NAIC-ID(RS)T-0275-96

NATIONAL AIR INTELLIGENCE CENTER

SELECTED ARTICLES

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

NAIC- ID(RS)T-0275-96

HUMAN TRANSLATION

NAIC-ID(RS)T-0275-96 20 September 1996

MICROFICHE NR:

SELECTED ARTICLES

English pages: 15

Source: Zhongguo Hangtian (Aerospace China), Nr. 178, February 1993; pp. 19-21; 23-25

Country of origin: China
Translated by: SCITRAN
F33657-84-D-0165
Requester: NAIC/TASS/Capt Paul Woznick
Approved for public release: distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE NATIONAL AIR INTELLIGENCE CENTER.	PREPARED BY: TRANSLATION SERVICES NATIONAL AIR INTELLIGENCE CENTER WPAFB, OHIO

TABLE OF CONTENTS

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

APPLICATIONS OF CCD CAMERAS IN ASTRONAVIGATIONAL MILITARY RECONNAISSANCE AND ASTRONAVIGATIONAL NATURAL RESOURCE REMOTE SENSING

Zhang Wanzeng

Translation of "CCD Xiang Ji Zai Hang Tian Jun Shi Zhen Cha He Hang Tian Zi Yuan Yao Gan Zhong De Ying Yong"; Aerospace China, No.2, Feb 1993, pp 19-21

I. INTRODUCTION

In the late 1960's and the early 1970's, following along with the development of modern sciences and technologies such as electronics technology, information recording and information transmission technology, and so on, and after the infrared scanning imagery technology of the 1950's and the Doppler scanning imagery technology of the 1960's, a type of photoelectric solid imagery remote sensing technology using a combination of traditional optomechanics and electronics--CCD imagery technology--quietly came to sudden prominence. This is the third leap in mankind's imagery remote sensing technology.

As far as infrared scanning instruments of the 1950's were concerned, they were also called infrared scanning radiometers. They were a type of infrared radiation electromagnetic wave spectrum sensing device which made use of refrigerated indium antimonide, tellurium cadmium mercury, or germanium adulterated mercury to act as detector elements in order to detect objects themselves. The operating wave bands were generally between 3-5 microns and 8-14 microns. Their special characteristics were that systems were capable of operating in conditions of darkness at night. The image information which was obtained--besides possessing imagery spacial resolution characteristics--also possessed comparatively high temperature resolutions. Their utilization value lay in possessing all weather detection capabilities as well as having a certain capability to reveal camoflage with regard to "hot targets". However, imagery spacial resolutions were relatively low (lower by an order of magnitude than general visual light remote sensing imagery).

With regard to Doppler scanning instruments which appeared in the 1960's, the wave spectrum ranges covered were wide (from ultraviolet to infrared). Wave bands were capable of being divided up relatively narrowly as well as amounts of information being abundant and slightly better. With respect to their appearance and applications, they possessed epochal significance with regard to imagery reading and interpretation and with respect to the revealing of camoflage in military terms. The typical system was the MSS Doppler scanning instruments on the U.S. Landsat satellite.

In the middle 1970's, CCD cameras appeared--in particular, CCD camera applications in astronavigational military reconnaissance. Astronavigational imagery reconnaissance was propelled into a brand new development stage. CCD cameras--besides possessing the special strengths of infrared scanning instruments and Doppler scanning instruments--also had their own special characteristics and advantages. Therefore, once they were introduced to the world, they received serious attention and favor from policy making organizations and military authorities in various countries, becoming an important objective pursued by military astronavigational great powers such as the U.S. and the former Soviet Union in the development of astronavigational reconnaissance. As a result, in the last ten years or so, they have made long strides and developed. During the Gulf War of 1990-1991, CCD cameras received testing in actual combat. They acquired military trends and battle field situations associated with Iraqi forces in a timely and accurate manner, seizing and safeguarding victory in the war and playing a decisive role.

II. CHARACTERISTICS AND ADVANTAGES ASSOCIATED WITH CCD CAMERAS

As far as digital transmission models of imagery satellites using CCD cameras as remote sensing equipment (simply called CCD imagery satellites) are concerned, in terms of military reconnaissance and natural resources remote sensing, there are outstanding characteristics and advantages. Summarizing, there are primarily the several areas below.

1. Timeliness Characteristics Are Good

Timeliness, accuracy, and continuity are the most basic factors associated with military intelligence. When the suddenness of war increases, battlefield situations change by the instant, and war is carried out in multiple layers of ground, sea, air, and space, in all directions, and in great depth by turns, the capability for rapid reaction of military units--speaking in a certain sense--is primarily dependent on the timeliness of intelligence. CCD imagery reconnaissance satellites are capable of taking reconnaissance information acquired and transmiting it directly back in real time to the ground, or via data relay satellites back to the ground, or taking reconnaissance information and recording it on such magnetic media as high density magnetic tape, and so on. They wait for when satellites pass over the air space of ground stations and transmit back to the ground again, thereby realizing real time or close to real time reconnaissance, causing the timeliness of intelligence to greatly improve. If satellites are also assisted by orbital maneuver technologies (causing satellites to possess capabilities for orbital changes and reconnaissance maneuver), and, in conjunction with this, planar reflectors are installed on camera systems, (the direction light axses point can be controled from the ground) it is also possible to very, very greatly shorten satellite reconnaissance repetition periods for the same area. For example, the observation period associated with the French SPOT earth resources satellite is 26 days. Due to installation on satellite solid imagery instruments of a planar reflector which is capable of varying the directions light axses are pointed toward, it makes imagery instruments possess sideward (oblique) observation capabilities. It is possible to observe an area 950km left and right of a center which is the satellite surface orbital track. As a result, satellite observation repetition periods for the same interesting area are shortened from the original 26 days to 2-3 days (shortening along with increases in geographical latitude).

/20

2. Amounts of Information Are Rich

Occupying a commanding position, taking in everything at a glance, and making photographs everywhere are some of the greatest characteristics associated with astronavigational imagery reconnaissance. Imagery reconnaissance satellites are capable of acquiring on the earth's surface, within their range of vision, natural and man made land forms, surface features, geomorphology, vessels at sea, as well as imagery information associated with various types of targets in the air. Within orbital reconnaissance coverage regions, the various types and amounts of information can be called all embracing and numbering in the tens of thousands. Practical realization clearly shows that, as far as CCD imagery satellites are concerned--besides having the characteristics possessed by imagery systems in general--the information which they collect and is represented in digital form--particularly, multiple spectral band imagery information--contains amounts of information which are far greater than other ordinary photography. After imagery processing systems utilizing computers and so on carry out processing on digital imagery, imagery detail can then be clearly brought out, obtaining extremely clear imagery information. Experimental results abroad verify this a step further. Low resolution satellite digital imagery contains the same amount of useful information as high resolution imagery. Utilizing such statistical methods as main component analysis as well as canonical correlations, and so on, it is then possible to take large amounts of "nonvisible" information and extract it out. Besides this, CCD cameras have a large dynamic range with regard to conditions in the sky. When the angle of elevation of the sun is comparatively low, visibility is relatively bad. In situations where photographic film generally has difficulty forming images, they are still capable of acquiring comparatively good, comparatively abundant imagery information. In the image formation processes associated with CCD cameras, one will also not have the appearance of phenomena such as under exposure or over exposure associated with photographic film.

3. Reconnaissance Information Suitable for Computer Processing, Advantageous to the Realizing of the Automization of Intelligence

As far as imagery satellites equiped with CCD cameras are concerned, the reconnaissance information is generally capable of having preprocessing carried out on it on board satellites in order to discard those large amounts of repetitive or useless information, thereby reducing the pressure on magnetic tape storage systems on board satellites, simplifying numerous and cumbersome satellite ground station and satellite reconnaissance information surface processing systems, making aviation reconnaissance systems even more suitable for war time use, and improving their war time survivability. After digital imagery information is sent back to the surface, it is posssible to directly input into computers, entering into applied technological processing. In conjunction with this, imagery intelligence is displayed on computer terminals, making command, control, communications, and intelligence form an organic strategic C3I automated command system, thereby very, very greatly increasing the level of automization of military units and rapid reaction capabilities of units.

4. Intelligence Benefits and Economic Benefits Are High

With regard to CCD imagery reconnaissance satellites--unlike returnable model photographic reconnaissance satellites which are limited in that way by the film the satellites carry, the number of return containers, and useful load--they are not only capable of implementing long term reconnaissance and monitoring with regard to the entire globe. They are also capable of carrying out "quick look" and fixed term reconnaissance on certain "hot spot" areas of interest in order to obtain reconnaissance on trends in areas and continuous intelligence. For example, U.S. Keyhole imagery reconnaissance satellites (KH-11) generally have operating lives of 2-3 years. As far as the former Soviet Union's transmission model imagery reconnaissance satellites are concerned, operating lives reached a maximum of 259 days. The

French SPOT satellite's operating life is 3-4 years (the first satellite actually operated in orbit close to 5 years). Therefore, military intelligence benefits and economic benefits associated with CCD imagery reconnaissance satellites are generally several times to even ten or more times those of the same type of returnable model photographic reconnaissance satellite.

III. EXAMPLES OF CCD IMAGERY SATELLITE ASTRONAVIGATIONAL MILITARY RECONNAISSANCE AND CIVILIAN REMOTE SENSING APPLICAITONS

1. The U.S.

The pioneer in the utilization of photoelectric imagery dirven scanning type (HRV) CCD cameras in astronavigational military reconnaissance was the KH-11 satellite which was sent into orbit on 19 December 1976 on an Atlas 3D carrier rocket. The KH-11's weight was 10.3 tons. Perigee was 247km. Apogee was 533km. Orbital angle of inclination was 96.95 degrees. Orbital period is 92.37 minutes. The satellite in question also possessed comparatively large capabilities for orbital variation and maneuver reconnaissance. It was capable, on the basis of remote control commands from the surface, of carrying out reconnaissance missions associated with certain necessary "hot spot" regions. During an unanticipated period of 11 years, the U.S. launched a total of 7 KH-11 satellites. Operating life reached a maximum of 1175 days. Imagery surface resolution was 1.5-3m.

The satellite where the CCD camera achieved successful applications in astronavigational military reconnaissance was the KH-12 (an improved model of the KH-11). It is the U.S.'s sixth generation imagery reconnaissance satellite. The first satellite was placed in orbit on 8 August 1989 by the Columbia space shuttle. The imagery surface resolution of the KH-12 is much, much better than the KH-11 satellite. It is capable of reaching extreme resolution limits of 0.15 meters. It is able to discover and identify surface objects 7cm in size. Due to the fact that the KH-12 carries 1360kg more maneuver fuel than the KH-11, it, therefore, possesses an even longer operating life and even greater capabilities for maneuver variable orbit reconnaissance.

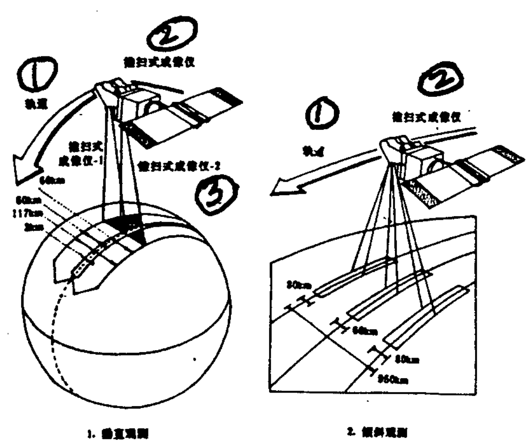
2. The Former Soviet Union

From December 1982 to the end of 1990, the former Soviet Union launched a total of 13 fifth generation imagery reconnaissance satellites. Among these, there was a CCD digital transmission model imagery reconnaissance satellite launched using an A-2 carrier rocket on 28 December 1982--Cosmos 1426. It weighed 6 tons. Perigee was 205km. Apogee was 351km. Angle of inclination was 50.5 degrees. As far as Cosmos 1810, which was launched on 26 December 1986, is concerned, its operating life reached a maximum of 259 days. This is the longest operating life in the history of their imagery reconnaissance satellites. Imagery ground resolution was estimated to be not much different from the U.S. KH-11.

3. France

CCD cameras in earth resource remote sensing satellites have broad application prospects and huge development potential. In this area, what must be reckoned to be comparatively successful is France's SPOT earth resources observation satellite. The original plan was to launch three SPOT satellites. The first satellite was launched into orbit on 22 February 1986. The satellite weighed 1750kg. Operating orbital altitude was 832km. Angle of inclination was 98.72 degrees. The period was a 101.4 minute solar synchronous orbit. Onboard, the satellite was fitted with two units of the same HRV type CCD camera. The cameras were composed of reflector mirrors, lenses, light filters, and 4 units of linear array charge coupling devices (that is, CCD) (each unit with 1728 image elements).

/21



Schematic of SPOT Satellite HRV Imagery Device Observation Patterns 1. Vertical Observation (1) Orbit (2) Driven Scan Type Imagery Device (3) Driven Scan Type Imagery Device-2 2. Oblique Observation (1) Orbit (2) Driven Scan Type Imagery Device

The operating spectral band range associated with HRV type CCD cameras is from visible light to near infrared (0.50-0.89 microns). Satellites are capable of providing panchromatic imagery associated with resolutions of 10m and multiple spectrum imagery associated with resolutions of 20m. As far as satellites in vertical observation configurations are concerned, the surface coverage range of each unit of HRV type CCD camera is 60km. During oblique observation, surface coverage range is 950km. That is, as far as projections along the central track are concerned, the maximum light axis inclination angle is ±27 degrees, corresponding to ±475km on the two sides of the surface track (that is, a surface coverage range of around a total of 950km with the surface track as center) (see Fig.).

SPOT satellite imagery was initially designed to primarily be used in oceanic surveys, geological mining prospecting, energy resource investigations, estimates of crop production, ecological environment monitoring, as well as planned land utilization, the drawing up and revision of medium and large scale topographical maps, and so on.

The applications of SPOT satellites in military affairs go without saying. In actuality, they are already used in the military intelligence collection of advanced nations--France included--and a number of third world countries. During the period of the Gulf War, France made use of SPOT satellites to monitor changes in the Gulf situation and the progress of the war. In conjunction with this, France made use of SPOT remote sensing imagery to draw up for the U.S. large scale topographical maps of the Gulf region.

IV. CONCLUDING REMARKS

Summarizing what was described above, the appearance and development of CCD imagery satellites is, under modern conditions, a necessity for scientific and technical development. Their appearance in the world and applications presage the development directions and trends associated with astronavigational imagery reconnaissance and astronavigational natural resource remote sensing. Just as the British scientist Kelake (phonetic) pointed out: "If a thing is theoretically possible, and it is necessary to society, then, it will, in the end, be realized." The author believes that if say, at the beginning of the next century, imagery spectrum instruments and imaging radar (SAR) will be the rulers of the astronavigational remote sensing stage, then, in the 90's of this century, using CCD cameras to act as remote sensing equipment for digital transmission model satellites will become the dominating force associated with astronavigational military reconnaissance and astronavigational natural resources remote sensing.

EUROPEAN MILITARY SPACE PLANS

Li Xue

Translation of "Ou Zhou Jun Shi Kong Jian Ji Hua"; Aerospace China, No.2, Feb 1993, pp 23-25

Ever since mankind entered the space age and even somewhat earlier, a good number of nations in the world then began to pay serious attention to the military applications of space. Without doubt, the U.S. and the former Soviet Union were far, far in the lead in military space activities. Morever, Europe, due to historical causes, as well as from different strategic considerations, temporarily fell behind. Recently, various types of signs clearly show that the governments of a good number of European nations have already recognized the need for Europe to have a unified cooperative military space policy. In conjunction with this, they have begun to inquire into various types of ways for carrying out this kind of international cooperation.

At the present time, in Europe, there are only France and the U.K. that possess practical models of space systems. NATO military satellite communications systems are capable of supplying all of the joint uses of European NATO member nations. These systems are the U.K.'s SKYNET 4 series, NATO's NATO 4 system, and France's SYRACUSE 1 and 2. All of these are communications satellite systems in every case.

Besides the systems described above, which are in the process of being utilized, a good number of Western European nations are just in the process of implementing other astronavigational plans. There are those made by single countries on their own. There are also those made by combinations of several countries. As far as these plans are concerned, some are to begin right away. Some have already entered into the development stage. These satellite projects can be primarily divided into three types: communications satellites, observation (monitoring) satellites, and electronic reconnaissance satellites.

I. COMMUNICATIONS SATELLITES

1. HISPASAT

HISPASAT is Spain's first communications satellite project. Its aim is to provide communications services for civilian and military users. This project includes three satellites (two satellites put into operation and one spare) as well as ground control stations to carry out command, control, and tracking with regard to satellites and communications equipment. The project costs 50 billion pesetas. In this are included expenses associated with using the European Aryan carrier rocket to launch two operating satellites. The first satellite was launched at the end of 1992. The second satellite will be launched 6 months after the first. The two satellites are both sent into stationary orbits. Orbital position is at approximately 31 degrees west longitude. The two satellites are roughly 70km from each other.

Each satellite has 18 transmiters. Among these, 2 are used in military communications. Satellites are capable of covering the whole of Spain. The broadcast communication range is capable of including most of the Latin American countries and part of North America. The HISPASAT project will satisfy the urgent needs of the Spanish military--particularly, the navy.

2. SICRAL

SICRAL is Italy's satellite communications system. It is primarily used for national defense and civil defense. One of its missions is the formation of strategic and tactical communications networks through multiple fixed, mobile, and portable surface stations, providing domestic, European, and world communications services for the Italian armed forces. Besides this, it is also capable of providing, for internal services and civil defense departments, emergency domestic communications and communications support for counter terrorism and counter narcotics activities.

Management of the entire system will be the responsibility of the various unit control centers based on combat requirements. The first satellite is planned for launch in 1994. SICRAL satellites opt for the use of three axis stabilization. Total launch weight is 2000kg. As far as development of the main parts of ground stations and transmiters is concerned, option is made for the use of technologies associated with Italy's civilian use satellite (ITALSAT). Moreover, the satellites in question will make use of counter jamming technologies and possess large capacity communications capabilities. They are capable of providing safe, reliable, and secure military communications services within satellite coverage areas. SICRAL satellites also plan to utilize networking with NATO systems.

3. EUMILSATCOM and INMILSAT

EUMILSATCOM and INMILSAT are joint military communications satellite systems directed at Europe and internationally. If development expenses associated with national military communications satellite systems continue to go up, then, one type of method for resolving this is the setting up of combined systems on the basis of joint requirements in order to satisfy common needs. At this time, the service lives of the military communications system satellites of two nations--the U.K. and France--are coming to an end. Therefore, representatives of the British ministry of defense and French colleagues are in the midst of actively discussing carrying through cooperative possibilities in terms of combined follow on model systems associated with SKYNET 4 and SYRACUSE 2. The two sides have already carried out a series of meetings on this question. In June 1991, Britain and France began to obtain support from Germany, Holland, Spain, and Italy with regard to developing a joint military communications satellite system (EUMILSATCOM). These discussions are still going on. At the same time, because the U.S. DSCS-3 system's service life is also about to come to an end, there are also possibilities of cooperation associated with France, the U.K., and the U.S.

II. OBSERVATION SATELLITES

1. HELIOS

HELIOS is a satellite observation system developed by a combination of France, Italy, and Spain. It was initially proposed by France. This project was already implemented in February 1986 after which Italy and Spain came in. Their respective investments are 14% and 7% of the total budget of 7 billion French francs on which the HELIOS project is formed.
/24

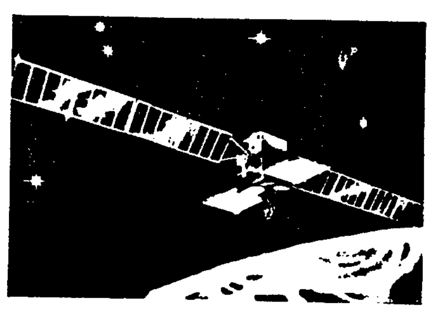


Fig.1 SICRAL Italian Satellite Communications System

HELIOS basically uses the foundation of the already mature SPOT civilian use remote sensing satellite system. HELIOS platform recording devices and high capacity electronic equipment are both the same as SPOT 4 satellites. The main distinctions lie in the areas of imagery equipment and counter jamming measures associated with telemetry and control data. HELIOS has optical and infrared monitoring devices. Surface resolutions reach 1 meter. Current spot satellites, however, only reach 10 meters. The entire project is the responsibility of the French general equipment agency (DGA). First generation HELIOS satellites were originally scheduled for launch in 1994 and 1995. At the appointed time, they will be supplemented with two second generation improved infrared satellites. This type of satellite is able to carry out observations day and night and in all weathers. It is said that, during HELIOS flights, they will carry an electronic monitoring useful load.

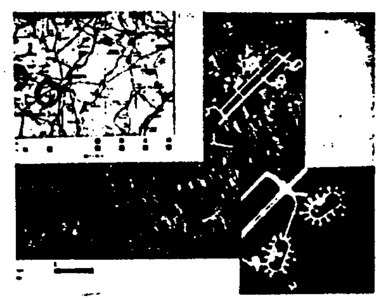


Fig.2 Infrared Observation Imagery Supplied by HELIOS. Resolution Reaches 1 Meter.

The economic benefits associated with participating in this type of international cooperation are easy to see. The three member states associated with HELIOS welcome other European states to also come in and participate.

2. OSIRIS

This is France's observation satellite, valued at 10 billion French francs. The satellite weight is approximately 2.5 tons. Option is made for the use of a SPOT 4 platform. On the satellite, there is a high resolution synthetic aperture radar. The resolutions will reach 3 meters or less. The satellite in question is planned to supplement or replace HELIOS in the period 2001-2003.

III. ELECTRONIC RECONNAISSANCE SATELLITES

Speaking in terms of Europe, electronic reconnaissance (ELINT) satellites are a new field. Relative to other military space activities, this type of satellite possesses even greater security.

1. ZIRCON

The U.K. Zircon satellite project is Europe's first open ELINT satellite project. According to reports, carrying out the plan will cost 500 million English pounds. The Zircon satellite will be positioned in a geostationary orbit at 53 degrees east longitude. Use is made of 30 meter umbrella shaped antennas. It can observe situations associated with independent federated entities, eastern Europe, and the Middle East.

Going through 4 years of development, 70 million English pounds are invested. It is said that the project in question has already been canceled. However, this news has not yet been verified.

2. CERISE

This is a French small model experimental satellite. The satellite in question makes use of its wide frequency band (1-20GHz) ultra high frequency receivers to receive radio transmission signals. It is capable of setting up a radio data base at altitudes of 600-800km. This satellite weighs less than 50kg. Its maximum life is approximately two and a half years. It costs 80 million French francs. It is manufactured by the Alcatel Espace company. It makes use of a UOSAT type platform associated with the Surrey satellite technology company. The data collected by CERISE will be a help to ELINT satellites later--for example, the development of ZENON. CERISE is projected to carry out its first launch in the middle of 1994.

3. ZENON

ZENON follows after CERISE and EURACOM experimental satellites. It is France's first and biggest electronic reconnaissance satellite. It costs approximately 5 billion French francs. It is projected for launch around 1999.

IV. WEST EUROPEAN UNION SATELLITE DATA PROCESSING CENTER

In 1991, the west European monitoring satellite unified organization, the West European Union (WEU), proposed to set up a WEU satellite data processing center. The center in question is at the present time just in the process of being built in Spain. Operations began at the end of 1992. It will be responsible for training analysis personnel. Processing is primarily done on images sent back by SPOT and Landsat satellites. In conjunction with this, relevent data is provided to various WEU member states. These data possess particularly important significance with regard to checks on the status of implementation of arms control treaties and environmental monitoring. The WEU also set up a special team to go a step further with research in regard to the possibility of European satellite monitoring systems carrying out medium and long term cooperative development activities.

V. CONCLUDING REMARKS

/25

The various nations of Europe are very interested in European military space cooperation. They have already recognized the importance of making use of combined space military facilities. Due to the fact that these facilities--in particular, military communications and monitoring satellite systems required by various European nations--are very expensive, the various nations of Europe, therefore, need to set up a cooperative international organization, opting for the use of bilateral or multilateral cooperation in order to reduce the development expenses and the number of satellites needed by each nation. At the end of this century, France and the U.K. will simultaneously replace their military communications satellites. This could very possibly turn into reality the idea of setting up a combined European system. Discussions associated with EUMILSATCOM and INMILSAT just verify this point. Even if it is one of the plans among them that is implemented, in that case, the first batch of real international military communications satellites will then go into orbit in the period 2001-2003.

In the same way, the idea of WEU cooperation in the area of monitoring and observation satellites also has great prospects. If cooperation associated with satellite data processing centers is successful, in that case, the next step will possibly be to set up, under the WEU organization, a multilateral European military observation satellite system.

Looking from a long term viewpoint, Europe will be able to draw up comprehensive, coherent European military space development policies. In the next 10 years, Europe will cooperate in the development of military space systems for practical use. When the time comes, the appearance of a European military astronavigational bureau is very possible.

NAIC-ID(RS)T-0275-96.3 /25

INDIAN IMPROVED MODEL GLOBE MISSILE TEST FIRING SUCCESSFUL

He Xing

Translation of "Yin Du Gai Jin Xing Di Qiu Dao Dan Shi She Cheng Gong"; Aerospace China, No.2, Feb 1993, p 25

An Indian improved model Globe tactical missile was test launched successfully. This is the 7th single stage Globe missile developed by India.

It is believed that improvements were carried out in the area of Globe missile structure. In February 1992, when test flights were done of the 6th Globe missile to carry out structural strengthening, it broke apart due to high overload maneuvers.

Globe missiles make use of a primitive storable liquid natural mixed propellant (that is, once oxydizer and fuel make contact, they then ignite, and there is no need for ignition systems). It opts for the use of anticorrosive red fuming nitric acid (IRFNA) as oxydizer and a mixture of dimethyl phenylamine and triethyl amine in the proportion of 50:50 as fuel. Propellant is sent to two propulsion chambers which operate differently. This type of mixed propellant is already obsolete. It theoretical specific impulse is quite low--only around 2205Ns/kg. The cause of opting for the use of this type of liquid mixed fuel may possibly be because its cost is low and development departments are very familiar with it. India also possesses development technology associated with dinitrogen tetroxide and unsymetrical dimethyl hydrazine propellant. Besides this, India also has high performance solid propellants.

According to reports, India is preparing to take dinitrogen tetroxide and unsymetrical dimethyl hydrozine and use them in Globe missiles. Utilizing these propellants will shorten Globe missile reaction time. Moreover, after fueling up with propellant, missiles will be able to continuously move. Due to the fact that the toxicity of these two types of propellants is very great, the existence of only a very small amount of leakage may create harm to personnel. As a result, once fueling is over with, propellants will not then again be vented out of missile propellant storage tanks. Modernized solid propellants, by contrast, overcome this problem. At the same time, they are also capable of improving performance.

Globe missile deployment is fast and launching is simple. Each Globe missile battery has 4 missile vehicles. Moreover, it is equiped with one missile replacement and loading vehicle, one propellant transport vehicle, and one command vehicle which provides target data for the missile guidance system before launch. Due to this type of missile being able to carry various types of warheads, and, in conjunction with that, being capable, on the battlefield, of replacement, it is, therefore, also necessary to have an independent vehicle for warhead transport. This then causes there to be too many transport vehicles, and attacks are easily met with.

The Globe Missile Will Go Into Service in 1993

Globe missiles are capable of replacing warheads, including prefabricated fragmentation warheads and cluster bombs. When the warhead weight is 1000kg, the firing range is 150km. When the weight of the wärhead carried is 500kg, the range can reach 250km. Compared to previous models, Globe missile warhead weight to overall missile weight ratios are the highest. The Globe missile fired in this instance is 8.5m long. The weight was not disclosed.

Globe missiles opt for the use of high precision, quick disconnect inertial guidance systems which India designs autonomously. The circular error probability of the missile in question has not been made public. The 300 meters which has been reported in Indian press circles may be on the high side.

The Globe missile is a type of low cost, easily mass produced weapon system. It is capable of rapid movement in flat terrrain. Moreover, it can be fired quickly after fuel has been added. In 1989 reports, the unit price of Globe missiles went to 17 million rupees (596 thousand U.S. dollars). The current price may slightly exceed 20 million rupees (700 thousand U.S. dollars).

Globe missiles are beginning mass production in early 1993. Somewhat later in 1993, they will be delivered to the Indian army for service.