# SPACE AND FOREIGN POLICY*

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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

*Text of the K.P.S. Menon Memorial lecture, at Andhra Bhavan, New Delhi, 29 October 1988.

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 eeonomic activity, Nearly 140 nations now utilize civilian space services in some from or the other. Thus space now actively enters into national and international polices 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 cf 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 metelorogical satellites

On the military side, weapons in space including nuclear 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 rapidlyexpanding 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.

Subsequently the following have come into force :

1968 : Agreement on Rescue of Astronauts and Return of Objects from Space.

1972 : Convention on International Liability for Damage caused by Space Objects.

1974 : Convention on Registration of Objects Launched into Space.

1979 : Moon Treaty, Exclusively peaceful use of moon and other celestial bodies.

1982 : Principles for direct TV broadcast from space. General Assembly vote for consultation and agreement.

1986 : Remote Sensing Principles
- Respect state sovereignty.
- Every country free to take from space.
- Raw data available to all by payment.
- States not responsible for value added products.

Other organisations which deal with space matters are :

ITU Coordinates geostationary orbit positions. Allocates radio frequencies for space services (150 member states).

WMO UN planning and coordination body for weather services (125 nations over 1000 met. readout stations).

INTELSAT (1964) Sateillite Communications, 109 members—used by 125 nations.

INTERSPUTNIK (1968) 15 members.

INMARSAT (1979) Mobile communications (43 members states)
- . Maritime - Serves 4000 ships
- . Aviation
- . Land

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 oi 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.

**Sunsynchronous orbits** Polar orbits with inclinations between 90-99 at 500-1000 km altitude are used for resource monitoring and weather satellites. Navigation and position fixing spacecraft are usually launched in multiples in circular orbits at 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 launche 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. |

| | | |
|---|---|---|
| **India** | Sriharikota Andhra Pradesh east coast | Flight corridor - 45°SE Malaysia, Sri Lanka, Indonesia and east coast of Australia. |
| **Israel** | Ashdod Mediterranean coast 20 Km south of Tel Aviv | Flight corridor - Almost due west over the Mediterranean Sea. |

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 protectton.

(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 objcctives 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) Allcation of geostationary orbit positions;

(b) 'Prior consent' versus 'Open skies' issue relating to direct TV boadacast and data collection through satellite remote sensing; and

(c) Space debris: pollution of the space enviroment.

### (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 advace 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 usally 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 repurcussions on the conduct of foreign affairs will need formulation and enuncication 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,C00 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 cnncentration 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 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 programes. 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 initative 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.

## REFERENCES

1. *Maintaining Outer Space for Peaceful Purposes*
   Ed. N. Jasentulive
   The United Nations University 1984.

2. *The Exploitation of space*
   Ed. M. Schwarz & P. Steres
   Butterworth & Co., London 1985.

3. *Journal of Space Law* Vol. 16 No. 18 1988

### Acknowledgements

I am greatful to S. Chandrasekhar for assistance in collecting material for this lecture, Raja Ram for helping with the figures.

(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. |
| | | 1959 | ITU/WARC FREQ. FOR ALLOT. SPACE |
| | USSR : IST MAN IN SPACE | 1960 | |
| | US IST ACTIVE COMSAT TELESTAR | 1961 | AD HOC COPOUS 25 MEM. |
| | | 1962 | |
| PARTIAL NUCLEAR TEST BAN ASAT STUDIED AND TESTED | | 1963 | UN DECL : LEGAL PRINCIPLES FOR SPACE |
| | | 1964 | INTELSAT |
| | US USSR COMSATS GEO SYN MOLNIYA | 1965 | FRANCE IST LAUNCH |
| | | 1966 | |
| RECON. & COM S/C ROUTINELY DEPLOYED | USSR LUNA ON MOON | | |
| | | 1967 | OUTER SPACE TREATY |
| | | 1968 | IST UN CONF. ON SPACE |
| | US : FIRST MAN ON MOON | 1969 | JAPAN - IST LAUNCH CHINA |
| | USSR. S/C ON VEUNS | 1970 | |
| | USSR : S/C ON MARS SALYUT | | INTERSPUTNIK- UK IST LAUNCH |
| | | 1972 | LIABILITY CONVENTION |
| ABM TREATY SALT | US. LANDSAT 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 IST FLIGHT | 1981 | USSR SETTLES CANADA CLAIM |
| | | 1982 | 2ND UN CON. MOON TREATY INTL. TV BR. CAST |
| SDI | | 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

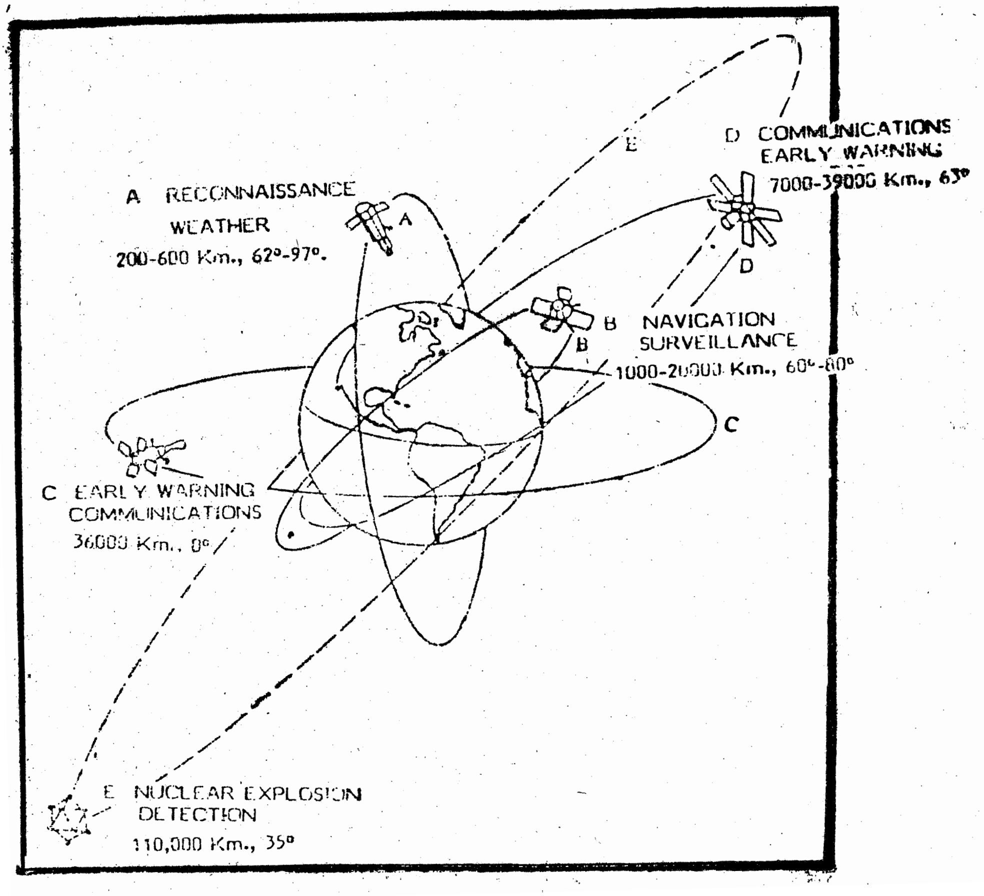



Fig. 2 SATELLITE ORBITS

# WORLD LAUNCH AND TRACKING STATIONS

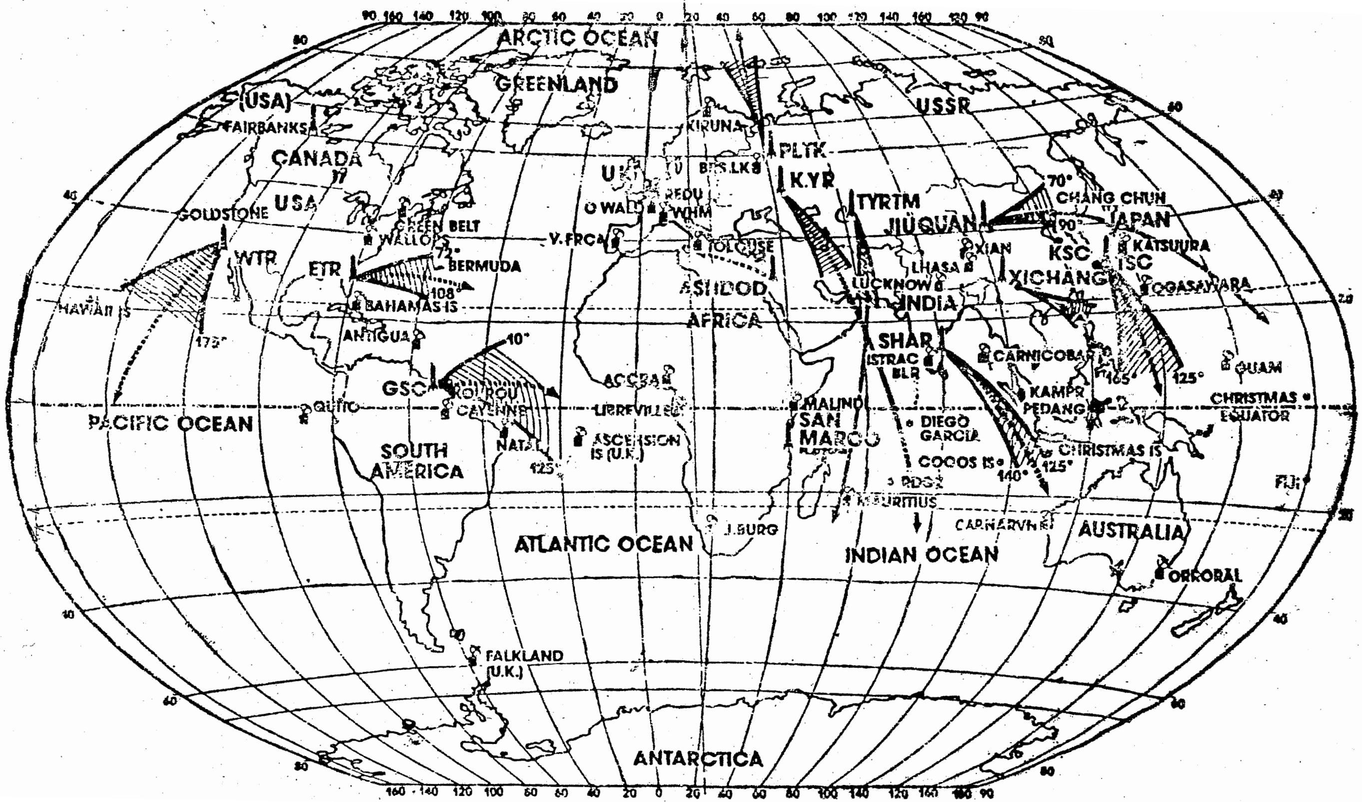



FIG. 3

FIG. 4 AERIAL VIEW OF SRIHARIKOTA & BAY OF BENGAL

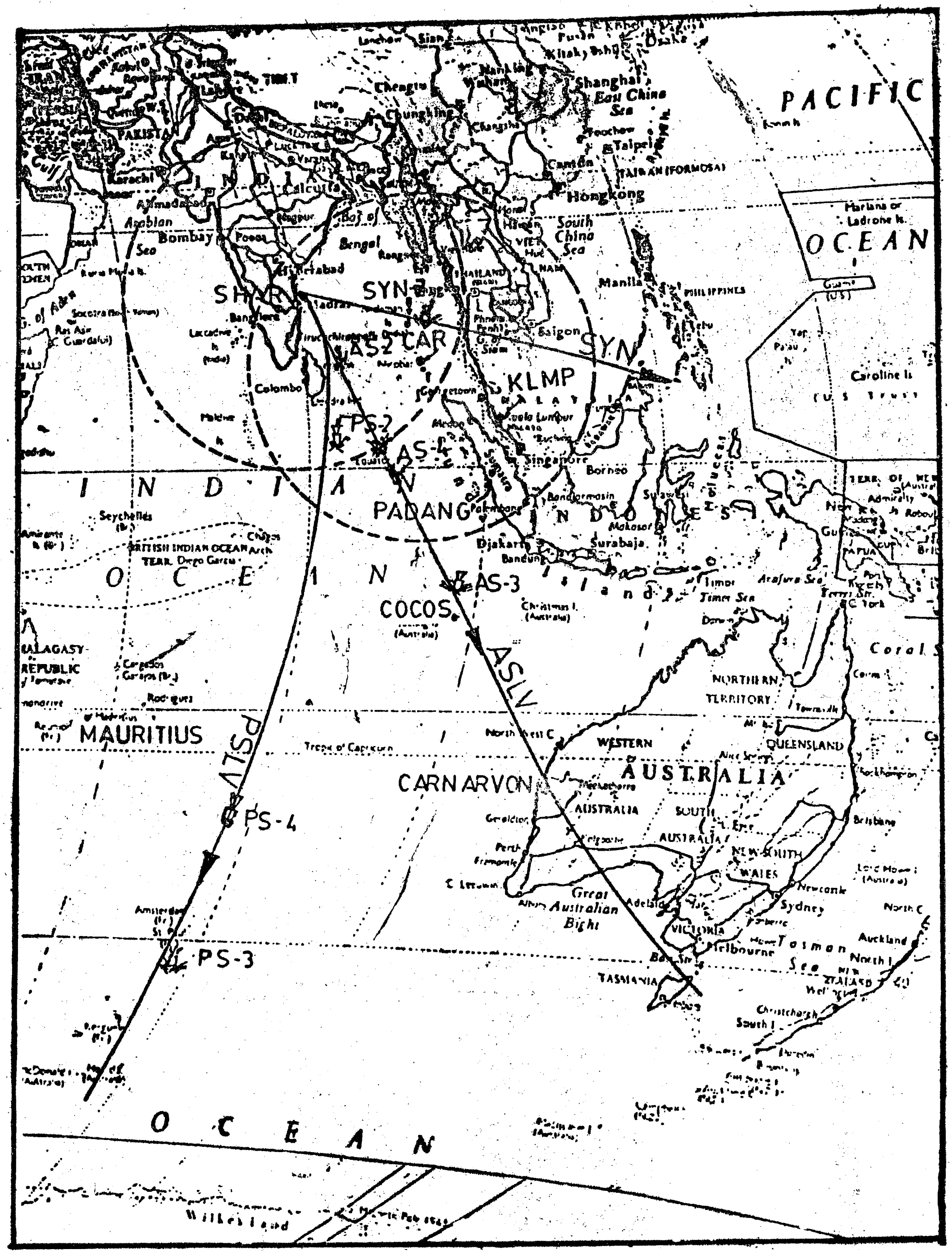



Fig: 5. SHAR LAUNCHING STATION

# GEOSYNCHRONOUS ORBIT - OCCUPANCY

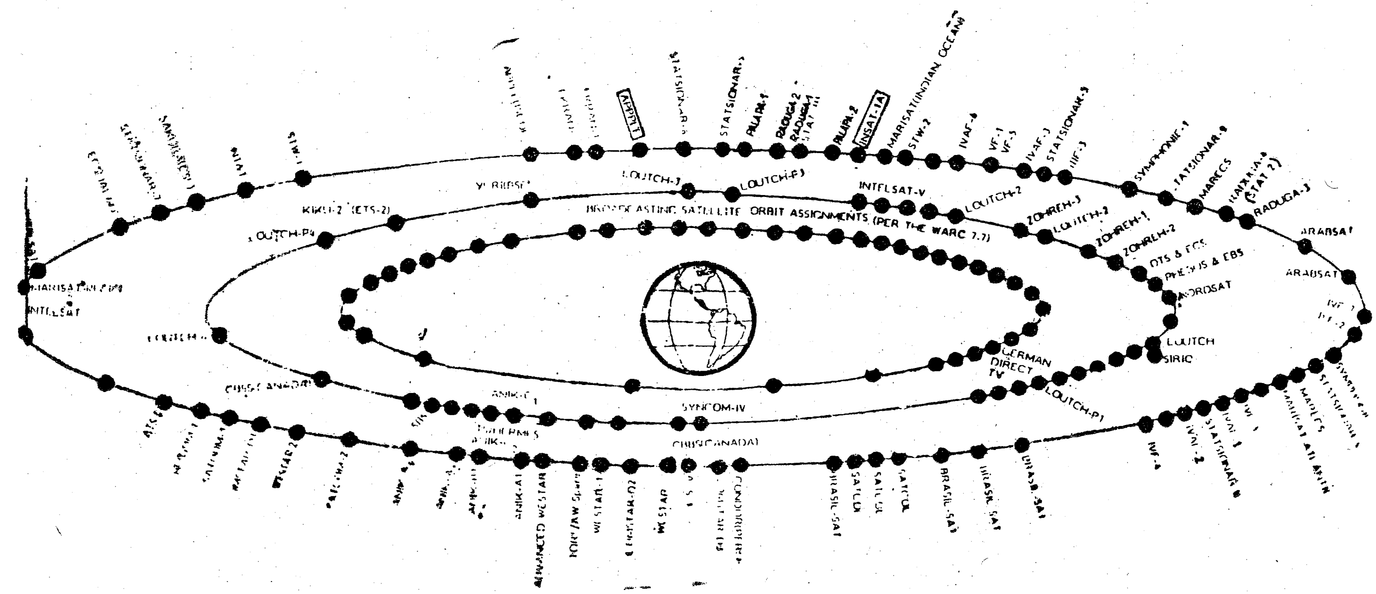
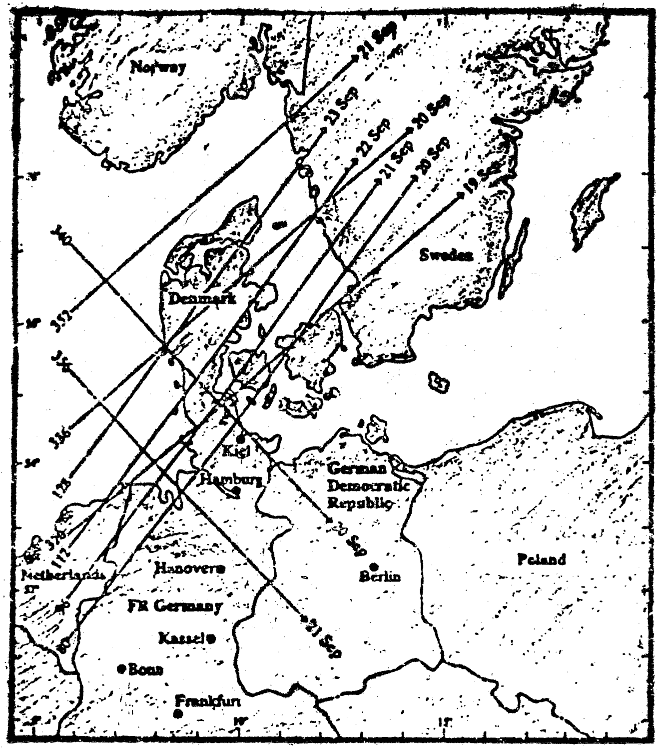
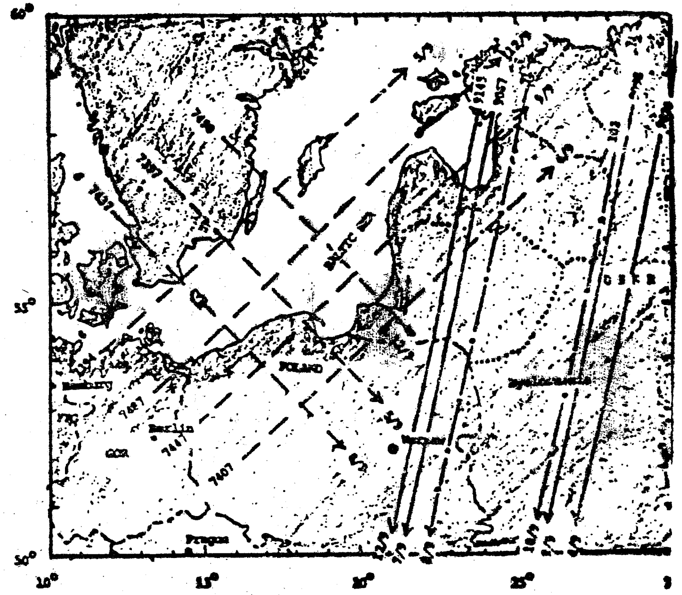



FIG: 6. CROWDING IN THE GEOSTATIONARY ORBIT



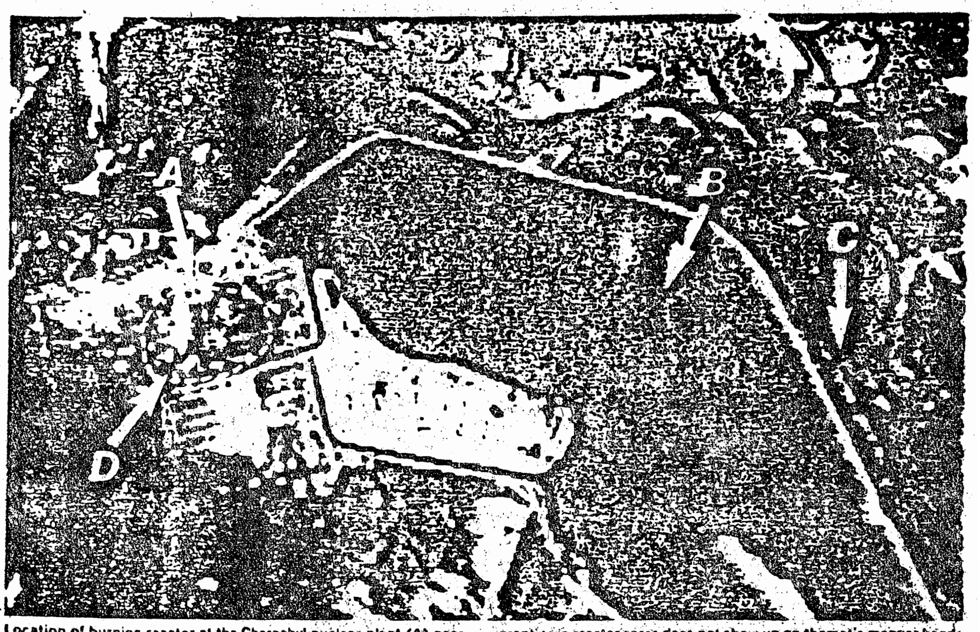

TRACKS OF SOVIET S/C COSMOS 1407
COSMOS 1402
OVER NATO MANOEUVRE " BOLD GUARD"
20-24 SEPT 1982




KH-11, 1980-10A
TRACKS OF US S/C KH-11, 1981-85A
NOSS-3C
OVER USSR " ZAPAD" MANOEUVRE
4-12 Sept. 1981

FIG. 9. SATELLITE RECONNAISSANCE OVER MILITARY MANOEUVRES

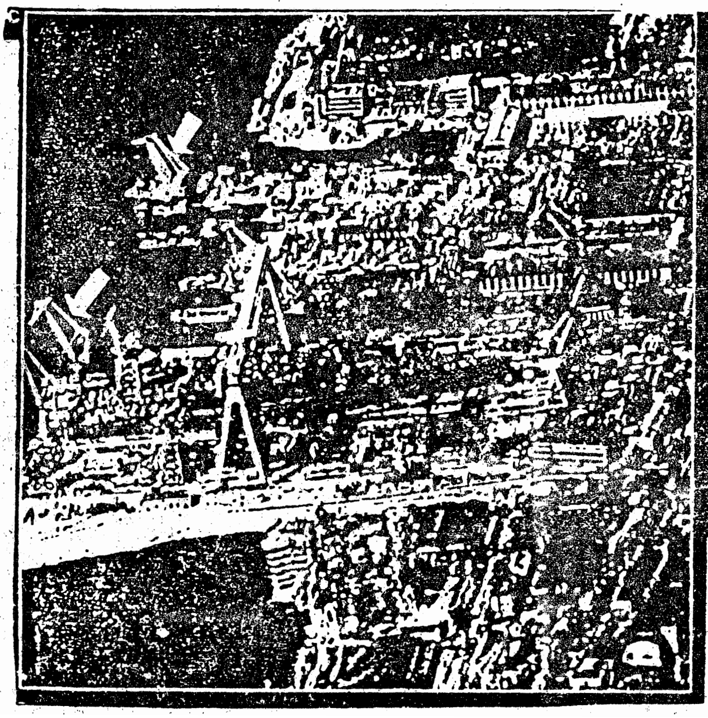
## *Soviet Nuclear Reactor Imaged by Landsat Thematic Mapper*




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 435 mi. 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. (Eosat), the U.S. Geological Survey and the U.S. Forest Service are studying the impact of released radiation, including crop damage



FIG. 10 THE BURNING REACTOR AT CHERNOBYL - LANDSAT PHOTO

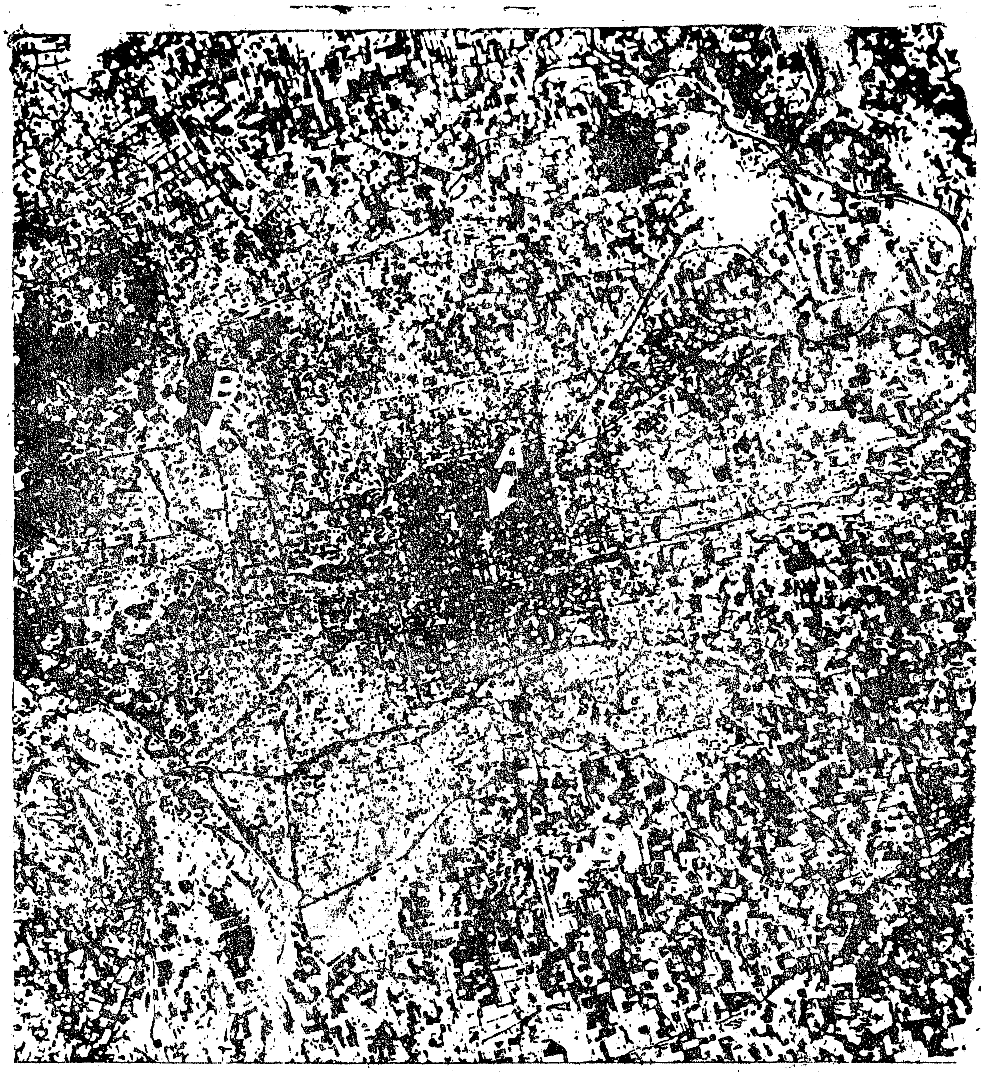


This image (C), taken by military satellite, shows construction of the first Soviet nuclear-powered aircraft carrier. Even girders of small cranes can be seen.

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

From this Soviet satellite photo (D) of the Columbia River delta, experts 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 + A/C RUN WAY - COLUMBIA RIVER




COMMERCIAL SPACE 17

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

# IRS-1A VIEWS DELHI


FIG. 14 NEW DELHI FROM IRS-1A

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