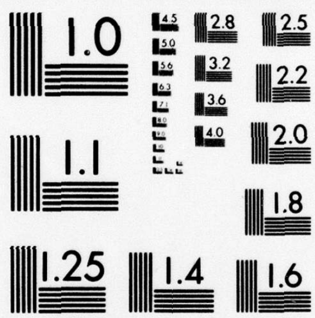
AD-A063 778   FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO   F/G 22/3
WARNING SATELLITE FOR GUIDED MISSILES.(U)
NOV 78 T WONG PIN

UNCLASSIFIED   FTD-ID(RS)T-1604-78   NL

| OF |

AD A06377

END
DATE
FILMED
3-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3

AD-A063778

FTD-ID(RS)T-1604-78

1

FOREIGN TECHNOLOGY DIVISION

WARNING SATELLITE FOR GUIDED MISSILES

by

Tao Wong Pin

Approved for public release;
distribution unlimited.

EDITED TRANSLATION

FTD-ID(RS)T-1604-78 8 November 1978

MICROFICHE NR: FTD-78-C-001521

WARNING SATELLITE FOR GUIDED MISSILES

By: Tao Wong Pin

English pages: 9

Source: Hang K'ung Chih Shih, Nr. 9, 1977, pp. 45-47

Country of origin: China
Translated by: SCITRAN
F33657-78-D-0619
Requester: FTD/SDSY
Approved for public release; distribution unlimited.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

WARNING SATELLITE FOR GUIDED MISSILES

Tao Wong Pin

Abstract: The primary objectives of defense are the early discovery of the enemy's ballistic missile launches and the detection of intercontinental ballistic missiles in their flights. Once detected, the missile's trajectory parameters, area of attack and flight time can be predicted. The use of warning satellite is one of the means in carrying out this defense mission. This article is an introduction to the general functions and principles of the warning satellite.

* * *

The great leader Chairman Mao has long pointed out that "In ancient wars, spear and shield are used. Spear is for offense, to destroy the enemy, and the shield is for defense and self-protection. Until today, the weapons used are still the continuation of them." Artificial earth satellites and ICBMs did not appear until 1957, and since the debut of ICBM, conventional warning system against airplanes has fallen far behind owing to the high speed, high altitude, long range, and great power of the ICBM. Since then, infrared detectors have been proposed for satellites in the detection of the infrared energy released in the launching of ballistic missiles. Today, warning satellites have become a major component in the warning system against ICBMs. Such satellites are capable of detecting the launch and active flight stage of ballistic missiles. The detection and tracking of intermediate flight stage and the re-entry of missiles are still in the investigatory and research stage.

Since ICBMs have very long range, they must reach a high altitude at launch. The relationships among their range, altitude and flight time are shown in the table below:

Missile range kilometers	Altitude kilometers	Flight time minutes
8000	1120	25.3
9600	1270	29
10200	1320	35.2
12800	1440	37.4

One can see that, for ICBMs of a range over ten thousand kilometers, it takes approximately 30 minutes from launch to target. Before warning satellites are used in the detection of ICBM, super long range radars of an action distance of 5000 kilometers are used in the detection of ballistic missiles. As a result of the earth curvature, the beam of radar waves is restricted to the horizon straight line distance of view and can only discover ballistic missiles after their midpoint or fifteen minutes after launch, see Fig. 1. In order to realize the advantage of early warning and the time needed for taking action, ballistic missiles must be discovered as soon as they are launched. Therefore, early warning satellites and super view distance radar are placed on the agenda. The latter will be discussed in a separate article.

Infrared Radiation and its Detection

Early warning satellites mainly rely on the infrared detectors to discover ICBMs. To facilitate the discussion, we will first describe infrared radiation and its detection.

"Without moving matters, the world is a void." Experimental sciences have totally confirmed this point of view, that is, all matter in the world is constantly in motion and no object is absolutely stationary. All objects

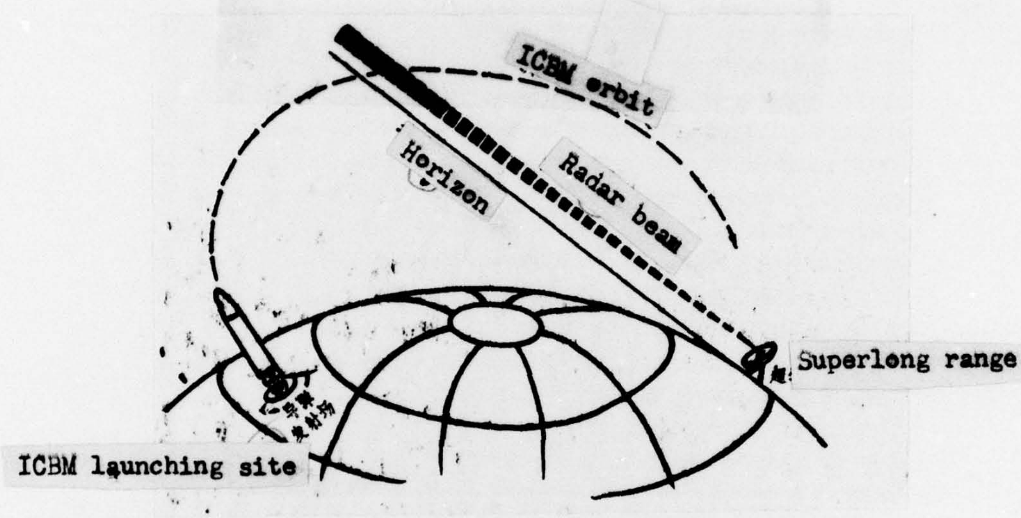


Fig. 1 Super long range radar detects ICMB only 15 minutes after launch

radiate infrared radiation as long as their temperatures are above absolute zero (273 degrees below zero on the Celsius scale). The relationship between the wavelength and the intensity of the infrared radiation is shown in Fig. 2. In this figure, the highest points of each absolute temperature curve are called the peak values.

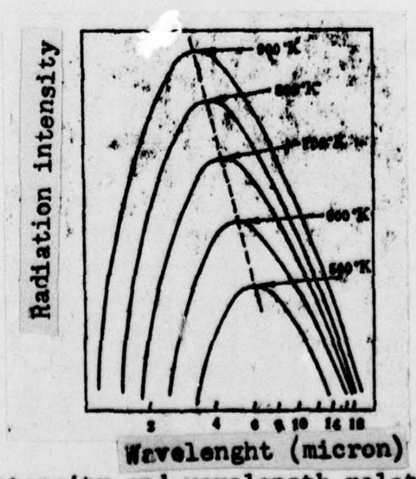


Fig. 2 Radiation intensity and wavelength relationship of infrared radiation.

The peak value wavelength varies with the absolute temperature ~~(K)~~ (°K) according to the following equation:

$$\lambda \text{ peak} = \frac{2896 \text{ (micron} \cdot \text{degree)}}{\text{T (absolute temperature)}}$$

$$= \frac{3000}{T} \text{ (micron)}$$

where absolute temperature $T^{(°K)}$ is given by T ~~(K)~~ (°K) = t ~~(c)~~ (°C) + 273°, and t ~~(c)~~ (°C) is the Celsius temperature we use daily. When t = -273° C, we have T = 0°K, or absolute zero. Since there is no stationary matter in the workd, absolute zero does not exist, and cannot be reached. Based on the above equation, we can calculate the peak value wavelength of various objects at different temperatures; e.g.,

1. Sun: T - 6000°K, λ peak $\approx$ 0.5 micron
2. Exhaust nozzle of aircraft and missile engines: T = 1000°K, λ peak $\approx$ 3 micron,
3. Objects at room temperature: T = 300° K (t = 27°C), λ peak $\approx$ 10 micron.

At present, the infrared detectors mounted on warning satellites are capable of detecting the tail flame infrared radiation from the launching and the active flight of ballistic guided missiles. The temperature here is above 1000°K and the infrared wavelength is from 2 to 3 microns. The temperature of missiles in their mid flight stage is relatively low and the wavelength of the radiated infrared is from 8 to 14 microns. In the early days, visible sensors such as photocells and television cameras have been used. Lead sulfide infrared detectors of the size of a sesame seed and made of semiconductor material started to be used in the 1960's. Such detectors have highly sensitive and consume very low level electrical power and are therefore suitable for installation on satellites.

Warning Satellites Launched in the 1960's

In the early 1960's satellites equipped with infrared detectors have been launched for experiemntal tests. Four satellites distributed in polar orbits (satellite orbits passing over the north and south poles) ranging from 480 to 4800 kilometers in altitude were tested for detection and warning functions. The low sensitivity of infrared detectors and questionable reliability prevented them from being put into actual use. The low sensitivity impaired detection distance and the poor reliatility is due to the detectors often mistaking sun lights reflected from clouds as a ballistic missile attack. In the late 1960's, the infrared detector sensitivity was improved and television cameras were installed on the satellite. After the satellite detectors initial warning signal, the observation crew on the ground will analyze the television picture and double check the warning signal. With these two complimentary equipments, the false alarms due to sun lights reflected from high altitude clouds were avoided.

The orbit's altitudes of warning satellites in the late 1960's had become higher and higher. A satellite orbiting at an altitude of 4000 kilometers was able to cover an area of 100 million square kilometers, or nineteen percent of the earth surface area. Thirty percent of the earth surface can be covered by a satellite orbiting at 16,000 kilometers. If stationary satellites were used to do the detection at an altitude of 35,800 kilometers (synchronous orbit altitude), then forty-three percent of the earth surface would be under their surveillance. Warning satellites launched in mid 1960's provided routes for improvement for the modern satellites launched in the 1970's.

Warning Satellites Launched in the 1970's

We will now use a typical satellite launched by a foreign nation in the 1970's as an example, and explain briefly the construction and operation of a warning satellite for ballistic missiles. This satellite is approximately 3 meters in height and 2.7 meters in diameter and a 3.6 meter long, 1 meter diameter infrared telescope was carried on its end. Thus, the total height of the satellite is 6.7 meters and the total weight is about 900 kilograms. The satellite is one variety of the synchronous satellites and it revolves around the earth in the same time as the earth rotation. To an earthbound observer, the satellite is stationary.

The satellite body contains thirteen different equipments, as listed below and shown in Fig. 3.

1. Infrared telescope,
2. Visible light sensor (video camera)
3. Nuclear explosion radiation sensor,
4. Transducer for posture control,
5. Solar locator transducer,
6. Satellite-bound electronics equipment,
7. Antenna for transmitting infrared sensor data,
8. Antenna for transmitting visible light sensor data,
9. Receiving antenna for command signals,
10. Auxiliary nuclear radiation sensor,
11. Three axes posture control thrust nozzle,
12. Solar cell wing plates,

13. Solar cap for infrared sensor protection.

As shown in Fig. 3, the structure of the warning satellite is rather similar to that of the communication satellite. It is equipped with a

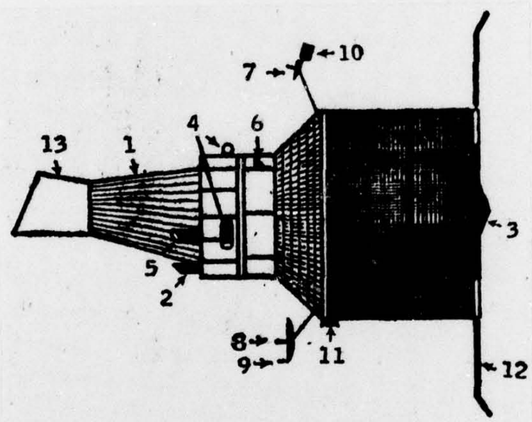


Figure 3.

three axes thrust nozzle and it receives power through the solar cell wings. Transmission antenna sends infrared sensor data and visible light sensor data to the ground and the receiving antenna accepts control signals from the ground. The satellite rotates at a rate of five to seven revolutions per minute to maintain the stability of its center axis. Relative solar position transducer keeps the solar cell panels aimed at the sun and also maintains the posture of the satellite. From the structure diagram, we see that the satellite has not only the infrared sensors for missile detection but also the nuclear radiation sensors necessary for nuclear explosion detection, so it can perform the detection of nuclear explosions at the same time.

The infrared detector in the satellite described above consists of two thousand lead sulfide infrared sensitive elements in an array arrangement. Each sensor element covers a ground surface area of 13.7 square kilometers and the total area covered is 27,400 square kilometers. When the satellite is working, the infrared sensors are aimed at the earth surface and periodically scan the area it covers. The electrical signals from the sensor are then modulated, amplified and digitalized before they are beamed to the ground. The visible light sensor is a video photographic instrument. As soon as the infrared sensor picks up the launching of an ICBM, the automatically controlled visible light sensor will be aimed at the missile and television images will be automatically sent to earth.

According to reports, the speed with which the satellite detects ballistic missiles is very fast. In general, the ballistic missile can be detected within 90 seconds after its launch. The present problem with detection satellites is that the sensitivity of the infrared sensors drops substantially after prolonged operation time. The coding of infrared sensors becomes a crucial problem. As the satellite passes through certain regions above the earth, the excessive solar radiation energy prevents the infrared detector from normal operation. For example, when the earth, the satellite and the sun fall on a straight line, the sun light will be shinning directly on the satellite and affect the operation of the satellite infrared sensor. At a time of war, enemy anti-satellite weapons can also put the satellite out of commission.

Because of the great variety of the offensive weapons in a modern war, the early detection and warning system against ballistic missiles must also diversify and cannot be inflexible. Needless to say, the discovery is the earlier the better. The present scheme is a complementary use of super long range radar, aircraft carried warning system, and detection satellites. This combination not only broadens the realm of detection and reduces, or avoids, false alarms, but also reduces the chance that a missile is launched but undetected. In the mathematics language of probability, this is to say that discovery probability is increased and false alarm probability is decreased.

An additional application of the infrared detector mounted on satellites is to spot nuclear submarines under water to a depth of 60 meters. As the nuclear submarine cruises underwater, it must release great amounts of heat in order to cool the nuclear power device and, as a result, the temperature of the surrounding sea water is often raised by 0.5 to 1 degree Celsius. The infrared detectors under test today, mounted on satellites, several hundred kilometers above ground, are able to measure the sea water temperature in the range of -7 to + 35 degrees Celsius with an error of $\pm$ 0.2 degrees. The location of a nuclear submarine can therefore be detected. The infrared submarine detectors are not perfected enough for practical application yet.

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION		MICROFICHE
A205	DMATC	1
A210	DMAAC	2
B344	DIA/RDS-3C	9
C043	USAMIIA	1
C509	BALLISTIC RES LABS	1
C510	AIR MOBILITY R&D LAB/FIO	1
C513	PICATINNY ARSENAL	1
C535	AVIATION SYS COMD	1
C591	FSTC	5
C619	MIA REDSTONE	1
D008	NISC	1
H300	USAICE (USAREUR)	1
P005	DOE	1
P050	CIA/CRB/ADD/SD	1
NAVORDSTA (50L)		1
NASA/KSI		1
AFIT/LD		1
LLL/Code L-389		1

ORGANIZATION		MICROFICHE
E053	AF/INAKA	1
E017	AF/RDXTR-W	1
E403	AFSC/INA	1
E404	AEDC	1
E408	AFWL	1
E410	ADTC	1
[redacted]		[redacted]
	FTD	
	CCN	1
	ASD/FTD/NIIS	3
	NIA/PHS	1
	NIIS	2