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21 June 1979

WEST

EUROPE

FRANCE: NUCLEAR, MISSILE, AND SPACE DEVELOPMENT

FOUO No. 461

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Effective 2 July 1979 this serial publication will be discontinued. Material presently appearing in this report on nuclear developments will now be published in a new WORLDWIDE REPORT: NUCLEAR DEVELOPMENT AND PROLIFERATION. Some military and space related articles will be published in the regular serial: WEST EUROPE REPORT.

The new report will consist of press and radio coverage of nuclear research programs; technical indicators of nuclear capabilities; production capability; construction and purchase of nuclear facilities; status of uranium and thorium supplies; level of technology in high explosives and advanced munitions; government and nongovernment attitudes on nuclear-related topics; international agreements for nuclear cooperation; transfer of technology; personalities, organizations, equipment and facilities.

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NATIONAL PARTICIPATION IN SETI, CETI DISCUSSED

Paris AIR & COSMOS in French 28 Apr 79 pp 38-39

[Column by Albert Ducrocq: "The Blue Chain"]

[Text] With the anniversary of Yuri Gargarin's flight, unfortunately marked this year by the aborting of the Soyuz 33 mission, April is traditionally an occasion for the Soviets to lift some corner of the veil that covers their space projects.

Thus, just this month the Russians outlined one of the objectives set for their future space stations: creation of an orbital collector whose usable surface would be measured at the least in dozens of square km, for a monitoring station for extraterrestrial civilizations.

That subject seems to us to merit the greatest attention.

For several reasons, the first being a reversal of the situation that for a long time had been expressed by an ever-increasing probable distance from the nearest extraterrestrial civilization, hence increasingly uncertain contact.

There was once a time--this was in the great period, in the euphoria following upon the use of the first telescopes--when the existence of inhabitants on the moon was believed in. They had been called Selenites, in advance. While no one was aware of the limits that would be imposed by the undulatory nature of light, it was announced that sufficiently powerful optical instruments would make it possible to see the Selenites from the earth.

Alas, the dream slowly vanished. Although the Americans, with an extra prudence for which no one could blame them, thought they ought to build a "Lunar Receiving Laboratory" in which to quarantine their crew returning from moon missions, it was practically certain even before man set foot on the moon that he would find no activity of a biologic type there.

Does some form of life exist elsewhere than on the earth, somewhere in the solar system? Today it is still impossible to say. Mars, the Jupiter and

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Saturn systems are guarding their mystery. On the other hand, to the scientists, there is nothing more to add: alone in our system, the earth is the bearer of intelligence.

So the neighboring stars are looked at. It seems logical to presume that many of them are surrounded by planets, like the sun.

But this consideration is tempered by a reflection: the events that allowed earth its prodigious odyssey require a combination of circumstances that, all things considered, must not happen so frequently. It is acknowledged first that around one star out of 1,000, there might gravitate a planet having experienced our destiny, the calculation of the probabilities locating this star at several dozen light years away, that is beyond the family called the near stars, in which the astronomers of the Sproul Observatory are especially interested. Then that proportion is further diminished; in the second analysis, it is acknowledged that perhaps only one star out of 1,000,000 is found to be surrounded by a system in which a civilization could be born, and this time the distance from that civilization is figured in hundreds of light years.

It would not be impossible for that evaluation to be still an optimistic one, and for the nearest civilization to be farther away.

That is where it stood yesterday.

But the new reality, in the years following the Second World War, was the lightning-swift development of radio-astronomy and, stimulated by it, the construction of ever more important radiotelescopes, while electronics recorded the progress which is well known, the substitution of semi-conductors for tubes being expressed by a spectacular lowering of the noise temperature of receivers, hence by an increase in their sensitivity.

Thus performance increased remarkably. As of today the range of the planet's large radiotelescopes is figured in thousands, inceed in tens of thousands of light years. We intend that if, somewhere in the galaxy there is a civilization at that distance, having the methods that are ours at present, we will be capable of picking up its low-intensity messages. And it could listen to ours.

This is the event behind the situation reversal we mentioned above. The progress of scientific knowledge has led us to move the civilizations farther away. But while that movement was going on another developed, incomparably more powerful, technological progress having caused to increase much more rapidly the range within which it may be acknowledged that, through hertzian waves, connections are established, this process giving promise of being spectacularly accelerated with the construction of large orbiting antennas.

That explains the attitude of the Americans and the Soviets, who today have already earmarked some of their radiotelescopes for a permanent station for monitoring the sky until they have special orbital stations for that purpose.

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And it is not by chance that this year, 1979, sees an awakening on the part of organizations as diverse as they are respectable, beginning with the very prudent International Astronomic Union. It put this question of listening posts for extraterrestrial civilizations on the agenda of its conference to be held in August of this year in Montreal.

Not only could Europe not be uninterested in this subject, but those in charge of the space programs--who can only hope to see their undertaking prosper with a powerful movement of public opinion--must very quickly understand that only this search for connections with extraterrestrial civilizations is capable, especially among the young, of arousing an enthusiasm comparable to that we formerly experienced with the conquest of the moon.

Let us come to an understanding.

Shortly after the Apollo missions it was affirmed that a page had been turned and astronautics was now going to be involved in methods of application. We will not underestimate the importance of these applications; even before 1969 we had emphasized--even though we had to preach in the desert--the interest presented by the satellites for cartography, detection of deposits, cadastral survey, agricultural development, hydrology, meteorology, national development planning, manufacture of new materials, prevention of illiteracy and establishment of new communications of all kinds. Today it is an accepted fact that a utilitarian astronautics is about to become part of the customs, it is accepted by those who make the decisions. And we say, so much the better!

But we will add: look out, man does not live by bread alone.

Astronautics is something other than a bringing of new methods to conventional technologies, however remarkable they may be. The methods, after all, will scarcely be noticed by the young; a person who telephones from one country to another, from one continent to another, does not much care whether the communication goes by way of cables or satellites. And if tomorrow's television programs come from the sky, it is not the satellite that will have created the television.

That is the other side of the coin: psychologically, if space programs were limited solely to applications, astronautics would lose its substance, which is first of all a discovery of everything that may exist outside the earth.

Thus, after man's walk on the moon, the connection with an extraterrestrial divilization must represent the objective for the new generation. Apart from the fact that the undertaking is fascinating--oh, how fascinating!--, communication with another civilization, if it occurs, will be an event incomparably more important in the history of humanity than the moon conquest.

At the beginning of the space age we witnessed a discouraging spectacle. Despite its extraordinary potential for technology and brain power, Europe found itself in the background of all the advanced undertakings; it left to others the concern for launching the first satellite, for sending the first man into

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space, for achieving the "man on the moon" operation and, practically without Europe's help the discovery of the solar system, which is soon to be entirely explored--with the exception of Pluto--will have taken place.

Can the Old Continent do something in the matter of connections with the intelligences of the universe?

It is because we think so that--in agreement with the Americans who are developing the SETI (Search for Extra Terrestrial Intelligence) program and the Soviets who are developing the CETI (Communication with Extra Terrestrial Intelligence) program--we have formed a SETI (Society for Study Toward Teledetection of Intelligence), whose first concern is going to be to launch the "Blue Chain" operation, to sensitize public opinion to the problem.

Why "Blue Chain?"

Quite simply because the earth is the blue planet in the solar system. Our world owes its color to its oxygen, its ocean, thanks to which superior life forms have been able to develop. And we have some reason to think that elsewhere in the universe oxygen and an ocean have also appeared--that is where other blue planets will be seen--and that is where there is the greatest chance of finding intelligence. Thus it is permissible to think that, whatever the distance separating them, the different blue planets of the cosmos have sought to enter into communication with each other.

How are the events going to unfold?

We imagine an analogy with the conquest of space.

Indeed, the latter was long regarded as a chimera. Men who prior to 1957 were talking of launching satellites were not considered serious people. The subject was treated as a joke by industrialists and decision-makers. And because for a long time there was no political desire to launch satellites (if there had been one, the Americans would have been able to launch satellites any time after 1949), it was impossible to say when astronautics would make its appearance. Thus the years went by and those who were excited by the subject were wondering if in their lifetime they would have the chance to see space experiments. It was largely military considerations that acted to urge men to build intercontinental missiles; putting satellites into orbit with them was to become child's play.

And from that moment things changed totally. As astronautics had formerly been calm and ignored, so it becomes agitated; the beacon lights of the great reality are turned upon it, while a fantastic course is embarked upon. First, because the Soviets and the Americans are competing for reasons of prestige, but also because each of them is discovering an interest in satellites and becoming aware of what is at stake. A space industry is created. Not only is it taken very seriously, but it soon becomes a major economic component.

Well, we are saying that in connection with liaison with extraterrestrial divilizations we could revive the same scenario.

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At the present time, scientists are unable to tell you when the contact will take place, the word contact meaning the reception of signals whose intelligent origin can be established, but nothing more; we hear without anyone being in a position to extract the information carried by the signals.

The share of the body politic in the operation is minimal--in a way this is fortunate--because, in contrast to the progress of astronautics, establishing a contact does not require considerable financial contributions, the real problem being judicious use of existing methods, and it is that consideration that makes us think that a European company can play an important role; we will of course have an opportunity to return to that point. On the other hand, a major factor of irresolution stems from the fact that at present no one has the slightest idea of the locations in the cosmos where the closest civilizations might be found. Thus in a way we are at the same point: no one can advance a date for establishing contact.

On the other hand, it must be wagered that when the contact has been established, the undertaking will take on, from one day to the next, a delirious dimension, and that at that moment a decoding course will be embarked on. At that stage, it is certain that the countries having a high technology will be the most favored, because deciphering the message could require the building of installations having nothing in common with what currently exists.

But it is characteristic that already it is being thought about in the world of specialists, as much in the United States as in the Soviet Union. In fact their creation will be indispensable when contact is established. And finally, we will have every chance to revive the equivalent of a trip to the moon. Barely 12 years intervened between Sputnik 1 and the Eagle landing--by Armstrong and Aldrin--on the Sea of Tranquillity. That seems to us to provide an idea of the size of the time lag that could elapse between the contact and the decoding, a time lag that should make us live through the most extraordinary period in the history of humanity.

Its great adventure is before us.

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STUDY OF POGO EFFECT ON ARIANE ROCKET PRESENTED

Paris L'AERONAUTIQUE ET L'ASTRONAUTIQUE in French No 74 1979-1 pp 21-27

[Article by Hrisafovic, industrial architect in the SNIAS (National Aerospace Industrial Company), and Estoueig, Rocket Department of the CNES (National Center for Space Studies)]

[Text] Analysis of the Pogo Effect on the ARIANE Vehicle

The Pogo effect is encountered with almost all liquid-propellant vehicles, and intense studies have been undertaken in many countries with the aim of reducing its amplitude or even eliminating it completely.

In the case of the ARIANE launcher, considerable effort has been devoted to the Pogo phenomenon since the beginning of the development program.

A brief summary is presented of the work done in Pogo synthesis for the purpose of eliminating the Pogo effect as a source of excitation of the vehicle and its payload.

Foreword

The Pogo effect is encountered with almost all liquid-propellant vehicles, and intense studies are conducted, in the countries carrying on laucher development, for the purpose of reducing its amplitude or even eliminating it completely.

In France, experience in this field has been acquired in the course of the DIAMANT A, VESTA, EUROPA, and DIAMANT B programs.

For the ARIANE launcher, considerable effort has been devoted to studies of the Pogo effect since the beginning of the program, previous experience having shown that the prediction is a long and delicate process and that the remedies must be defined very early.

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The CNES, the prime contractor for the ARIANE program, has assigned the synthesis studies relative to the Pogo effect to the SNIAS, within the framework of the activities of the industrial architect responsible for the overall studies for the launcher.

The SEP [European Propellant Company] collaborates on the synthesis studies under subcontract from the SNIAS.

As regards the other components of the Pogo-effect study:

--the propulsion and hydraulics studies relative to the Pogo effect have been assigned to the SEP, which is responsible for the propulsion for the launcher's three stages;

--the structural dynamics studies are overall studies, and on this basis, are handled by the SNIAS.

The ONERA [National Office for Aerospace Studies and Research] is involved as it is for all critical development studies, providing direct technical assistance to the CNES.

The purpose of the present article is to give a brief summary of the Pogo synthesis work done and of the work and corrective action planned up to the end of the development phase.

Philosophy of Proportioning of the Launcher on Basis of Risk of Appearance of Pogo Effect

Taking Pogo Effect into Account in Launcher Development Plan

As regards the basic conception of the launcher, it is defined by the imperatives imposed on the system by the missions to be carried out, by the planning, and by the cost. Furthermore, theoretical knowledge of the behavior of nonstationary elements (the pumps in particular) are insufficient to permit certain forecasts on plan, and consequently, the Pogo effect could not be taken into account at this stage of the vehicle's conception.

In its conception, therefore, the launcher does not give any guarantees that the Pogo effect will not appear in flight, and its main structure is not proportioned to support the supplementary dynamic loads due to instability of the Pogo loop. It is therefore imperative to take the necessary measures to keep this effect from appearing in flight.

To counteract the Pogo effect by stabilizing its loop, it is therefore necessary to use means specially developed for these purposes: SCP (Pogo Corrector System). These devices, designed to be mounted on the supply lines near the engine's pumps, have the role of lowering the hydraulic frequencies of the lines, reducing the gain of the Pogo loop, and modifying the phases as necessary, so as to make the system stable.

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For their type of functioning, passive versions of these devices have been chosen. In order to be able to deal with several modes at once, establishment of a sequence based on the evolution of the modes in function of the rate of emptying of the tanks has been provided for.

The active systems, despite their very attractive performance characteristics, were ruled out from the start, mainly for development reasons.

The needs in a corrector system and definition of their specifications are determined on the basis of modelling of the whole of the loop. These models, which are theoretical ones at the outset, are updated as the result of numerous tests (dynamic mockup for the structure, partial tests and bench firings for the hydraulics and the propulsion), and the flight prognosis as well as the adjustments of the SCP's are based on the most complete data which the tests on the ground can yield. Nevertheless, the study results should not be considered to have absolute exactness, and it can happen that the Pogo effect appears during the first technological firing, albeit with intensity limited by the SCP's.

It is therefore necessary to make sure that the launcher's most sensitive elements can successfully tolerate the eventual appearance of a limited Pogo effect during the first technological firing, while at the same time maintaining a proportioning principle for the main structures which is realistic, taking into account the low probabilities of risk of instability in operational firing, and which is compatible with the performance objectives.

Thus, two basic principles of proportioning, depending on the type of structure concerned, are determined.

Principle of Proportioning of the Main Structures*

In the basic principles adopted for launcher structure proportioning established at the beginning of the ARIANE program and expressed in the specification of the conception of the structure, it is indicated that the Pogo effect is not considered as a source of excitation for the main structure.

For this reason, the documents established as a result of the studies at the system level and defining the mechanical loads on the launcher's structural elements:

--general stresses
--dynamic ambience
--special loads

do not involve any case of load acting on the main structure because of appearance of the Pogo effect.

---

* By "main structure" we mean here any structure constituting the outer casing of the launcher and transmitting general stresses.

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It was therefore assumed, for the proportioning of the main structure, that the Pogo loop was stable and that the probability of its becoming unstable was low enough for it to be useless to take account of its possible harmful consequences on the structure of the launcher.

During the proportioning phase proper, it was systematically avoided to take even small margins on structural strength by way of Pogo prevention, considering that margins taken according to rule might penalize the system heavily by reducing its performance characteristics, while at the same time not giving any guarantee.

Principle of Proportioning of Particular Structural Subassemblies

The critical elements with respect to dynamic stresses are:

--the toroidal water tank of the first stage
--the toroidal water tank of the second stage
--the launcher's equipment case, with the payload support
--the supports for the heavy equipment mounted in the skirts of the various stages or fastened to the engine bedplates.

The supplementary conditions imposed on these elements for their proportioning are:

--the intensity of a limited Pogo effect is arbitrarily chosen as $\pm$ 4.0 g--a value which, though far from negligible, is not among the most severe presently known. The corresponding frequency range is defined by the first Pogo synthesis, and to cover the eventual effects of the three stages, it extends from 10 to 45 Hz;

--a minimum frequency of 60 Hz is imposed on the elements cited so as to avoid frequency coupling between the structural elements listed above and the excitation $\pm$ 4.0 g.

Therefore, in summary, we decided to strengthen (and even make oversized, for the operational firings) a certain number of structural elements so that they could reasonably support the loads due to the structure-propulsion coupling during the first technological firing. As regards the following firings, the SCP's should do their job fully by suppressing the Pogo effect as a source of excitation of the vehicle and of the payload.

Articulation of Studies - Pogo Synthesis

Development Plan

The plan for development of Pogo activities was established in 1973 and covers the period from 1973 to 1981--that is, the entire period of development and testing of the launcher.

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This plan contains and defines in time all the activities connected with establishment of the different branches of the Pogo loop, as well as the updating of them in consequence of the different events corresponding to the stages of development of the vehicle. It answers to two imperatives:

--having sufficient means of theoretical and experimental study available to obtain the diagnosis quite early;

--developing and integrating the adjustable SCP's into the vehicle system for the first technological firing.

The principal activities are:

Structure Activity: definition of the various mathematical models of the structure and updating them, on the basis of:

--completion of the proportioning of the structural elements;

--the results of the tests of the dynamic mockup of the launcher;

--the results of the qualification tests of the structural elements;

--the results of the vibration tests of the equipped subassemblies;

--the results of the flight tests at the time of the technological firings.

Hydraulics-Propulsion Activities: definition of the mathematical models of the Viking and HM7 engines, definition of the models of lines, definition of the models of the Pogo corrector systems (prototypes and flight models).

Updating of the models on the basis of:

--the hydraulic tests of the lines on the test bench;

--the development and qualification firings of the Viking and HM7 engines;

--the development firings of the engines with the Pogo "transient" tests;

--the tests of specific Pogo turbopumps;

--the hydraulic tests of the SCP's (prototypes and flight models) on the test bench;

--the bench firings of the L140, L33 and H8 stages;

--the results of the flight tests on the occasion of the technological firings.

These activities take place by launcher stage, taking into account the characteristics proper to them and taking into account the arrival of new specific

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data acquired in the area of the different branches of the Pogo loop. For this reason, the three activities are carried out in parallel:

--the Pogo activities of the 1st stage (L140)
--the Pogo activities of the 2nd stage (L33)
--the Pogo activities of the 3rd stage (H8).

This ongoing work results in syntheses before key dates written into the Development Plan: the first Pogo diagnosis, taking into account the known characteristics of the system; definition of the requirements to be laid down for the SCP prototypes; definitive choice of the flight versions of the SCP's; adjustment before the first technological firing; corrections after this firing; adjustment before the second firing; etc.

Pogo Synthesis

A Pogo synthesis is characterized by the following aspects:

--the principal goals to be achieved;
--the input data to be taken into account;
--the carrying-out of the work to be done.

The plan for development of Pogo activities is conceived on the principle that a synthesis gets under way only after the outcome of certain activities at the system level which make it possible to define the elements of the Pogo loop better and thus furnish the necessary input data.

A synthesis comprises, by definition, the following phases:

--collection of the input data;

--the preparatory work, including, in particular, critique of the input data and updating of the models;

--the work relative to the synthesis itself.

Review of the Studies Carried Out

First Pogo Synthesis (1974)

The studies and calculations done involved only very simplified models, considering the state of definition of the equipment and the state of advancement of the theoretical studies and of the various experimental programs.

The studies carried out had the purpose of defining the stability conditions for the Pogo loop in function of its different parameters. It proved necessary to choose a reference parameter. This parameter is the critical damping of each structural mode calculated at different instants of flight. The critical damping is defined as the damping of the launcher structure which takes the system to the limit of stability.

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For the first Pogo sythesis, the real damping of the structure being unknown, a fixed value of 0.7 percent was chosen, and consequently it was considered that any mode having a critical damping higher than this value presents serious risks of instability of the Pogo loop.

Conclusions of the First Pogo Synthesis

This synthesis showed risks of appearance of instability of the Pogo loop during the flight of the first two stages. These risks can be effectively countered with the aid of relatively simple devices placed on the supply lines. This diagnosis made it possible to take an effective decision, which was to go ahead with development of prototype corrector systems, and this despite the absence of experimental data confirming the models used.

Second Pogo Synthesis (1976)

On the basis of the improvement in knowledge of the different elements constituting the Pogo loop, a second synthesis was carried out, taking into account:

--the new structural model resulting from completion of the proportioning of the launcher structure;

--the results of the tests done on propulsion;

--the results of the tests done on the prototype Pogo Corrector Systems.

For this synthesis, the theoretical model for calculation of stability was improved in several respects:

--finer representation of the supply lines;

--account taken, as supplementary sources of excitation, of the hydraulic forces arising in the supply lines, as well as in the bottoms of the tanks (OUTFLOW);

--account taken of the scattering on the parameters of the Pogo loop.

Finally, an initial estimate of the coefficients of structural damping of the launcher was established.

The method of study adopted for the second synthesis is as follows:

--the stability calculation furnishes the critical damping (mean value and typical deviation) for each mode taken into account;

-a structural study furnishes the damping of the structure (mean value and typical deviation) for each mode taken into account;

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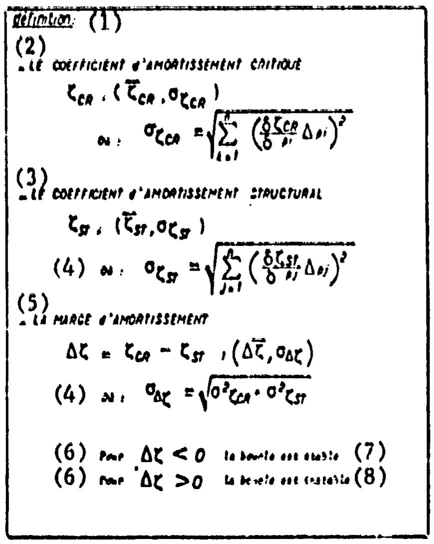
--the stability of the Pogo loop is verified for each mode separately by application of the stability criterion especially established for the Pogo studies for the ARIANE launcher and presented in plates 1 and 2.



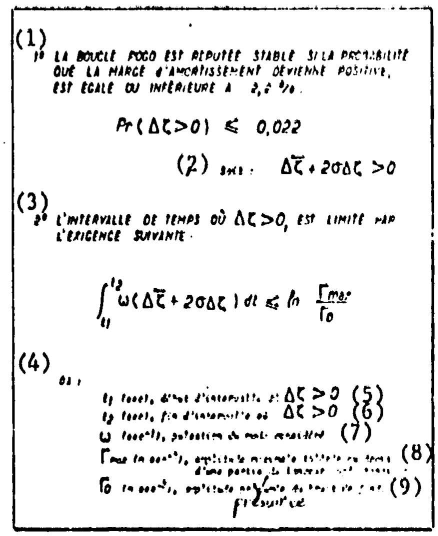


Plate 1--Criterion of Stability of Pogo Loop

Key:
1. Definition
2. Coefficient of critical damping
3. Coefficient of structural damping
4. in which
5. Margin of damping
6. for
7. the loop is stable
8. the loop is unstable

Plate 2--Criterion of Stability of Pogo Loop

Key:
1. Pogo loop considered stable if probability that damping margin becomes positive is equal to or less than 2.2 percent.
2. I.e.
3. Time interval in which $\Delta\zeta > 0$ is limited by following requirement:
4. in which
5. beginning of interval in which
6. end of interval in which
7. pulsation of mode considered
8. maximum amplitude tolerated at right angle to a part of launcher considered sensitive
9. presumed amplitude of background noise

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Study of L140 First Stage

The evolution of the damping for each mode in function of the rate of emptying of the tanks is represented in plate 3. One notes that the only unstable modes are the first mode (mode for the launcher as a whole) and the third mode (mode of the UDMH [unsymmetrical dimethylhydrazine] tank).

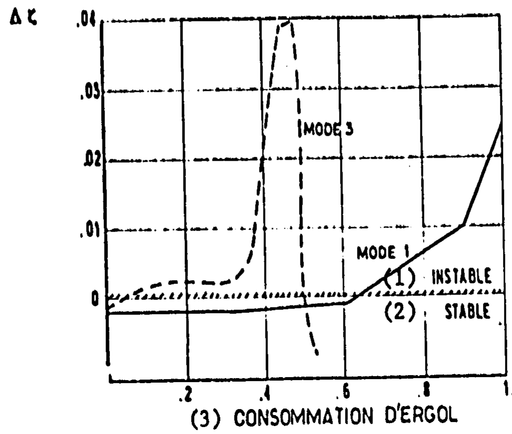

Plate 3--Criterion of Stability of L140 without Flight-Version SCP (2nd synthesis)

Key:
1. Unstable
2. Stable
3. Consumption of propellant

Study of the effectiveness of the Pogo Corrector Systems leads to conclusions nearly identical with that of the first synthesis: a bubble-type accumulator placed on the N_2O_4 line is absolutely necessary. The possibility of in-flight switching of the inertia of this system between a low value and a high value gives increased stability (plate 4). Addition of an accumulator on the UDMH line further improves stability at the beginning of flight. In the meantime, the stability of the Pogo loop of the L140 having been provided for with a single system on the N_2O_4 line, the specifications for the flight-version SCP were defined as follows:

Location: tibia forward of N_2O_4 pump
Inflation time: less than 7 seconds
Capacity: $C=3.0\cdot10^{-6}$ ($msec^2$) under 5 bars
Self-inductance (inertia) variable in flight between the following two values:

$$L1 = 6 \pm 2\ (m^{-1})$$
$$L2 = 40 \pm 10\ (m^{-1})$$

Damping reduced: $= 0.5 \pm 0.3$ with L1
$= 2 \pm 0.5$ with L2

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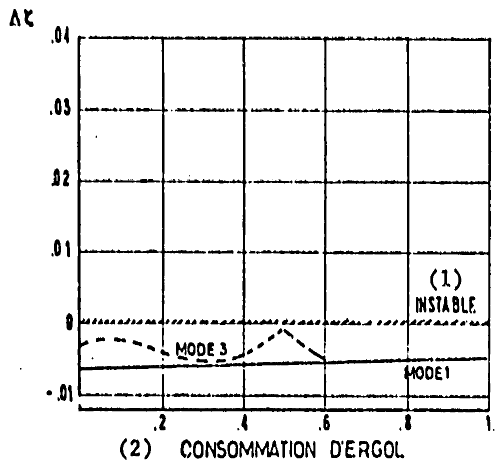

Plate 4--Criterion of Stability of L140 with Flight-Version SCP (2nd synthesis)

Key: 1. Unstable 2. Consumption of propellant

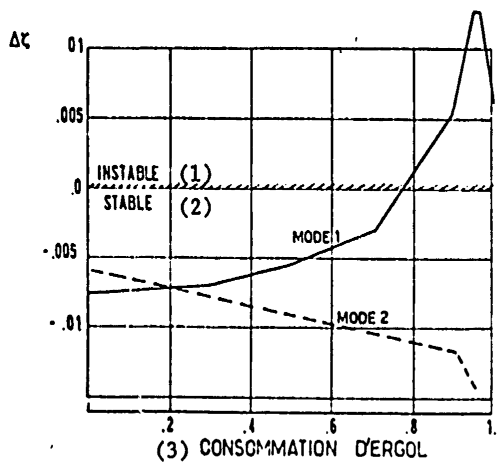

Plate 5--Criterion of Stability of L33 without Flight-Version SCP (2nd synthesis)

Key:
1. Unstable
2. Stable
3. Consumption of propellant

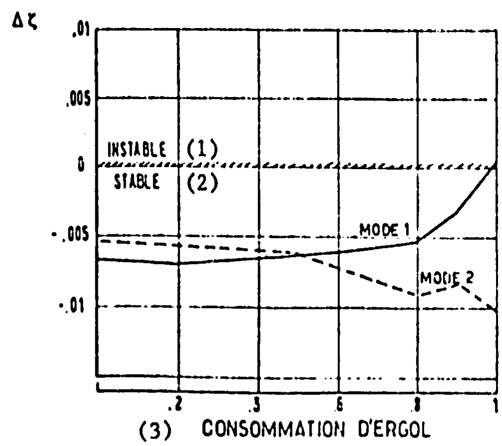

Plate 6--Criterion of Stability of L33 with Flight-Version SCP (2nd synthesis)

Key:
1. Unstable
2. Stable
3. Consumption of propellant

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The system should be adjustable on the ground and checkable on the ground and in flight.

Study of the L33 Second Stage

The results of the studies of the second Pogo synthesis confirm the results of the first synthesis: only the first mode is unstable, and this is at the end of flight (plate 5). On the other hand, addition of one accumulator on the N_2O_4 line is no longer sufficient to stabilize this mode totally (plate 6), and it is necessary to put a second accumulator on the UDMH line in order to regain a negative damping margin.

The following specification are therefore established for the flight-version Pogo Corrector System of the L33:

--N_2O_4 Line

Location: tibia forward of the N_2O_4 pump
Inflation time: less than 7 seconds
Capacity: $C = 2.6\cdot10^{-6} \pm 0.4\cdot10^{-6}$ ($msec^2$) under 5 bars
Self-inductance: 6 ± 2 (m^{-1})
Damping: $= 0.5 \pm 0.3$

--UDMH Line

Location: tibia forward of the UDMH pump
Inflation time: less than 7 seconds
Capacity: $C = 10^{-6} \pm 0.2\cdot10^{-6}$ ($msec^2$) under 5 bars
Self-inductance: $L = 12 \pm 3$ (m^{-1})
Damping: $= 0.7 \pm 0.3$

These systems should be inflatable in flight.

Study of the H8 Third Stage

The H8 second synthesis brought out the risks which could be presented for the high-frequency modes by the isovolume compensator blower as initially planned. It has been replaced by a simple blower. The risks are thus eliminated, and the work on the ground-version prototype corrector system has been continued only as a protective measure (to cover risks connected with particular satellite structures).

Conclusions of the Second Synthesis

Far deeper knowledge of the characteristics of the ARIANE launcher has henceforth made it possible to evaluate the risks of instability of the Pogo loop and to fix the characteristics of the SCP devices which will be mounted on the launcher for the flight.

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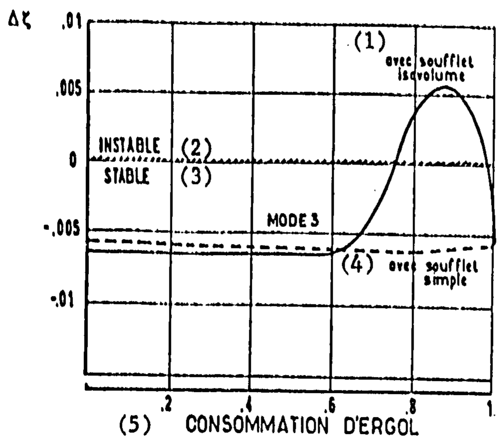

Plate 7--Criterion of Stability of H8 without Flight-Version SCP

Key:
1. With isovolume blower
2. Unstable
3. Stable
4. With simple blower
5. Consumption of propellant

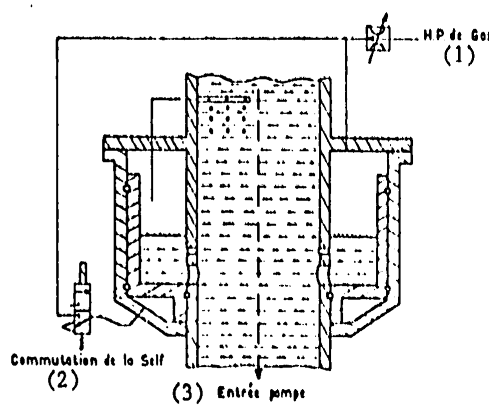

Plate 8--Constant-Level Gas Accumulator

Key:
1. Gas HP
2. Commutation of self
3. Pump intake

Third Synthesis (1978)

Only the results of the third H8 synthesis are available.

Study of the H8 Third Stage

The third synthesis done with modellings brought up to date in function of the tests for the oxygen pump, on the one hand, and the structure (dynamic mockup) on the other hand, confirm the outcome of the preceding syntheses.

The present configuration of the H8 (simple compensator blower on the oxygen supply line), without corrector system, presents no Pogo risk for the satellites studied: rigid satellites of the L01 or L02 type, L03 payload: APPLE plus METEOSAT.

Work and Corrective Action Planned to End of Development Phase

Intervention Possibilities

The criteria for choosing corrector systems have been effectiveness, reliability, and also the greatest possible flexibility as regards adjustments. These

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criteria have led, after testing on types of SCP differing in their principle (gas injection, accumulator) and their technology (blower-type or trapped-bubble accumulator), to adoption of the constant-volume accumulator as the SCP (plate 8: configuration of the NL 140 accumulator with variable self).

The stages undergoing integration comprise--for the L140:

--an N-type accumulator on each engine, with the possibility of:

--choice of two sequences (two simultaneous commutations of self on the four engines);

--adjustment of capacity (which could be different on each of the engines).

--for the L33:

--an N-type accumulator and a U-type accumulator, with possibility of regulation of the instant of inflation (simultaneous on the two SCP's) and of the capacities of each accumulator.

--for the H8:

--a sounder configuration, with elimination of the isovolume compensator, and and protective measures taking the form especially of an experimental study on a prototype high-pressure accumulator.

New Ground Elements

The three syntheses under way for the L140 and the L33 will take into account the latest hydraulics and propulsion test with modulated flow (tests of Viking turbopump, Viking engine and HM7 engine) and the exploitations of the Dynamic Mockup tests.

They will determine the definitive flight adjustments.

The adjustments of L01, as regards the sequences, were defined in June 1978. The capacities of the SCP's will be fixed in May 1979.

The fourth syntheses will integrate supplementary data (overall tests) for the forecasts before the first flight. The fourth H8 synthesis will supplement the present diagnosis with a study of the effect of the satellite's structural characteristics covering the whole range of possibilities for ARIANE's probable missions.

Exploitation of the Technological Flights

A measurement plan is provided for the technological launchings which is sufficient to make possible, if an instability were to appear, an analysis iden-

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tifying the operational anomaly or the modelling error causing it and to evaluate the advisability of a different adjustment of the corrector systems for solving the problem.

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ARIANE MAY PUT SPACE SHUTTLE INTO ORBIT IN 1990

Paris LE MONDE in French 19 May 79 p 17

[Article by Maurice Arvonny]

[Text] On next 8 June, when the first visitors enter the Aeronautics and Space Salon, which is held every second year at Le Bourget, the first thing they will see is the tall silhouette of the European launcher, the Ariane [Ariadne]. No doubt it was for that reason that this launcher was much talked about in the course of the dinner-discussions on Wednesday, 16 May, to which the French Aeronautic and Space Manufacturer Group (GIFAS) organizer of the Le Bourget Salon, had invited Hubert Curien, president of the National Space Studies Center (CNES).

The Ariane, the first firing of which is set for the beginning of the month of November, has an assured commercial future for several years (LE MONDE, 14 February). A decision for an improvement of the launcher, which would enable it to place two telecommunications satellites in orbit simultaneously starting in 1983, has been practically reached. The decision was not formally adopted at the meeting of the European Space Agency Council on Wednesday, 16 May. That is solely because two countries have not yet obtained financing of their quota parts for the improvement program, estimated at 300 million francs over 4 years.

On the 1987 horizon the CNES is studying a new improvement, consisting of lengthening the first stage, whose fuel capacity would increase from 140 to 190 tons. Next, for 1990, it is contemplating replacement of the present second and third stages with a single stage fueled by liquid hydrogen and liquid oxygen. Such is now the case for the third stage whereas the first two use the combination of nitrogen tetroxide and a hydrazine derivative. These modifications presuppose the perfection of an entirely new motor.

Ten Tons Into Orbit

At this point the Ariane would put a payload of 10 tons into low orbit and would be well adapted to serve manned orbiting stations where vacuum and weightlessness will be used on the industrial scale for preparation of new materials. For this mission there will be associated with the Ariane a

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hypersonic glider, the Hermes, which would be capable of changing its orbit several times before returning by landing in gliding flight, as the American space shuttle now does; but with this difference from the latter: Hermes would have no pilot and its guidance would be completely automatic. It may transport five men, or 1,500 kilograms of cargo, and have autonomy of a week. As it is probable that well before 1990 a system for recovery of the Ariane first stage, will have been developed, there thus results a device similar to the American space shuttle, with recovery and reuse of most of the equipment, but more flexible. The Ariane can transport payloads other than the Hermes; for example, additional stages making it possible to attain geostationary orbits or trajectories toward the planets. It will also be able to place into orbit the orbiting stations which the Hermes will then serve and supply.

This evolution of the Ariane into a system of multi-purpose transport is analogous to what the Soviet Union is doing at this very time; it is also working on a recoverable shuttle. Another similarity which was revealed by the recent mission of the CNES and French Manufacturers to China: the Chinese are constructing, and should launch in 4 or 5 years, a rocket which is very similar to the Ariane. The French engineers were impressed by the level of technical development attained in the first two stages of the Chinese rocket. On the other hand the Chinese were clearly behind in their thrid stage, which utilizes liquid oxygen and liquid hydrogen. There is one of the points where interesting prospects for French-Chinese cooperation exist. There also are possibilities for cooperation with Brazil which desires to provide itself with a satellite launcher.

These prospects for improvement and for cooperation do not resolve a serious employment problem. Although the industrial teams which are building the Ariane have work, such is not the case for those who performed the studies and the tests. The SEP [European Propulsion Company], which is responsible for the motors of the three stages and for those of the missiles of the deterrent forces, employs more than 1,000 persons in the Ariane program. But for production fewer than 400 will be needed, which has led the company to seek diversification of its activities outside of the field of heavy propulsion by association with Matra for construction of air-air missiles and by seeking industrial uses for certain inert materials (carbon, rubber-metal composites) developed to meet propulsion requirements.

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ESA COUNCIL'S LATEST DECISIONS DESCRIBED

Paris AIR & COSMOS in French 14 Apr 79 pp 35-36

[Article by Pierre Langereux: "Ariane, a Sixth Rocket"]

[Text] The Council of the European Space Agency (ESA), meeting at Paris 3-4 April 1979, has decided to begin construction of a sixth rocket in the "Ariane" series to put into synchronous orbit an Intelsat 5 telecommunications satellite. Five of the 11 member countries--Germany, Italy, Sweden, Denmark and Belgium--declared themselves ad referendum: to think about it! But considering the contracts ESA has with Intelsat, construction of this rocket is absolutely necessary and the CNES [National Center for Space Studies] has been authorized to begin production. It should be kept in mind that the first five Ariane Series rockets already in production (in addition to the four experimental rockets in flight) are designed to launch five satellites: Exostate, ECS 1, MARECS B, Sirio 2 (twin launch) and Spot. The production of a second five in the series has already become necessary, taking into account the satellites either currently in construction in Europe (ECS 2, MARECS C, and two Telecom 1's) or in planning (TV-SAT and another Intelsat 5). This new series will not be decided on until January 1980, but long-term component manufacture must be launched very soon.

Agreement with Eutelsat

The council also has approved the text of the letter mandating the director general of ESA to sign an agreement with the European organization Eutelsat Interimaire which will be charged with management of the telecommunication satellites ECS (also the MARECS).

The ECS program comprises a total of five satellites, four to be launched by Arianes beginning in 1981. The total cost of the program is 306.8 million accounting units of which 220.6 MUC will be from ESA and 80 MUC only from Eutelsat Interimaire. But in order to utilize the ECS satellites, the member sates of Eutelsat Interimaire must also finance the construction of 20 to 25, possibly even 30, earth stations, at 6 MUC per station, a supplementary investment of 120 to 180 MUC.

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The council has also approved the construction of a third maritime communications satellite MARECS C, for the international organization INMARSAT, as well as preliminary studies for future European teledetection satellites LASS and COMSS (cf., AIR & COSMOS nos 756 and 758). This preparatory program, which will cost 9 MUC, has been approved by nine member countries of which Italy ad referendum, Ireland has not made a statement, Spain will make its announcement soon, and Canada is also interested.

ESA's 1979 budget has still not been approved and the organization continues to live under "provisional twelfths" (as last year), while Italy contest the monetary conversion rates of the agency, at least until a solution is found on the European level.

Finally, Ireland has ratified the ESA convention. Only France among the 11 members has not done so. Thus ESA continues to function under the constitution of the former organization ESRO [European Space Research Organization].

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FRENCH ASTRONAUT, OTHER SPACE DEVELOPMENTS PROJECTED

Paris AIR & COSMOS in French 7 Apr 79 pp 43-44

[Article by Pierre Langereux]

[Text] France plans to send a man into space in the course of the next decade on the occasion of a joint space mission with the USSR, Hubert Curien, president of the CNES [National Center for Space Studies] told us. This will be the new French-Soviet grand project of the end of the 1980 decade after the Venera 83 project, now in preparation, in which Soviet probes will launch two French balloons in the Venusian atmosphere in June 1983.

On 27 March the president of the CNES stated to the engineers of the AAF (French Aeronautical and Astronautical Association) that the CNES is planning to send a Frenchman into space on the occasion of an important Soviet space mission intended for preparation of materials under weightlessness.

The project, which is being discussed by the CNES and the Cosmic Research Institute (IKI) of Moscow, may be realized in the course of the 1980 decade by sending, into space, a French astronaut who will take with him specimens of materials to be processed in the furnaces--Soviet or French--previously installed aboard the Soviet orbiting station, somewhat like what has just been accomplished by the two new Salyut 6 cosmonauts with the French experiments in preparation of materials under micro-gravity of the ELMA program of the CNES (see AIR & COSMOS, No 759).

A "major project" of French-Soviet cooperation is involved, Curien told us. The CNES president believes, as a matter of fact, there will be significant developments in space metallurgy, in the second half of the next decade, for fabrication of new materials (alloys which cannot be made on earth, and so forth) or of existing materials but with improved properties (more homogeneous silicon single crystals, and so forth).

The French and Soviets have in fact found out that they had similar approaches to the subject of space metallurgy with the view toward developing such activity

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to the industrial scale, Curien explained. The Soviets, arriving in this discipline later than the Americans, are now very much devoted to operations of preparing materials under weightlessness which has become an organized activity with specific objectives. In the future the USSR plans to accomplish metallurgical operations in weightlessness in automated systems which will be regularly visited by astronauts bringing the substances to be processed in the orbiting station and taking back to earth the special materials thus produced.

For its part the CNES in March just completed the feasibility study for project MINOS (Specialized Orbiting Industrial Modules) the objective of which was evaluation of the possibilities of constructing a system enabling new materials to be produced on industrial scale in orbit in an automated station which would be periodically visited by French astronauts through use of "mini-shuttles" transporting crews and products of that small cosmic factory.

MINOS: Factory in Space

The MINOS system, studied by the CNES, in cooperation with the industry--AEROSPATIALE [National Industrial Aerospace Company] and Matra--and ONERA [National Office for Aerospace Studies and Research] (parametric study of reentry) would consist of:

a permanent orbiting station of several tons, launched by the European launcher Ariane [Adridne], and essentially comprising a unit for production and processing materials combined with an electrical power supply module of 10 kilowatts (from a photovoltaic generator) which would also provide stabilization to the station ensemble (residual acceleration 10^{-5}g), and

a transport module (mini-shuttle) also launched by Ariane and capable, on the one hand, of carrying several hundred kilograms of material to be processed in the orbiting station with which it would effect an automated rendezvous and, on the other hand, providing for return of materials and their recovery on earth within and area of limited size (25 kilometers long) either off the coast of Guiana Space Center (CSG) or in the Gulf of Gascony.

The orbiting ensemble should have a useful life of more than 7 years, which implies feasibility of repairs in orbit by telemanipulation, this technique also making it possible, with automated rendezvous to assemble large structures in space and to modify the configuration of the station.

The MINOS system concept, by offering facilities totally automated or remotely controlled from the ground, in fact opens to France an entire sphere of new utilizations of space, not only for space metallurgy, but also for other applications such as earth observation (with automated recovery of films and instruments).

It also appears that "the operation of such an automated system may be achieved by use of manned flights for purposes of inspection or maintenance," the CNES states.

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CNES Studying a Reusable "Shuttle"

It is for that reason that, along with the MINOS study, the CNES since 1977 has been undertaking forward-looking studies of the launching facilities Europe will need about 1990.

The studies effected during the last 2 years have resulted in the concept of a "polyvalent launching means" (Ariane 5) derived from the present launcher and combined, for certain low-orbit missions, with a "reusable manned vehicle" which would be a hypersonic glider of 10 tons, with delta wings. This reusable space "mini-shuttle" could thus carry five astronauts, or only two crew members and 1,500 kilograms of cargo. It could remain in orbit for a week to accomplish the transfer and assembly of modular ensembles and provide service to permanent orbiting stations launched by France.

This hypersonic glider would be launched by a two-stage Ariane 5 rocket designed to place a mass of 10 tons into a circular orbit at 200 kilometers altitude inclined 30 degrees to the equator (in a firing from Kourou).

The first stage of the Ariane 5 would be the first stage of the present rocket with stored fuels and lengthened tanks, and with four solid fuel boosters to assist take-off. The second would be a cryogenic stage with 40 tons of liquid hydrogen and liquid oxygen supplying a motor of 60 tons thrust in vacuum. The new launcher nose would have a usable volume of 170 cubic meters and usable diameter of 4.5 meters

To launch the hypersonic glider this new nose would replace that of the Ariane rocket, not usable in this configuration.

It would also be possible to add to the two-stage launcher a supplimentary propulsion system under the nose for high energy missions (geosynchronous transfers and planetary flights). This propulsion assembly would comprise a cryogenic stage (derived from the Ariane's cryogenic third stage and--optionally--a higher stage either solid fuel or stored fuels.

Such an Ariane 5 rocket would enable Europe to launch heavy payloads of the Spacelab type into low orbit, to construct manned or visited orbiting modular stations, and, more generally, to assemble large structures in space, as well as to launch 2.7 ton satellites into geosynchronous orbit or even to explore the planets of the solar system with automated probes (2.5 tons to Venus or 600 kilograms to Jupiter).

"Development of such a launcher, subject to certain technological points whose feasibility remains to be demonstrated, would take 7 to 8 years," the CNES has announced.

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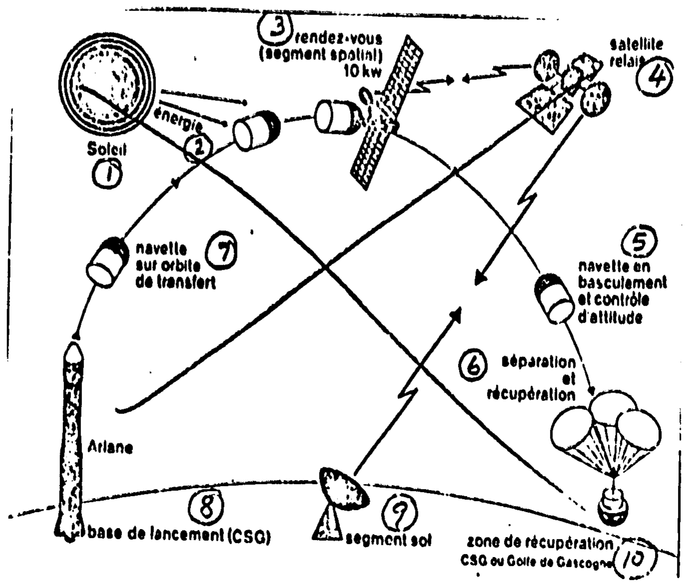

MINOS system with orbiting station and shuttle launched by Ariane

Key: 1. sun 2. energy 3. rendezvous (space segment) 10 kilowatts
4. relay satellite 5. shuttle tipped over and altitude controlled
6. separation and recovery 7. shuttle module in orbit
8. launch base (CSG) 9. earth segment 10. recovery zone--
CSG or Gulf of Gascony

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DELEGATION NEGOTIATES SPACE AGREEMENT WITH PRC

Paris LE MONDE in French 6-7 May 79 p 5

[Article by Alain Jacob: "A French Delegation Begins Negotiations on a Space Agreement With Beijing (Peking)"]

[Text] A French delegation on space affairs led by Yves Sillard, director general of CNES (National Center for Space Studies) has just spent 3 weeks in China. They were received by Fang Yi, the Chinese vice prime minister specializing in scientific affairs. The delegation's visit was richly informative, as the Chinese authorities had agreed to show some installations never seen until now by foreign observers. Though the French specialists had not been able to visit the Chinese launch sites, they were at least able to see the shops where the launch rockets are assembled. They were surprised by China's level of development, which seems much more advanced than they had supposed.

A Chinese launch vehicle, named "Long March 3," is equivalent to the European rocket Ariane, now in preparation and expected to be in operation about 3 to 5 years from now. A synchronous orbit satellite, the first to be designed and constructed in People's China, is expected to be launched in 1982 or 1983.

In review, the Chinese are clearly still behind in two areas: cryogenic propulsion methods (used in the last stage of Ariane type rockets) and miniaturization (the most recent Chinese satellites launched and recuperated weighed close to 2 tons).

Global Negotiations

The Franco-Chinese conversations dealt with five areas in particular: telecommunications by satellite; direct "community" television (that is, allowing retransmission through space of programs originated on Earth by local stations); teledetection of terrestrial resources; cryogenic propulsion methods and rockets; and lastly, atmospheric balloons and scientific experiments.

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At the beginning the two parties held differing positions. The Chinese were interested in teledetection methods used in France and in technology transfer in cryogenics. But these were matters the French deemed "sensitive" (teledetection can be used for military observations as well as civilian), and they were not prepared to open up on these questions except on condition that they had access to other sectors in which the Chinese had already made agreements with concurrent countries: systems of telecommunication with the United States and direct television with West Germany. This repeats a classic negotiations strategy, already experienced by the French prime minister during his 1978 visit to China, which consists of tying exchanges of technology of military interest to orders for civilian goods.

The negotiations have, it seems, brought these points of view closer together; the French, insisting on the "worldwide" character of negotiations dealing with space agreements between the two countries (in opposition to Chinese acquisitions seeming too selective), have persuaded the Chinese to envisage use of the European rocket Ariane rather than American rockets until their Long March 3 is ready. On the Chinese side, in the domain of direct television, the French will go with the international cooperation agreements of the other nations.

A working program has been established providing for a French cooperation project to be set up within a month followed by a visit to France this fall of a Chinese space mission. After this an agreement could possibly be concluded.

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INITIAL TEST OF VIKING-3 MOTOR REPORTED

Paris AIR & COSMOS in French 24 Mar 79 p 49

[Article by Pierre Langereux: "First Test of Viking-3 Motor"]

[Text] Last 19 March the SEP [expansion unknown] had performed a static test of the Viking-3 version of the Viking-4, second stage of the European rocket "Ariane." The test took place successfully at SEP's launch site PF2 at Vernon (Eure). The motor attained a thrust of 593 knots, about 60 tons during 180 seconds, more than nominal flight time--Viking-4 should deliver a thrust in vacuum of 713 knots during 138 seconds (295.8 seconds of impulsion). The test was continued until the fuel in reservoir was exhausted, with simulation of the pressure differences when the fuel pumps cut in, as would occur during flight and also regulation of the afterburner by two servomotros fed by the gas of pressurization.

The 19 March trial was the second with the same Viking-3 motor in order to verify the possibility of reusing and reigniting the motor: a primary test of 10 seconds had been performed on 13 March.

Another Viking-3 motor will be tested in late March under the same conditions as the preceding test, and two tests of the second stage Viking-4 motor, with simulated altitude, will take place in late April and late May on the testing site of DFVLR [expansion unknown] at Hardthausen (Germany).

Finally, the first static tests of two Viking-5 motors (flight test with a different Viking-2 contour on the first stage) will take place at Vernon in late May or early June.

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MILITARY OBSERVATION SATELLITE TO BE CONSTRUCTED

Paris AIR & COSMOS in French 12 May 79 p 43

[Article by Pierre Langereux]

[Text] Provision for construction of the SAMRO, the first French military observation satellite, is made in the fifth military program authorization bill, which will be in effect starting in 1983, it has just been announced by Yvon Bourges, French defense minister.

Thus for the first time it has been officially confirmed that this projected satellite, under study for a number of years, will be built. The present military program act (1977-1982) in fact provided only a modest financial participation by the armed forces in the development of the SPOT civil observation satellite of the CNES [National Space Studies Center], certain technical features of which will be utilized in the SAMRO, and of the European Ariane [Ariadne] launcher, which will enable the SPOT to be placed into orbit (in 1984), as well as the SAMRO (probably before the end of the 1980 decade.

As a matter of fact the armed forces expect that the Ariane rocket will have passed its tests and that the SPOT satellite will have been developed--if not launched--before making commitments for construction of the SAMRO satellite and its reconnaissance equipment (cameras with visible range and infrared optics) but also that of control stations and equipment for reception and processing of data, can be estimated at about 6 billion francs!

To this must then be added the operating expenses of the system, and costs of renovating and improving the SAMRO satellites, and so forth.

Because, once launched, the French satellite reconnaissance system will have to provide a "permanent" service, like its American and Soviet predecessors. For France this therefore amounts to launching itself into an operation of large scope.

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CROTALE MISSILE PROTECTS NATION'S MILITARY AIRFIELDS

Paris DEFENSE INTERARMEES in French May 79 pp 32-37

[Text] The development of the threat from the air and the lessons learned from the latest conflicts, those in the Near East, in particular, pursuaded most of the air forces to boost the protection of their airfields against air raids.

A group of measures is being implemented in France:

Hardening the shelters for combat aircraft;

Camouflage of installations to make their visual acquisition by the attacker more difficult, using the vegetation in the area as well as painting of buildings, concrete surfaces, hardstands, and taxiways;

Upgrading of ground-to-air armament through the positioning of "Crotale" missiles at certain air bases and further equipment of all bases with AA guns.

Why "Crotale?"

Penetration and air raids conducted at very low altitudes and great speed represent an ever growing danger.

The low-level action radius of tactical aircraft in service throughout the world has been increased considerably in recent years. It presently amounts to 700 kilometers for the most recent aircraft, thus placing all of our airfields within range of aircraft stationed well beyond France's land or sea frontiers.

Finally, very low-level and high-speed approach makes it possible to achieve a tactical surprise, or at least to reduce the reaction time available to the defense. This type of attack represents a permanent threat from here on in, a threat which moreover is independent of weather conditions in view of advances in "all-weather" penetration.

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Concerning the ground-to-air defense of air bases and sensitive points we must have means permitting us:

As soon as possible to detect one or several aircraft penetrating at high speeds and very low altitudes; in this area, we can presently encounter speeds of 300 meters per second and altitudes of 500 meters;

To identify these aircraft and to sound the alert in minimum time;

To guarantee the tracking of the target, the calculation of the firing elements, the firing as such, and the destruction of attacking aircraft before they have fired.

The development of Crotale was originally undertaken upon request of South Africa, at the time one of the chief customers for French military equipment. The entire system was developed by Thomson-CSF, the general project manager, while Engins Matra was charged with developing the missile as such.

The specifications at the beginning of the Crotale program called for the following six main points:

Simultaneous engagement of multiple targets during several raids;

Rapid target acquisition;

Immediate firing and re-engagement [of target];

Maximum effectiveness;

High attrition prior to employment of attacker's weapons;

Air transportability.

The development work was begun at the end of 1964 and was completed in March 1970; it was aimed at the adoption of six characteristics permitting the satisfaction of all of the specifications. Crotale used automation extensively, to such a point that the gunner is more of a watchman rather than an operator.

The functions of acquisition, coordination, and [target] designation are entirely automatic. Besides, the fire power (at least 12 missiles ready to fire), the possibility of achieving the first intercept at a longer range, the high destruction probability and the separation between the firing unit and the acquisition unit permit the system to meet all of these urgent requirements.

Crotale is the only coordinated low-level air defense system in service, capable of responding to saturation air raids.

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It is designed as a real air defense "center" capable of coordinating the fire of several units with the help of a central acquisition unit which automatically evaluates the threat and gives the order for the units to fire so as to prevent overkilling, that is to say, the concentration of more than abundant fire.

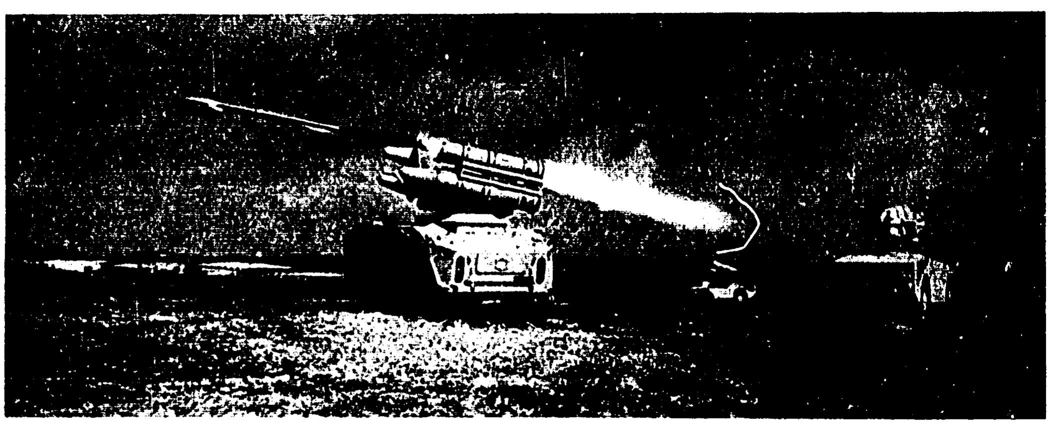
This is a short reaction-time system, using a high-performance and highly maneuverable missile, with great instantaneous fire power, making it possible very quickly to fire upon the most dangerous targets.

The first missile as a matter of fact can be fired at a target only 6 seconds after initial detection (first radar echo); just 2 seconds later, a second missile can be fired by the same firing unit.

All-Weather Operational Capability

The Crotale system presents very interesting general features. It has an all-weather, day-time and night-time operational capability (which, for example, is not true of the Roland 1 of the Ground Forces); it has a more convenient development potential, as shown furthermore by the new SA 10 missile developed by Thomson-CSF; it can be deployed rapidly and does not present any problem in terms of size and weight; Crotale can also be easily adapted to the terrain in which it is deployed. Finally, it can be air transported by C-136 Hercules, C-141, and C-160 Transall aircraft.

While the general features of Crotale are such that they permit high performance, it is indispensable for us to have a high processing capacity in terms of real time and a perfect reaction capacity. That is to say, the system must have retrieval units and computers with a high processing capacity, working in terms of real time.



Firing a Crotale Missile; on the right, we can see the acquisition unit and, in the background, there is a second firing unit.

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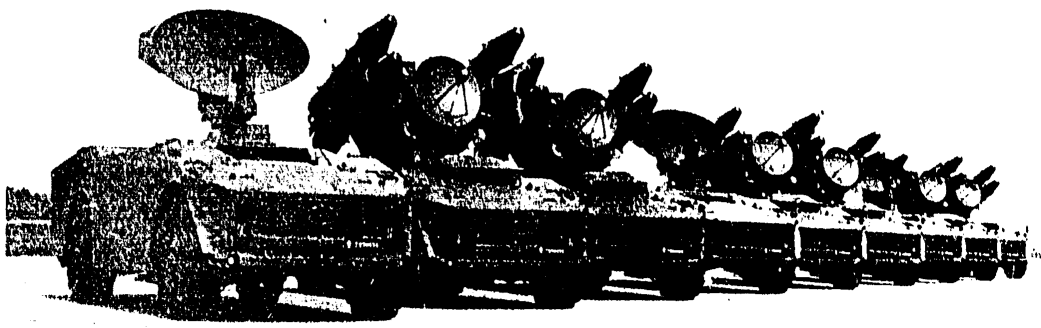

Air Force Crotale squadroon, comprising three acquisition units and six firing units.

These programmable numerical computers must also, through a simple program change, permit optimization for a new and special tactical situation, as well as the performance of other tasks (technical tests, maintenance tests with location of trouble spots, etc.).

Finally, it must be possible to coordinate the fire and to direct the engagement of firing sections from a central point and through one responsible officer only. All of this presupposes the engagement of targets in an omnidirectional, all-azimuth fashion; engagement in a preferential sector, as a function of tactical data, and, as the case may be, integration of numerical data in real time coming from the higher-echelon surveillance units.

This latter point is particularly important because it enables us, for example, to visualize a situation where we interconnect the Crotale unit in a given zone with the air defense CDC [Computer Center?] or an airborne detection system so as further to increase the fire coordination as a function of more voluminous tactical data.

The above also presupposes a high effectiveness level and overkill suppression; in case of saturation attacks--since these are the most probable in view of the nature of the potential enemy--it is necessary to fill the enemy's attempts (30 targets registered, 12 targets under automatic tracking by acquisition units).

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We must also be able repeatedly to engage targets reputed to be dangerous (presumed to carry tactical nuclear devices) by firing in salvoes--[in] 3 seconds.

Finally it is absolutely necessary for us to be able to keep a large number of missiles on the trajectory, without any confusion in the order of the missiles in flight.

This important consideration is tied to the processing capacity necessary for this system and led to the separation of the firing elements from the acquisition units.

Operation

Starting with detection at a range of 18 kilometers by the watch radar, the Crotale can perform four successive interceptions against a raid by several aircraft before they reach their targets.

The interception probability is 0.8 with a single missile and 0.96 with two missiles, fired in a salvo against the same target. The system was optimized to intercept a standard target with an equivalent radar surface of one square meter, fluctuating, flying at an altitude of between 50 and 3,000 meters, at Mach 1.2-1.5, capable of maneuvering at a load factor of more than 2g [G] at the system's range limits.

It also enables us to intercept aircraft diving (up to an angle of 20 degrees) at targets situated 1.5 kilometers behind the defended position.

Description

The Crotale system comprises firing units and acquisition units; each acquisition unit can be teamed up with three firing units although we generally prefer a ratio of 1:3.

The acquisition unit comprises a 12-ton Hotchkiss-Brandt armored vehicle with oil-pneumatic suspension, with four electric motors directly operating the four wheels. These motors get their energy from a 230-horsepower combustion engine permitting a maximum speed of 70 kilometers per hour and a range of 600 kilometers; the energy furnished by the alternator supplies all of the electronic equipment.

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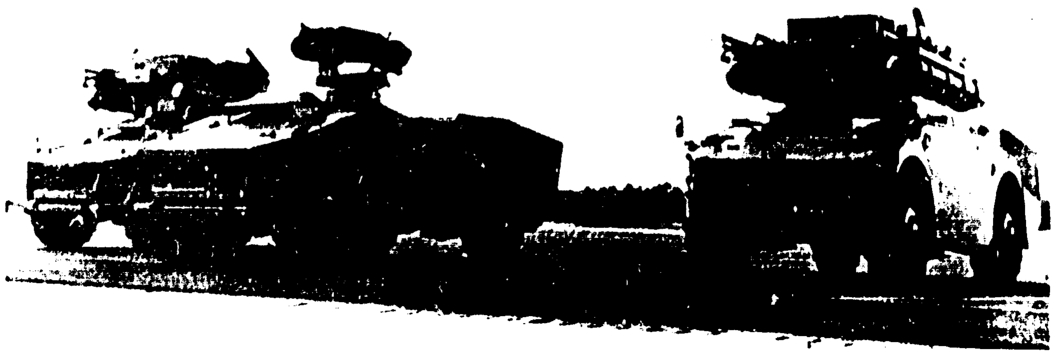

Crotale section ready to move: The turret of the firing unit carries only two missiles, facing to the rear, whereas the acquisition unit's radar antenna is lowered.

This unit has a three-man crew: Driver, chief operator and assistant operator. In the acquisition unit, we have a Thomson-CSF Mirador IV surveillance and acquisition radar working with a Doppler effect and with coherent pulses making it possible to spot even aircraft flying at very low altitudes; these are generally easily confused with fixed echoes.

This radar automatically eliminates all of the clutter on the operator's screen and facilitates immediate evaluation of threat posed by the target.

The antennae rotation speed is 60 revolutions per minute and permits a detection probability of 90 percent; the radar operates on the S band. The vehicle also has a IFF unit working on real time, associated with a SN-1050 computer unit; both of these together permit the simultaneous processing of 12 "problems" whose solutions are shown synthetically on the control screen which illustrates the real instantaneous situation.

The computer with precision processes the data furnished by the surveillance radar and supplies a final target evaluation. The moment a track has been considered dangerous, the computer queries the IFF computer and starts the processing of the approach trajectory while calculating the data necessary for the intercept.

These data are transmitted by cable (for distances of less than 400 meters) or by hertzian waves (for distances of up to 5,000 meters) to one of the firing units.

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The latter, made up of the same 12-ton vehicle, is equipped with a quadruple mount and a tracking radar capable of accomplishing the simultaneous guidance of two missiles. This radar follows the variations in the relative positions of the target and the missile or missiles fired so as to evaluate the respective trajectories and to correct them in order to bring the missiles to the point of intercept.

The tracking radar works on the Ku band, necessitated by the limited dimensions of the antenna . Besides, the firing unit is equipped with a remote-control transmitter operating on the X band which transmits the heading variations to the missiles in numerical form; it is furthermore equipped with an IR range finder which measures the angular distance between the trajectory of the missile and the axis of the radar during the initial phase, as well as a closed-circuit television unit permitting tracking in case of radar failure under certain conditions.

The firing vehicle finally is equipped with a computer identical to the one mounted on the acquisition unit; it takes care of calculating the parallax with respect to the acquisition unit and its correction; it also handles target acquisition and tracking; intercept probability calculation; "control" data processing as well as firing the warhead when the missile arrives in the proximity of the target or when it must self-destruct.

The Missile

The Crotale missile is characterized by a "canard" configuration which permits great maneuverability; it is stabilized by four ailerons forward, permitting great guidance precision. The fuselage is 2.89 meters long and has a diameter of 0.15 meters; the missile weighs about 80 kilograms. Its minimum range is 500 meters whereas its maximum range is close to 8.5 kilometers.

The missile comprises an IR proximity fuse, which is not sensitive to CME [ECM?] and atmospheric disturbances; it has an explosive charge of 15 kilograms, effective within a radius of 8 meters, inside of which the explosion produces a cloud of fragments moving at a speed of 2,000 meters per second.

Further to the rear, we find the SNPE [National Propellants and Explosives Company] rocket engine enabling the missile to attain a speed of Mach 2.3 after an acceleration phase of 2.3 seconds. This very rapid acceleration makes it possible to reduce the minimum interception range and also to reduce the flying time over short distances, when the action time is very limited.

The high degree of automation in Crotale permits maximum human error reduction; the operator's function as a matter of fact is confined to two operations. On the one hand, in the acquisition unit, the operator assigns the target to the particular firing unit which the computer designates as being the most suitable.

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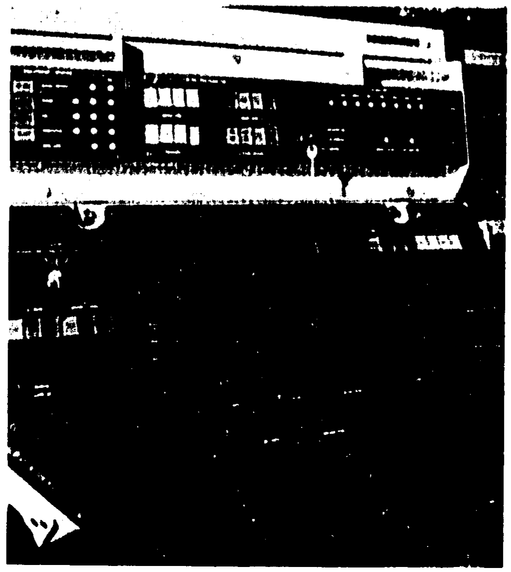

Firing unit control panel.

In the firing vehicle, the operator pushes the firing button when the latter goes on automatically. Man thus acts only to watch and to confirm the work of the computer by means of a manual operation.

Versions

There are presently three versions of the Crotale system, only three of which presents differences among each other.

South Africa, which was behind the request for Thomson-CSF to develop a ground-to-air missile intended to replace the Bloodhound missiles which Great Britain refused to supply South Africa with, ordered an unspecified number of the basic version which was called the Cactus.

The French Air Force ordered 20 Crotale acquisition units which will be matched up with the 20-millimeter guns to provide low-level air defense for air bases. The first unit became operational in 1977 and Crotale squadroons are currently in service at the Istres, Avord, and Apt bases; the squadrons at Saint Dizier and Luxeuil will be organized this year.

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The Crotale training unit is deployed at the 118th air base at Mont-de-Marsan. We might note that, upon its establishment, each squadron fires twice for effect; after that it fires live just once a year.

The French Navy ordered the Crotale Naval naval version which will be mounted on the six vessels of the Georges Leygues class, the three F-66 frigates, the Jeanne d'Arc helicopter carrier and possibly the new PA-75 aircraft carriers.

Satisfactory Mobility

Upon request of Saudi Arabia, Thomson-CSF developed the Shahine version which consists of Crotale turrets mounted on the chassis of the AMX-30S medium tank. This version has firing units armed with six missiles instead of four and a more high-performance radar mounted on the acquisition vehicles.

The missile itself was made about 10 centimeters longer and was equipped with a more powerful engine. The Shahine will be matched up with the twin-barrel SP AMX-30S AA units likewise ordered by Saudi Arabia, with four or five twin-tube units being deployed with each Shahine tank.

During comparative tests performed by the U.S. Army, which also included the Rapier and the Roland II and which led to the selection of the latter, Crotale turned out to be slightly less performing than Roland.

The choice of the latter was also motivated by its cross-country performance which was definitely superior as well as by the fact that the Roland vehicle, by combining the acquisition and firing components, is entirely autonomous.

These considerations summarize the advantages and disadvantages of Crotale. Initially developed for South Africa--a country where speed on the highway and across the desert plain is more important than a real cross-country capacity--Crotale undoubtedly is not suitable for a mission requiring the tracking and protection of armored formations in a cross-country setting.

But, such as it is deployed by the Air Force, it is mostly capable of accomplishing its mission of defending air bases.

This in fact is a sophisticated air defense system which has the advantage of being highly mobile, rather than constituting a real tactical system. Its mobility furthermore is considered satisfactory by the air force which recently proved that by moving a section of Crotale from Orange to St. Dizier by rail; the system was operational at its new base less than 12 hours later.

Finally we might note that the very short time required for moving a section into firing position (less than 5 minutes), combined with the very brief response time, gives Crotale major assets in accomplishing its mission.

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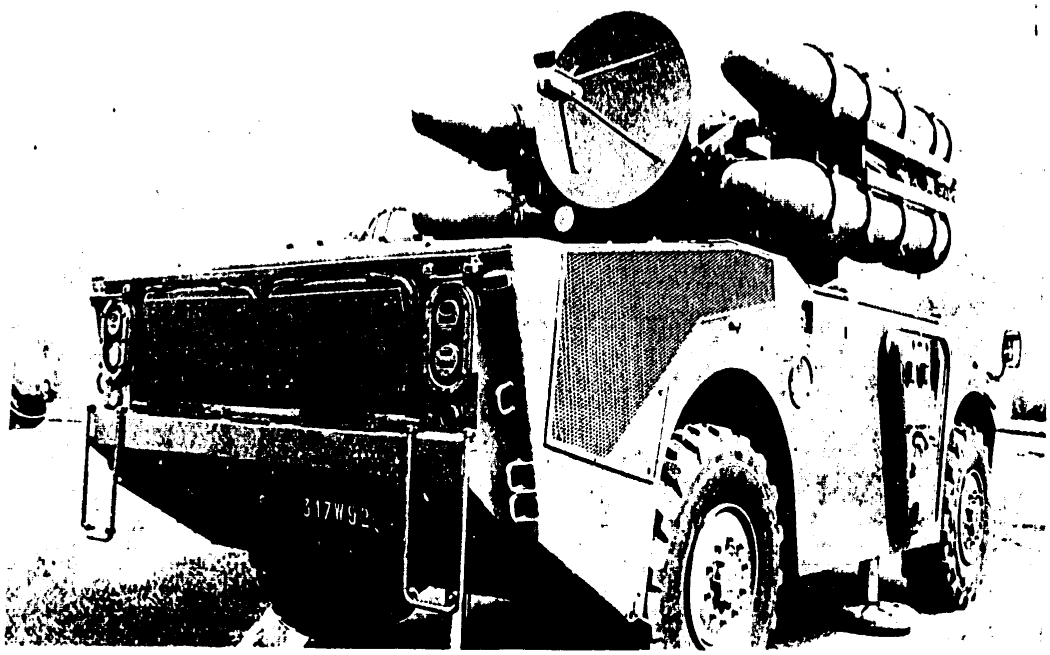

Detail view of firing unit.

Technical Characteristics

Acquisition Unit: Surveillance:

Azimuth: 360 degrees per second;

Altitude: 50-4,000 meters.

Detection probability: 0.9 for one antennae revolution on a target covering an area of one square meter fluctuating at 18 kilometers.

Threat evaluation:

Automatic urgency evaluation, 30 targets in sight, 12 targets tracked.

Target designation: one, two, or three firing units, automatic or manual designation, remote-controlled or automatic missile destruction.

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Firing unit coordination:

Keeping tabs on firing operations, recording of condition and status of firing units.

Firing Units

Target tracking:

Automatic target pickup, involving target covering an area of one square meter, moving at 16 kilometers, two additional redundant modes.

Missile firing: At standard target supervised by operator, at emergency targets with complete automatic mode, individual rounds or salvo or two (3 seconds), remote-controlled or automatic missile destruction.

Missile guidance:

Pickup phase: IR preliminary guidance; guidance phase: Radar mode; guidance performed by computer in real time; transmission of orders to missile by remote control.

Missile

Remote-controlled, roll-stabilized, single engine.

Solid fuel; Speed: Mach 2.5 in 2.3 seconds.

IR proximity fuse; controlled fragmentation military payload.

Payload: 15 kilograms; destruction radius: 8 meters; total weight: 83 kilograms.

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EUROMISSILE ORDERS NOW WORTH 9.5 BILLION FRANCS

Paris AIR & COSMOS in French 5 May 79 pp 37, 39, 41

[Article by Pierre Langereux]

[Text] The Euromissile order book now amounts to about 10 billion francs for the three weapons programs: Milan, HOT [expansion unknown] and Roland, jointly developed by the two parent com anies, Aerospatiale [National Industrial Aerospace Company] (France) and Messerschmitt-Bolkow-Blohm (MBB) (FRG).

Off to a modest start of 80 million francs in 1973, the order book (except for taxes) jumped to 1.647 billion francs the following year when the Milan light antitank missile went into production. Since then, it has not stopped steadily and swiftly climbing, reaching the figure of 9.6 billion francs in 1978 thanks to the successive appearance on the market of the HOT heavy antitank missile (in 1975) and the Roland surface-to-air weapons system (in 1978). Euromissile has thus racked up a "record" number of orders these past few years: 3.7 billion francs in 1977 and 3.5 billion in 1978. This year, the Franco-German Joint Subsidiary Group (GIE) shoudd record another 3.3 billion francs worth of orders, which should keep its order book at about 9.5 billion francs. Thereafter, Euromissile estimates that new orders will decrease to about from 2.5 to 3 billion francs a year, which should stabilize the order bo at about from 9 to 9.5 billion until 1986. From then on, the order book should decline if no new program appears to replace it.

Saturated Production Capacity

Euromissile sales figures (except for taxes) have also been steadily and swiftly advancing for 6 years. Going from 283 million francs in 1974 to 1.878 billion in 1978, it should continue its spectacular growth to reach 2.5 billion this year (up 37 percent) and 3.4 billion in 1980 (up 36 percent), according to current estimates.

This is the upper production capacity threshhold for Aerospatiale and MBB, whose mass-production lines — in Bourges (France) and Nabern (FRG) — are practically at saturation point. The current order book represents about

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3 years of production for the Milan, HOT and Roland assembly lines, but with a redistribution of production quotas that will change according to the demand.

For the moment, there is no inventory. Everything has been sold. Euromissile is, moreover, obliged to resort to staggered delivery schedules in order to simultaneously meet the needs of all clients in terms of their plans for putting the new missiles into operation in their units.

The average delivery time for the different weapons (in their currently available forms), from the time the order is received, is 12 months for the Milan, 16 for the HOT and 20 for the Roland.

Euromissile estimates that the turnover will level off at about 3.4 billion francs during the next 3 years. Therefore, no drop in overall production is at present planned, even if the distribution of production schedules among the three programs is likely to change.

26 Client Nations

The three Euromissile missiles and weapons systems are currently being sold in 26 countries throughout the world, including France and the five NATO nations, among them the FRG, Great Britain and the United States.

The Milan is being sold in 18 countries, including France and the FRG (half the sales volume), and exported to 16 other (50 percent of the sales volume), including Great Britain which is now licensed to manufacture the Franco-German missile.

The HOT has been ordered by 10 countries, including France and the FRG (35 percent of the sales volume), and is exported to 8 other countries (65 percent of the sales volume).

The Roland is now being ordered by five countries, including France and the FRG (85 percent of the sales volume), and exported to three others (15 percent of the sales volume), among them Brazil and another Latin-American country. The United States is planning to obtain a license to manufacture the Franco-German weapons system. In principle, the ultimate decision to go into production in the United States is imminent (sometime in May). The U.S. Army has just recently confirmed its purchase order for the system.

Over 100,000 Missiles Produced

Production should exceed the 100,000-missile mark for all types by the end of this year. Milan production should come to 90,000 missiles and 4,300 launchers, HOT production to 14,000 missiles and 470 launchers (in three different models) and Roland production to about 2,200 missiles and 80 launchers.

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The Milan will be produced at the rate of 20,000 missiles a year and in Great Britain (British Aerospace), which will produce about 5,000 missiles a year at a fixed rate. Euromissile plans to maintain its production rate for at least another 6 years. This would bring its production total to about 210,000 missiles by 1985. But in fact, Euromissile even has hopes of attaining a total production figure of from 250,000 to 300,000 missiles, counting the 18 countries that are already clients and a dozen others considered to be potential purchasers. Specifically, Euromissile expects Belgium to put in a new order for the Milan which could be signed before the coming Le Bourget Show. This transaction, amounting to from 3 to 4 billion francs and subject to sizable making-up prices to the advantage of the Belgian industry, would involve supplying Belgium with about 6,000 Milan missiles and 330 launchers. Let us bear in mind that Belgium had already acquired 1,500 Milans and 75 launchers to replace its French ENTAC [expansion unknown] antitank missiles (see AIR & COSMOS No 750).

HOT production should continue at the rate of 10,000 missiles a year for another 7 years, in the opinion of Euromissile, which expects to sell a total of about 100,000 missiles. Despite the fact that the price is still higher than that of the American TOW [expansion unknown] antitank missile, the HOT in fact has several decisive operational advantages over the former, notably the superior penetrability of its hollow warhead, which the United States is interested in for an improved version of the TOW.

With the appearance of a few new clients, the Roland should reach its mass-production cruising speed during the next few years. Specifically, Euromissile expects to receive a new order — perhaps two — this year for the "position defense" version mounted on trucks or trailers and compatible with an external data-acquisition and processing system. Euromissile now offers this version as a surface-to-air missile system which can be coupled with cannons and a control unit composed of a radar device for the surveillance and identification of targets, like the Contraves (Switzerland) Skyguard or the Dutch Signal Devices Company (Netherlands) Flycatcher. The shelter-equipped version is also adapted for the defense of fixed positions and, like the other tank-mounted versions of the Roland, for the antiaircraft defense of moving battle fleets.

But the Roland's real breakthrough will come when the United States begins to mass-produce the Franco-German weapons system. However, this risks raising a new problem with regard to the distribution of export markets betwen American manufacturers and Euromissile.

What Future for Euromissile?

In principle, Euromissile activity is not solely limited to the current Milan, HOT and Roland programs. In particular, the group had planned to undertake new studies for a light air-to-surface missile and a second generation sea-to-sea missile. But the ASSM [expansion unknown] antiship supersonic missile project, which has been studied in conjunction with the ASEM

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[expansion unknown] Group and several NATO nations (see AIR & COSMOS No 672), ran into financial difficulties just when it was about to enter into its development phase. This means the program will probably be shelved until 1980-1981.

At the present time, there is no major tactical missile program in sight for Euromissile that would be likely to replace the three programs now in operation, adopted 15 years ago (1962-1964) by the French and German governments.

Euromissile Order Book and Turnover
(millions of francs, taxes excepted)

	1973	1974	1975	1976	1977	1978	1979	1980
Sales volume	3	283	669	715	1227	1878	2500	3400
Order book	80	1647	2862	4516	7555	9601	9477	9000-9500

Euromissile Sales Distribution and Current and Potential Production of Franco-German Missiles

Missiles	Sales Volume Distribution (averages)	Buyers (contracts accepted or signed)	Production (end 1979)	Overall Prospects (missiles)
Milan	50% France-FRG 50% export (18 countries)	18 countries	90,000 missiles 4,300 launchers	250-300,000 missiles (+ 10 countries)
HOT	35% France-FRG 65% export (8 countries)	10 countries	14,000 missiles 470 launchers	100,000 missiles
Roland	85% France-FRG	5 countries	2,200 missiles 80 launchers	
		26 different countries	+ 106,000 missiles	nearly 400,000 missiles

Milan, HOT, Roland Specifications

The Milan is a supersonic (180 m/sec) antitank missile with a range of from 25 to 2,000 m, which reaches its maximum range in 12.5 seconds. The rate of fire is three rounds a minute and the warhead can perforate the NATO trippe target (350 mm of steel at an angle of incidence of 65°). It is a light missile (11.3 kg with the container, activated by a portable (17 kg) launcher.

The HOT is a long-range antitank missile: 75 to 4,000 m from surface vehicles or 400 to 4,000 m from helicopters. It flies at subsonic speed (250 m/sec) to reach its maximum range in 17 seconds. The 6-kg warhead can perforate all kinds of armor, known or being developed. The HOT missile weighs 32 kg with its container. Like the Milan, the HOT is a wire-guided

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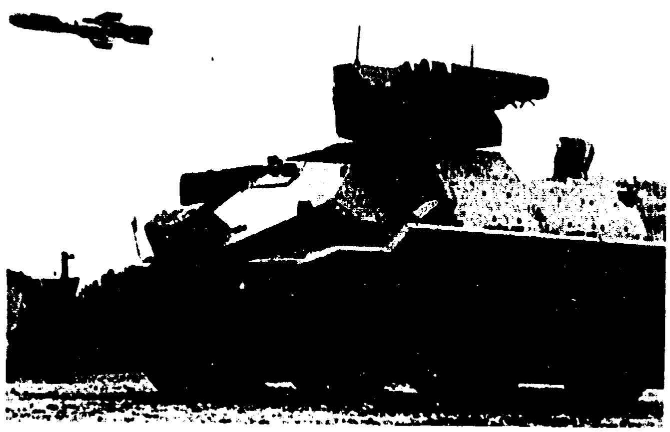
missile with infrared tracking and automatic remote controls. All the gunner has to do is keep the sights on target until the moment of impact.

The Roland is a low-altitude ground-to-air weapons system with a maximum firing range of 6,200 m in horizontal and 5,000m in vertical trajectory.

The surveillance radar is capable of detecting targets starting at a distance of 16 km and targets can be tracked automatically by means of the launch radar or manually by means of an optical sighting device. The weapons system is self-propelled and comes in two models: clear-weather (Roland 1) or all-weather (Roland 2). It can be combined with a control unit for the defense of fixed positions.



Launching of a HOT heavy antitank missile from a Panhard light armored vehicle equipped with a UTM [expansion unknown] 800 turret.

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NIGHT COMBAT WITH MILAN, HOT MISSILES DISCUSSED

Paris AIR & COSMOS in French 5 May 79 pp 45, 47

[Text] In the past, night combat was exceptional. It was reserved for specialized light units that had been specially trained and was generally used for pinpoint operations: sabotage, infiltration, etc. However, the night could be used to advantage for troop redeployments or concentrations. Night attacks were generally carried out with the aid of lights to illuminate the battlefield, rockets or projectors.

It is no longer like that today. More and more, combat vehicles are equipped with the means for traveling and even fighting at night. In the face of this threat and simultaneously with the improvement of means of detection, it became indispensable for antitank weapons to be able to operate in the dark. Euromissile therefore studied the appropriate devices for the Milan and HOT antitank systems.

Infrared Cameras

If we exclude active systems (illumination of targets with visible or infrred light), there are two ways of seeing in the dark, by light intensification or thermic imagery.

Light intensifiers amplify residual luminosity. Their performance therefore depends on the latter and will be less effective on a very dark night or in the woods than on a starry night, for example. Operating in the visible spectrum, they do not change the general appearance of the countryside and are particularly well adapted to night driving or flying.

Thermic imagery makes use of the infrared radiation of objects, partially linked to their temperature.

The brilliant spots correspond to hot ones and are often potential targets: not only vehicles with their motors running or recently shut off, but also power generators revealing the presence of a command post or simply human beings. Armored vehicles show up easily, if only because of the solar radiation they have absorbed during the day.

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Two "windows" in the atmosphere are available with infrared radiation: close infrared (3 to 5 microns) and distant infrared (8 to 14 microns) bands. The latter is the one used in the Euromissile system because it avoids the glare due to the missile tracers and cuts down the interference caused by hot spots in the countryside (which especially radiate in the close infrared band). It is little affected by the possible presence of fog and makes possible a well-defined image.

From the technical standpoint, the detection cells have to be chilled and this limitation must be taken into consideration in using the system. As for performance, it should be as close as possible to that obtained during the day.

The Milan missile night-launching device was designed according to the specifications of the three general staffs: German, French and British.

Minimal performance:

Detection of the presence of a possible target up to a distance of 2,000 m.

Reconnaissance of the kind of target up to 1,500 m.

Identification of the kind of target and launch range up to 1,200 m.

Field of vision: $6^{\circ} \times 3^{\circ}$.

Presentation in the form of a case weighing nor more than 6 kg and capable of being adapted to existing launchers without the need for modifying them.

Range in excess of 2 hours.

The development of this thermic infrared camera was set in motion about 2 years ago through a joint agreement of the three governments: French, German and British, which decided to evaluate several concurrent proposals before choosing the device that was to be mass-produced. The operation is being conducted by the German firm, Messerschmitt-Bolkow-Blohm, and charged to Euromissile which will guarantee marketing of the night-vision camera in all the interested countries, that is, the 18 countries that have the Milan, including those to whom it has been exported.

Three industrial groups, each of which is offering two cameras, are currently competing:

SAT [Telecommunications Corporation] (France) and ELTRO [expansion unknown] (FRG) for the Minicat 1 and Minicat 2 cameras.

TRT [Radio and Telephone Telecommunications Company] (France) and Siemens (FRG) for the Mira 1 and Mira 2 cameras.

Marconi SDS [expansion unknown] (Great Britain) for the two British cameras.

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The manufacturers' tests for these cameras, conducted in France and Great Britain, are carried out in exactly the same way as are tests made for the official services. During night launches carried out last year, direct hits on a target tank placed 1,900 m from a Milan launcher were obtained.

Very soon, about June, the official services should choose the camera model that will be mass-produced following a technical and military evaluation in 1981. By that time, the development program and tooling operation should be completed so that the first mass-produced cameras should appear in 1982.

Mass production of the Milan thermic infrared camera will be conducted through a new industrial organization that will bring together all of the three groups' competing firms, which will work under the direction of the one retained to manage the project. The mass-production operation will be equally divided among the three participating nations, with one or two final assembly lines.

Operation will conform to specifications. The night-launching device will be adapted to the standard launcher with the thermic imagery device mounted above the optical sighter. There will therefore be no modification in the operation of the system for the gunner.

The cells will be cooled by means of the Joule-Thomson effect, thanks to the expansion of compressed nitrogen. The range provided by a bottle (.3 liter) is over 2 hours and the heat exchange takes only a few seconds. Based on the results already obtained, we may rest assured that the ranges in question will exceed 3,200 m for detection, 2,000 m for reconnaissance and 1,500 m for identification and launching.

VENUS System for the HOT

The device to be used for night launching of the HOT missile depends largely on the kind of assembly.

The first users of the HOT had not required the ability to launch at night for surface vehicles. This is why the periscope (on the Jaguar JPZ [expansion unknown]), the UTM [expansion unknown] turret (on the Panhard M3) and even the Lancelot turret (on the AMX10) are not so equipped. But this possibility has not been excluded for the future.

On the other hand, the Mephisto and HAKO [expansion unknown] assemblies now being developed will include a night-launching device. Particularly for the Mephisto, it will be integrated into the periscope and will benefit from the same stabilization produced by the action of rate gyroscopes on the sighting mirror, with the thermic camera being mounted above the daytime sighting device.

For armed helicopters, the VENUS (Stabilized Night Range Finder and Sighting Device) is now being developed in collaboration with the SAT, TRT and SFIM

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[Measurement Instruments Production Company] to equip the Light Combat Helicopter (HCL) which uses the Aerospatiale Dauphin (see cover photo) as a basic carrier. It consists of a stabilized platform under a bubble in the nose of the helicopter which contains a HECTOR [expansion unknown] thermic camera that operates in the distant infrared band and is provided with a double-objective optical system as well as a standard type range finder for tracking the missile. The image provided by the camera is displayed on a cathode ray tube which the gunner views through the eyepiece of his sights. As far as the operator is concerned, the operation is the same as for daytime launching.

The VENUS system makes it possible to observe both the target and the launch. Naturally, the pilot has to be equipped with some means of flying the helicopter in the dark (microchannel binoculars, for example).

VENUS Specifications

Features

Thermic camera:	large field
	small field
Locator:	large field
	small field
Equipped platform:	clearance at rest
	clearance in position
	diameter
	weight

Performance

Target detection:	over 4,000 m
Target engagement:	up to 2,000 m
Operating conditions:	zero visibility
	temperature from -40° to $+50^{\circ}$ C
	NATO operating conditions

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Demonstration of the three Milan launchers in competition. From top to bottom: the Marconi SDS (Great Britain), the SAT (France)-ELTRO (FRG) and the TRT (France)-Siemens (FRG).

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Aerospatiale Dauphin helicopter armed with eight long-range (4,000 m in daytime use) Euromissile HOT antitank missiles ready for launching in their launch bays (two 4-missile pods). The nose of the helicopter is equipped with the VENUS stabilized night range finder and sighting device for night launching of HOT missiles. This device permits detection of targets at a distance of over 4,000 m and engagement up to 2,000 m at zero visibility.

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BRIEFS

MILITARY OBSERVATION SATELLITE--The minister of defense [Ivon Bourges] has announced that the 5th military planning law, to become effective in 1983, calls for the development and construction of a military observation satellite called SAMRO. To be developed according to technology perfected for the SPOT civilian satellite, it will be orbited by an Ariane launcher and will cost approximately 6 billion francs (for the development and construction of the satellite and accessory equipment, with operating costs not included). [Text] [Paris DEFENSE CONJONCTURE in French 21 May 79 p 3]

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