough up to a point space proliferation may lead to smaller countries getting access to information which the big powers usually keep to themselves. This may exercise a restraining influence in world

disarmament forums. Once again we see the convergence and interdependence of space and international policies. It is, however, clear that space is pushing the world towards the creation of an international institution which not only discusses space issues but develops and implements agreed legal practices which must be followed by all nations. The U N. COPOUS along with the Committee on Disarmament, if equipped for this task seriously, may yet see to it that space is used as a world preserving force and not as a destabilizing one. This would be in the interest of all nations.

Conclusion

Arms control and disarmament, environmental monitoring and preservation of the world, global communications and resource assessment are issues which concern all nations—in their domestic as well as foreign policies. To each one of these space technology makes significant contributions. Whether these turn out to be benign or malignant depends on the policy which nations follow—collectively as well as individually.

In safeguarding peace as well as development it should be clear to policy makers that the responsibility falls not only on the main protagonists—the big powers—but equally on all nations and peoples. It is equally clear that in promoting national space interests in an interdependent world genuine cooperation and principles of equity are as applicable to foreign policy as to domestic national problems. The Five Continent initiative which resulted in the New Delhi and Mexico declarations had the support of the majority of nations and clearly indicated that the voice of the non-nuclear weapon nations must be heard and heeded on nuclear issues. Similarly it is clear that the non-space nations must have a say in how outer space is utilized. Nations with space capabilities have the responsibility to recognise this.

The case of space technology forcefully illustrates that as nations master and use it for their own good they cannot escape consideration of the interests of others. Expediency and ideas of the absolute sanctity of national sovereignty need to be reconciled and harmonized with global considerations of peace and survival of the earth. The promise of space itself can hardly be realized unless nations cooperate peacefully.

India's space programme is reaching the stage when the policy for domestic and international use need to be orchestrated explicitly with full national consensus. The time is ripe for the formulation of a National Space Act and its promulgation after approval by Parliament. Then we can hope space and foreign policy to reinforce each other in conformity with the peaceful aspirations of the people of India as well as the world.

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I am grateful to S. C.
Raja Ram for helping with

Courtesy: K. P. S. Men

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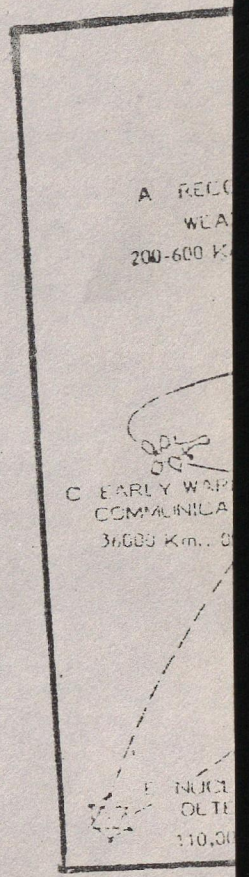
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(Courtesy : K. P. S. Menon Memorial Society, New Delhi)

SPACE EVENTS

MILITARY	CIVIL	YEAR	INTERNATIONAL
LAUNCHERS AND ICBM'S DEV.	USSR SPUTNIK-I	1957	SPACE ERA BEGINS
	US : ISTSATELLITE	1958	UN COPOUS-AD HOC. FREQ. FOR ITU/WARC ALLOT. SPACE
		1959	
	USSR : IST MAN IN SPACE	1960	
PARTIAL NUCLEAR TEST BAN ASAT STUDIED AND TESTED	US IST ACTIVE COMSAT TELESTAR	1961	AD HOC COPOUS 25 MEM.
		1962	
		1963	UN DECL : LEGAL PRINCIPLES FOR SPACE
		1964	INTELSAT
RECON. & COM S/C ROUTINELY DEPLOYED	US COMSATS	1965 1966	FRANCE IST LAUNCH
	USSR COMSATS		
	USSR LUNA ON MOON	1967	OUTER SPACE TREATY
		1968	IST UN CONF. ON SPACE
ABM TREATY SALT	US : FIRST MAN ON MOON	1969	JAPAN - IST LAUNCH
	USSR. S/C ON VEUNS	1970	CHINA
	USSR : S/C ON MARS SALYUT	1971	INTERSPUTNIK- UK IST LAUNCH
	US. LANDSAT	1972	LIABILITY CONVENTION
	US. SKYLAB	1973	COPOUS-46 MEMBERS
		1974	REGISTRATION CONVTN.
	APOLLO-SOYUZ	1975	
	US PHOTOS FROM MARS	1976	
		1977	
	COSMOS 954 CRASH IN CANADA	1978	LIAB CONV. INVOKED
	SKY LAB RE. ENTRY	1979	ESA IST LAUNCH
		1980	INDIA IST LAUNCH
	US SPACE SHUTTLE	1981	USSR SETTLES CANADA CLAIM
	IST FLIGHT		
SDI		1982	MOON 2ND UN CON. TREATY INTL. TV BR. CAST
		1983	
		1984	5 CONTINENT DELHI DECLN.
		CHALLENGER LOST	1985 1986
REAGAN-GORBA-CHEV AGREEMENT		1987	REM. SENS. PRINCIPLES
		1988	ISRAEL IST LAUNCH

FIG 1. CALENDAR OF SPACE EVENTS



AR	INTERNATIONAL
57	SPACE ERA BEGINS
58	UN COPOUS-AD HOC
59	ITU/WARC FREQ. FOR ALLOT. SPACE
60	
51	AD HOC COPOUS 25 MEM.
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53	UN DECL: LEGAL PRINCIPLES FOR SPACE
54	INTELSAT
55	FRANCE 1ST LAUNCH
56	
7	OUTER SPACE TREATY
8	1ST UN CONF. ON SPACE
9	
10	JAPAN - 1ST LAUNCH
11	CHINA
	INTERSPUTNIK- UK 1ST LAUNCH
	LIABILITY CONVENTION COPOUS-46 MEMBERS
	REGISTRATION CONVNTN.
	LIAB CONV. INVOKED
	ESA 1ST LAUNCH
	INDIA 1ST LAUNCH
	USSR SETTLES CANADA CLAIM
	MOON
	2ND UN CON. TREATY INTL. TV BR. CAST
	5 CONTINENT DELHI DECLN.
	REM. SENS. PRINCIPLES
	ISRAEL 1ST LAUNCH

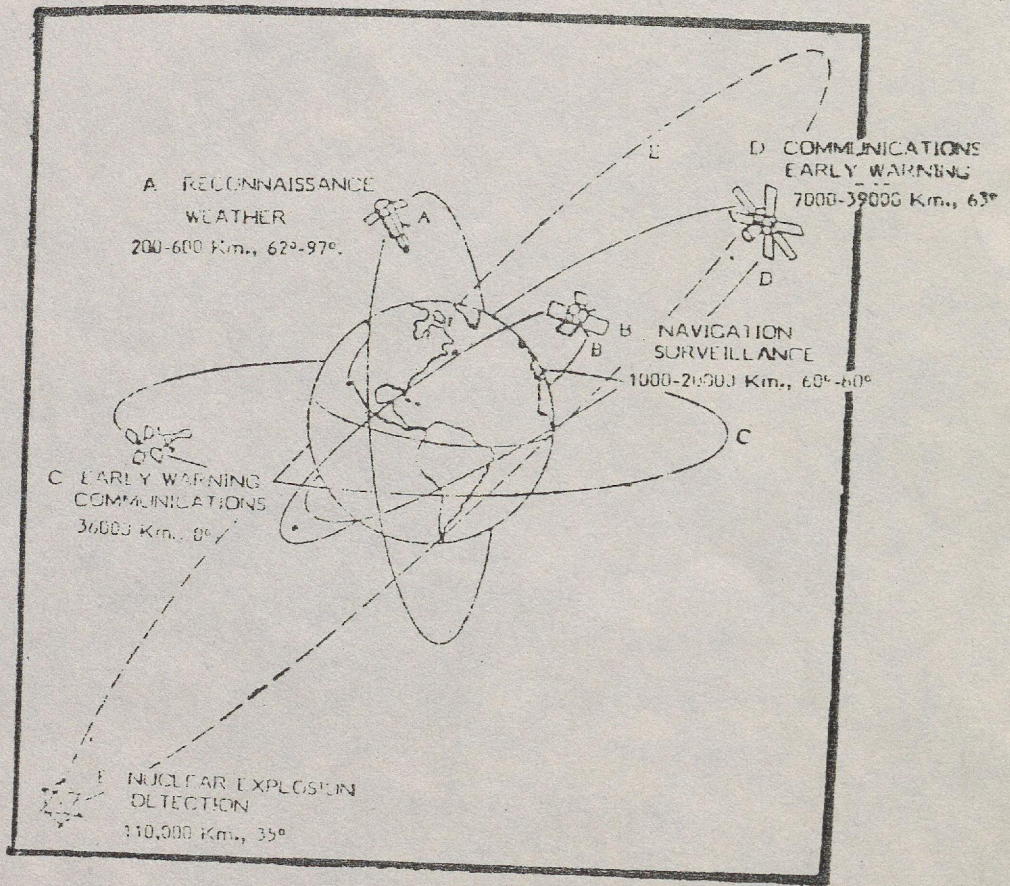
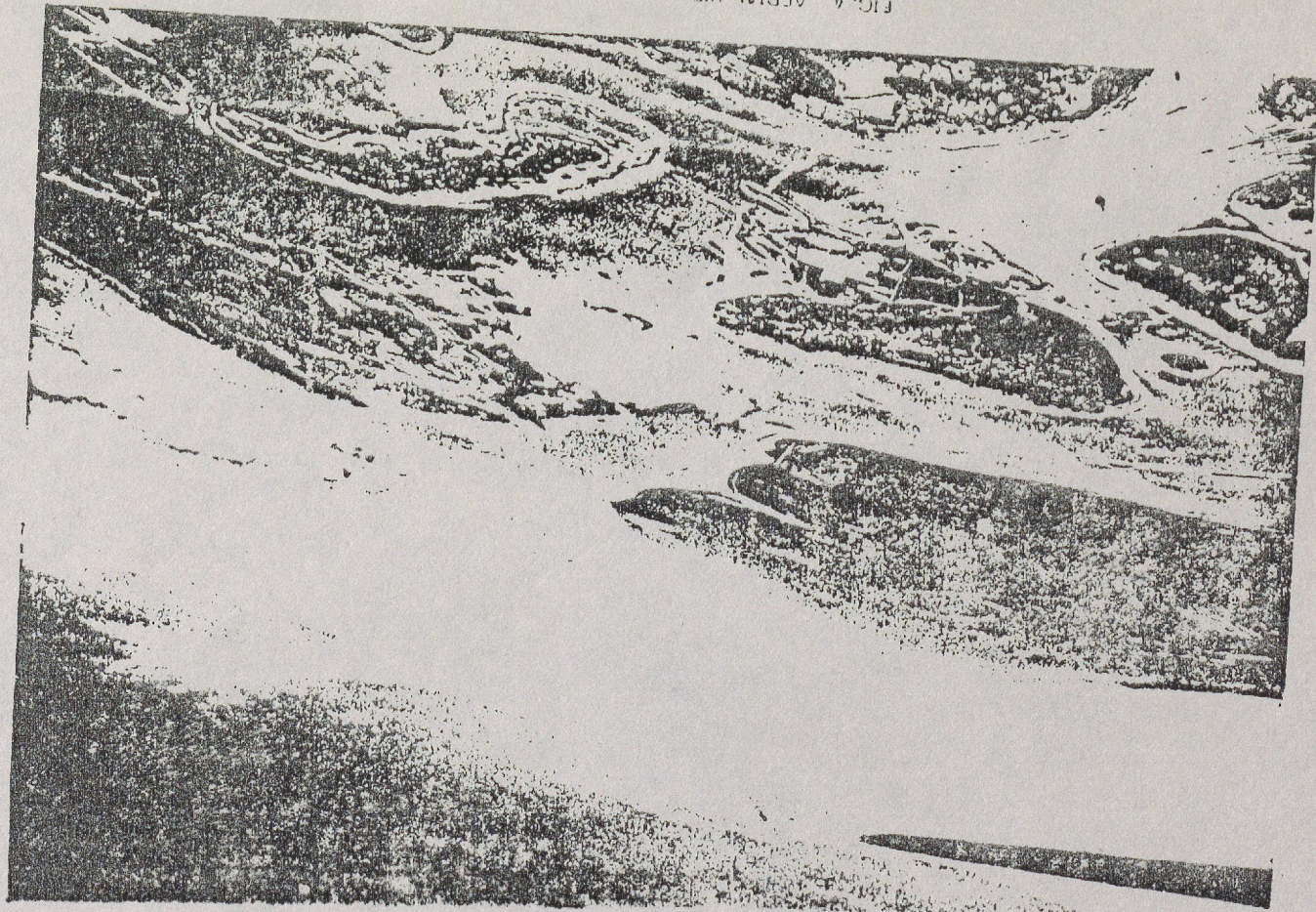
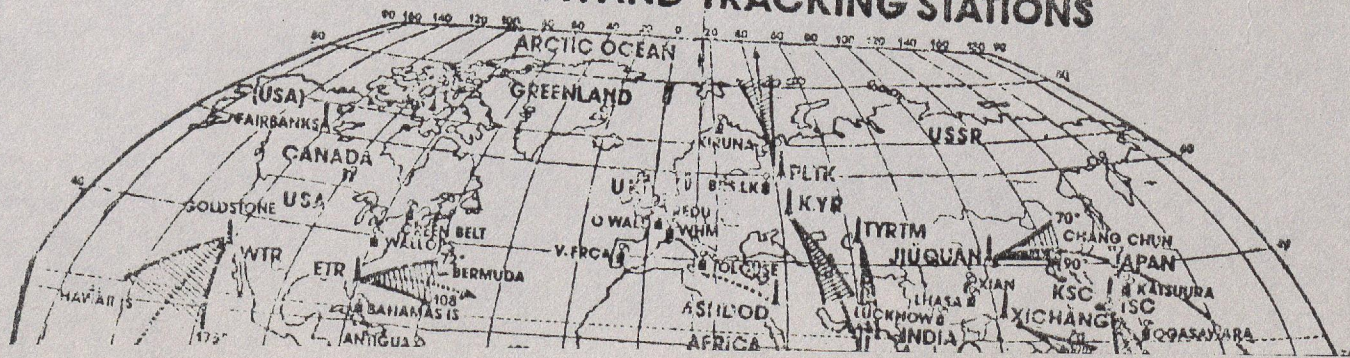


Fig. 2 SATELLITE ORBITS

FIG. 4 AERIAL VIEW OF SRINAGOTA & BAY OF BENGAL



WORLD LAUNCH AND TRACKING STATIONS



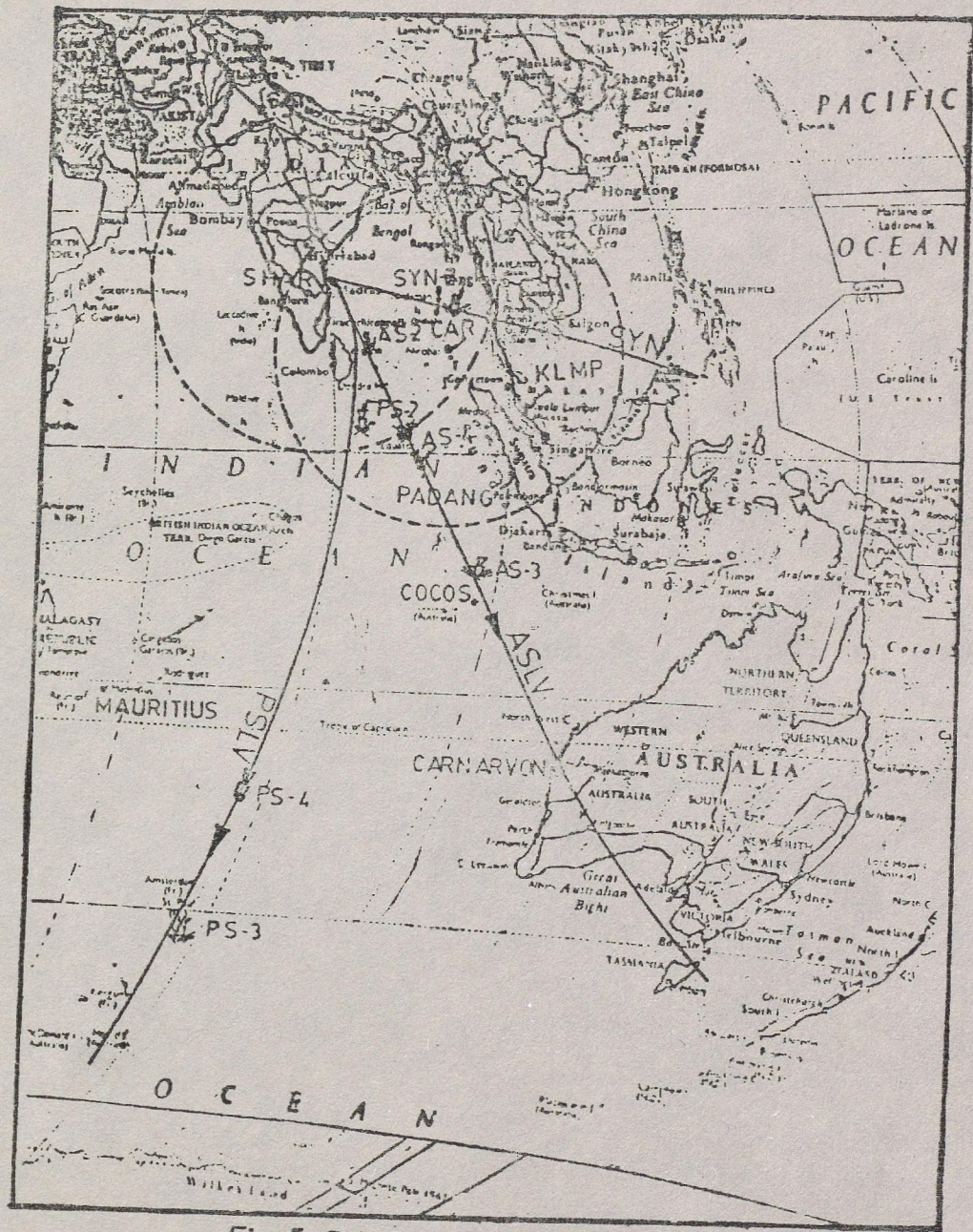


Fig: 5. SHAR LAUNCHING STATION

GEOSYNCHRONOUS ORBIT - OCCUPANCY

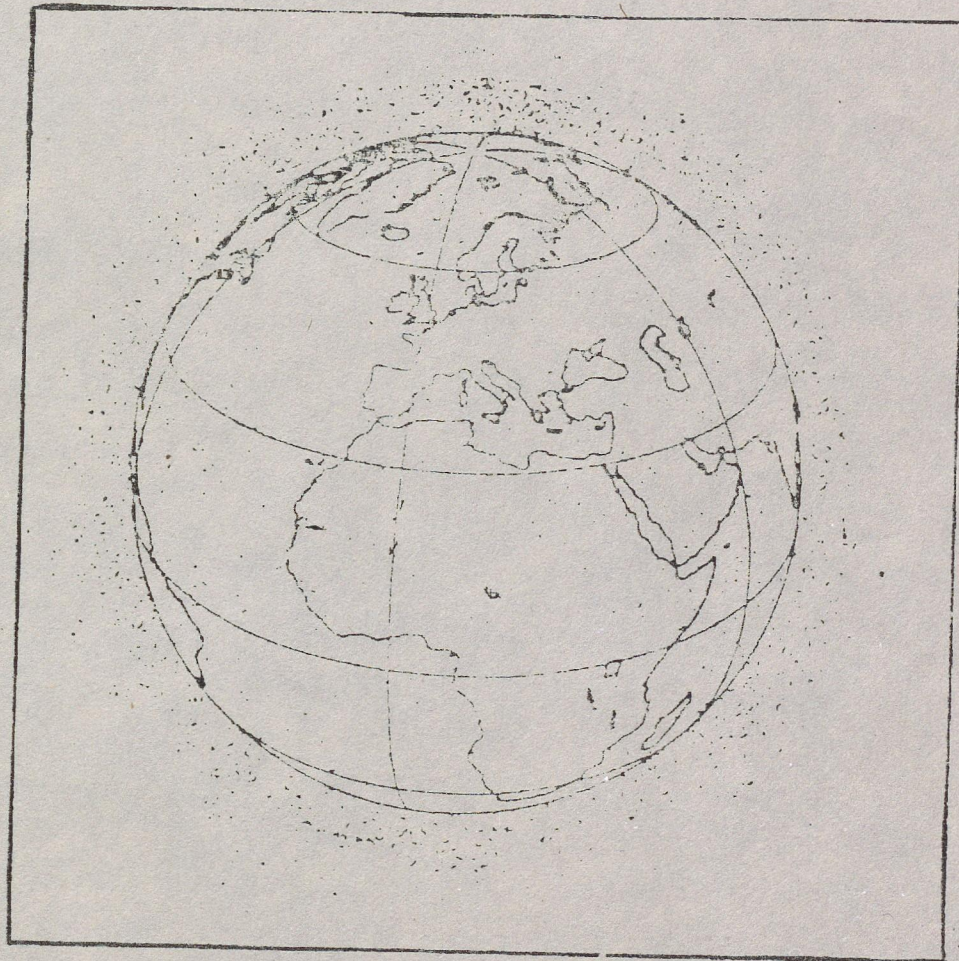
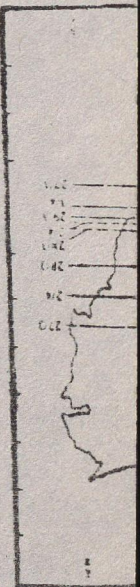
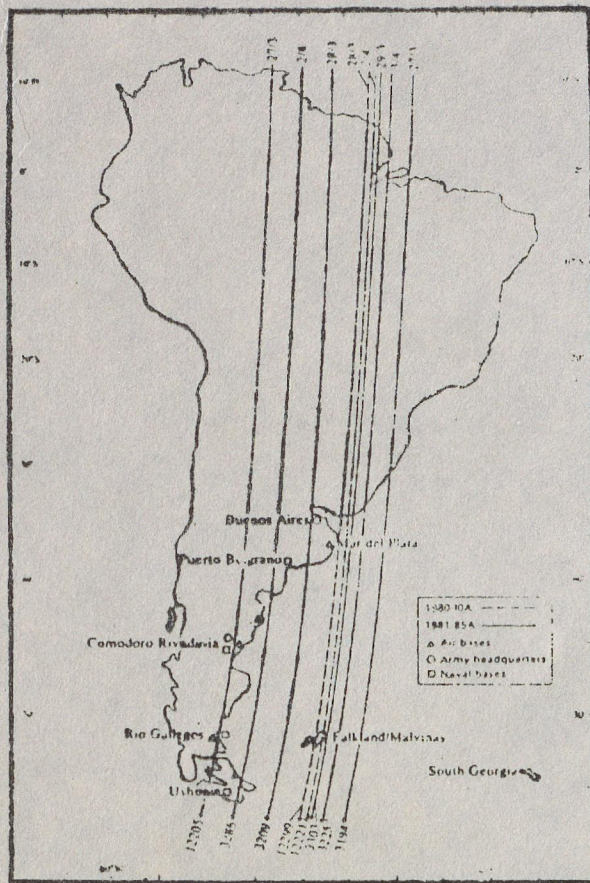
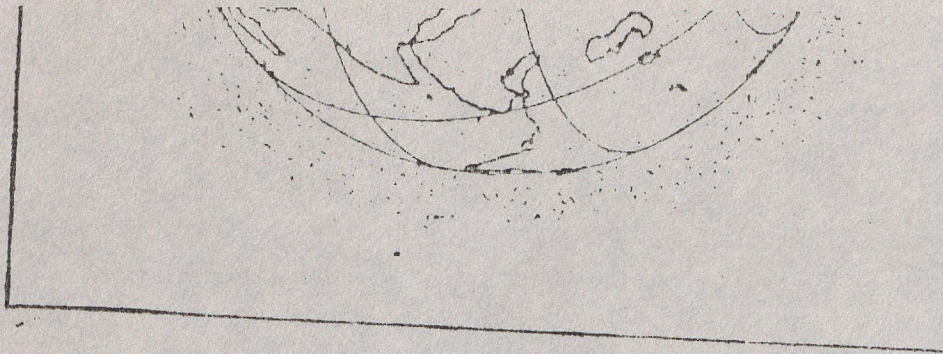
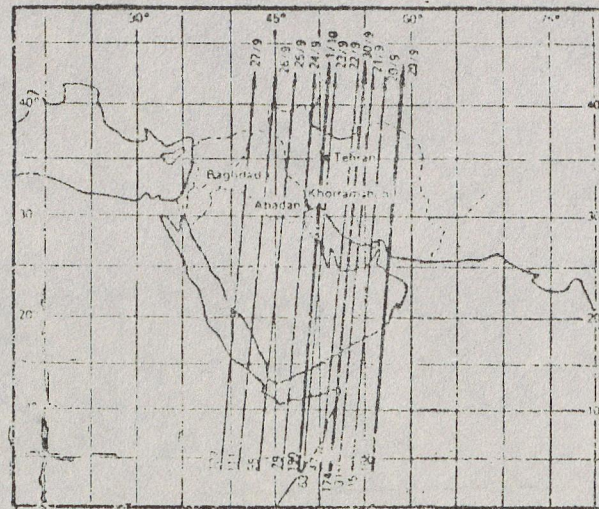


FIG. 7 SPACE DEBRIS



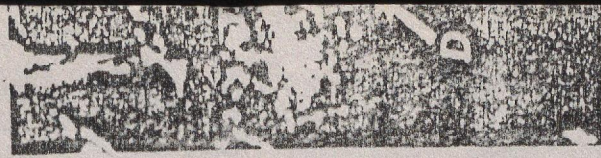


US. 1980-10A & 1981-A OVER THE FALKLAND ISLANDS
MARCH-APRIL 1982

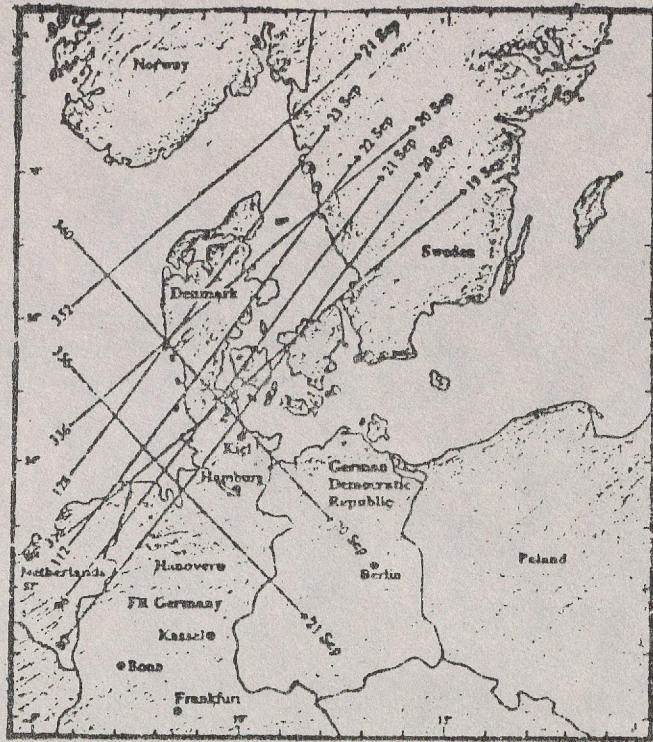


USSR COSMOS 1210 OVER IRAN-IRAQ
SEPTEMBER 1980

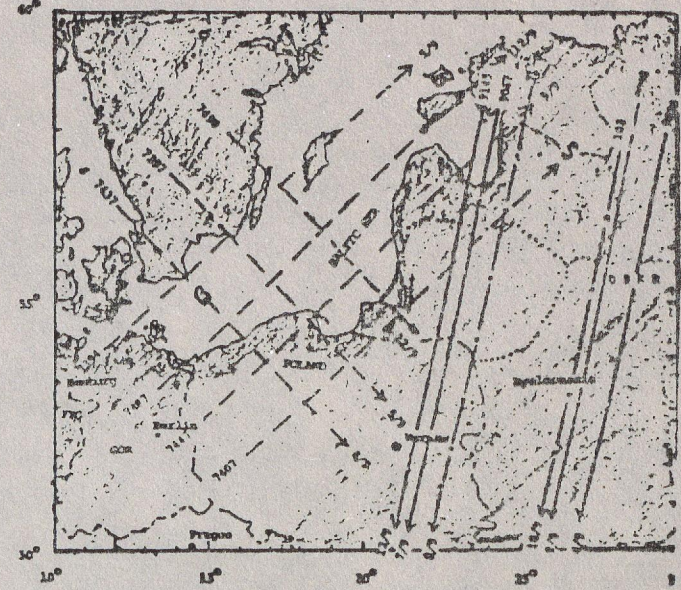
FIG. 8 SATELLITE SURVEILLANCE OF MILITARY OBJECTS



Location of burning Key in the Soviet U...
 larger cooling pond
 major image. The
 The spacecraft pas
 an altitude of 835
 reactors were in r

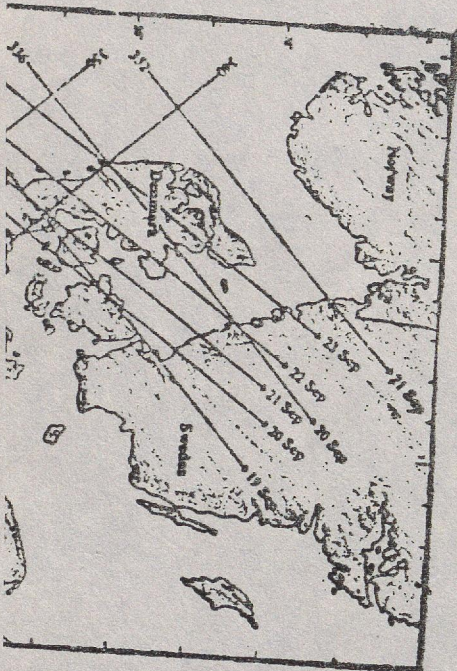


TRACKS OF SOVIET S/C COSMOS 1407
 COSMOS 1402
 OVER NATO MANOEUVRE " BOLD GUARD"
 20-24 SEPT 1982

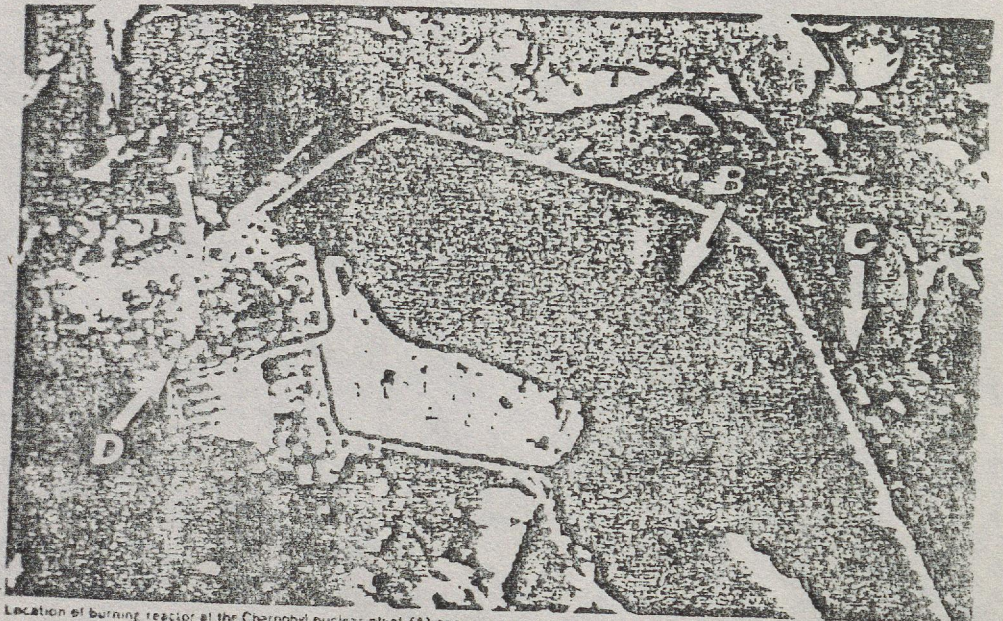


KH-11, 1980-10A
 KH-11, 1981-85A
 NOSS-JC
 TRACKS OF US S/C
 OVER USSR " ZAPAD" MANOEUVRE
 4-12 Sept. 1981

FIG. 9. SATELLITE RECONNAISSANCE OVER MILITARY MANOEUVRES



Soviet Nuclear Reactor Imaged by Landsat Thematic Mapper



Location of burning reactor at the Chernobyl nuclear plant (A) near Kiev in the Soviet Union appears as a dark rectangle to the left of a large cooling pond (B) at the center of this Landsat 5 thematic mapper image. The Pripyat River (C) bypasses the edge of the pond. The spacecraft pass occurred 9:30-9:45 a.m. Kiev time Apr. 29 at an altitude of 635 m. Some observers believe the data show two reactors were in meltdown but the thin smoke from the burning

graphite in reactor cores does not show up on thematic mapper bands 2, 3 and 5 used to process the image. A single black plume of smoke from other burning debris in the area of the reactors (D) is evident however. The reactors are surrounded by a triangular section of burning terrain. Earth Observation Satellite Co. (Eosa), the U.S. Geological Survey and the U.S. Forest Service are studying the impact of released radiation, including crop damage.

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FIG. 10 THE BURNING REACTOR AT CHERNOBYL - LANDSAT PHOTO



This image (C), taken by military satellite, shows construction of the first Soviet nuclear-powered aircraft carrier. Even gliders of small cranes can be seen.

FIG. 11. SOVIET NUCLEAR POWERED A/C CARRIER - US MILSAT

FIG.

This page (C) taken
military satellite
ow construction of
t first Soviet nuclear
wered aircraft carrier
en girders of small
nces can be seen.

from this Soviet satel-
lite photo (D) of the Co-
lumbia River delta,
ships can make out
details of ships at dock
and spot airplanes on
the runway (lower left).
Resolution is roughly six
meters.

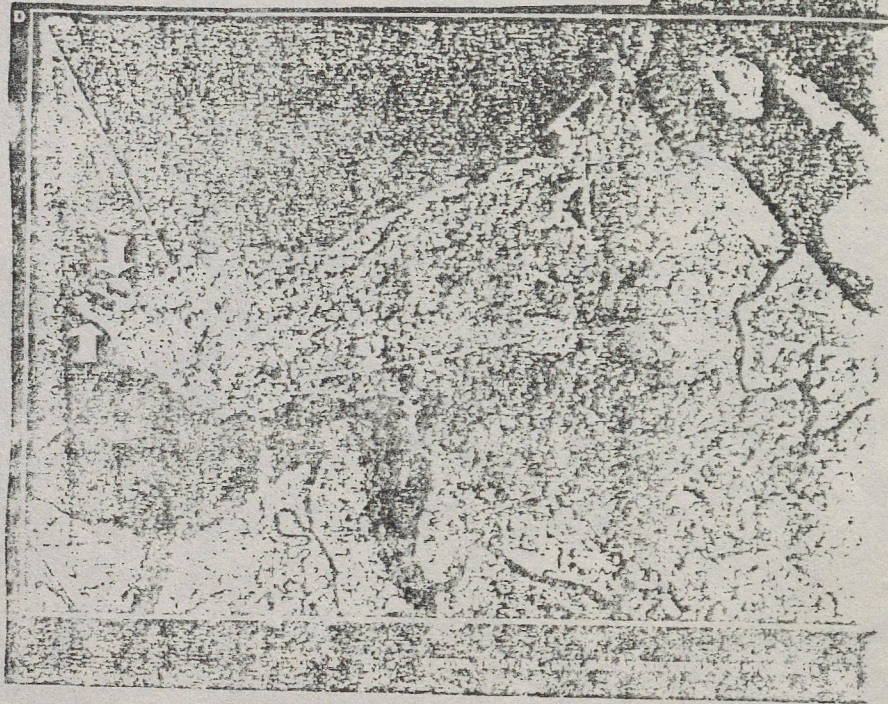


FIG. 12 SOVIET SATELLITE PHOTO OF SHIP DOCK - AIR RUNWAY - COLUMBIA RIVER

IRS-1A



COMMERCIAL SPACE 17

FIG. 13. BEIJING FROM LANDSAT: FORBIDDEN CITY & MILITARY AIR FIELDS

IRS-1A VIEWS DELHI



SPACE 17



FIG. 14 NEW DELHI FROM IRS-1A



FIG. 15 AGRICULTURE BETWEEN SAMARKAND & BOKHARA IRS-1A