November 1972

AIR DEFENCE IN A SUPersonic AGE

(MADGE)

Surprise, the traditional ally of the attacker, is ten times more deadly in a supersonic age. Modern raiders reach their targets only minutes after they are picked up on the radar screens and the only hope for their potential victims is to engage in a race against the clock and reduce their reaction time.

For the past thirty years, air commanders have conducted their operations on principles generally similar to those that governed land warfare a century or more ago. Then, generals made most of their moves on the basis of what they could see through a spyglass.

By the late 1950s, it became clear that manually operated Air Defence systems were no longer adequate to cope with the threat posed by modern, fast-flying or supersonic aircraft.

The Supreme Allied Commander Europe, at that time General Norstad, expressed it this way: "Except as a part of a whole, there is no air defence of any one nation ...."

The warning was clear and the nations were not slow to act upon it. The history of Air Defence in NATO is one of progressive integration.
First Step : A Trilateral Organization

It was in 1958 that a trilateral organization known as IPG (International Planning Group) was set up by Belgium, Germany and the Netherlands. United in the need for air defences covering the three countries as a whole, these nations equipped themselves with high performance weapons systems designed to ensure prompt reaction on the part of control and intervention operations.

As a preliminary to the NADGE project, the Belgian, German and Netherlands Air Force Staffs undertook the study of an up-to-date system to cover their common defence sector (Air Defence Ground Environment, or ADGE).

At the same time, the inter-allied military authorities worked out an overall plan to improve performance of existing radar installations, reduce reaction time, and achieve automation of data-handling. To SHAPE fell the task of initiating this work. In 1960, the civilian organization of the Alliance joined the military body in working out a joint NATO project which became known as NADGE (NATO Air Defence Ground Environment).

Preliminary work, which was necessary for the operation of the IPG sites involved the setting up of a Programming and Training Centre (PTC) at Glons, near Liège in Belgium. The next step was to plan the realization of the NATO Air Defence Ground Environment (NADGE) System.

The system has been based on an electronic network made up of high-capacity, high-speed computers, the introduction of new radars and the modernization of existing facilities. All the loop-holes which had existed between the individual stations have been closed, and NADGE, with its unbroken chain of stations running from north to south provides a powerful barrier against the intrusion of enemy aircraft into the NATO European airspace.
There are 84 stations located in Norway, Denmark, Germany, the Netherlands, Belgium, France, Italy, Greece and Turkey. For purely strategic reasons, the United Kingdom is not integrated into the system but has its own facilities, which meet the NADGE standards and can, if necessary, receive data from stations on the Continent through automatic links.

The Construction Programme

The NADGE project was part of a NATO Common Infrastructure Programme, but because of the size of the contract (£110 million sterling), special steps were taken to ensure that each participating country received a share of the work.

The supply of the basic equipment was entrusted to a consortium of six manufacturers in NATO countries, known as NADGECO. Thomson-Houston (France) was responsible for the giant tri-dimensional radars, Telefunken (Germany) for the construction of these radars under French licence, Marconi (United Kingdom) for the height-finding radars, Signaalapparaten (Netherlands) for the gap filler radars, Selenia (Italy) for the consoles, and Hughes Aircraft (USA) for the computers. Other large firms supplied various equipment under sub-contracts. The scale of the project can be judged from the consortium's technical proposal, which ran to 8,000 pages, and the system design reports which had 65,000. The system comprised some 5,000 major items of equipment which required the building of 200 structures and gave rise to difficult technical problems such as the use of helicopters to transport radars to prepared sites on mountain sides in Norway.

Some older stations, with manual equipment, were integrated into the system. The 84 stations range from simple monitoring posts responsible for picking up enemy aircraft and reporting their presence to the control centre, which, with its tactical electronic process, is responsible for interception, to the specially built operational stations which represent about
20 per cent of the project. The 35 main stations have advanced equipment such as Thomson-CSF tridimensional radars (azimuth, distance, altitude) and Hughes H3118 computers which pick up at supersonic speed, process and simultaneously feed to the controller the data he requires on the aircraft spotted, and submit at his request specific information regarding its altitude, course, speed and identification (friend or foe). The computer can select the most suitable weapon system (type of aircraft or missile), and work out the best course and angle of attack for the interceptor and its flight and attack plan. Finally, it can guide the pilot back to his base, or to another base if he is low on fuel. All these operations are calculated in micro-seconds.

Duplication is built into the system to allow for survivability after battle damage. For instance, if a site is destroyed, command and control can be passed from this sector to another as the situation demands. The radar surveillance area goes far beyond the Iron Curtain and extends to the highest altitude reached by today's aircraft. The area of operation encompasses some 3,000 miles of sky. Each NATO country is responsible for its own geographic area, and the areas are known as NADGE Sectors.

In its daily, round-the-clock, all-the-year operations, the entire NADGE system is supervised by SHAPE, the Allied Headquarters for Europe. But the NADGE installations and air defence weapons and forces remain under national control. Only in an emergency would they be placed directly under the overall operational control of the Supreme Allied Commander Europe (SACEUR).

Methods of Operation

NADGE is divided into four basic functions:
Detection: The NADGE Surveillance System must remain on guard against sudden air attack. Thus, it must constantly watch the whole area of concern to the NATO nations, from just above the ground to high in the atmosphere, in order to detect all air traffic approaching or penetrating the NATO area.

Identification: Detection of aircraft must be followed by rapid and accurate identification, based on the use of electronic devices or on flight plan correlation. Information obtained from flight plans filed by pilots before departure, and in-flight amendments and position reports, are compared with an actual radar track of an airborne object. If the information on the flight and the track correlate within established criteria, the track may be identified as a "friendly" aircraft. If the flight plan and track do not match however, or if there is any doubt, the object is classified as "unknown" and interceptors may be "scrambled" (ordered to become airborne immediately) to make visual identification.

Interception: Owing to the large number of flights taking place daily within NATO's European airspace, some of these are bound to show at Command and Control centres as "unknown". Most can be re-identified as "friendly" through further communications checks. But it is common to find a few instances where interceptors are scrambled to identify the "unknown" aircraft visually.

The NADGE sites and the regular fighter-interceptor squadrons in the NATO Air Defence System constantly practise the operations which would take place in an emergency.

Destruction: The concept of aerial warfare is that of a family of weapons, or defence in depth. The aim is to subject an invading force to continuous attack from as far out as possible as it approaches a target area.

An enemy bomber formation might first be attacked by surface-to-air missiles then by interceptors and, finally, by the short-range, point defence missiles.
Command and Reporting Centre

Within each Sector, the Command and Reporting Centre and its computer is the hub of the whole system. Information from radars and other sources are fed to the computer that will rapidly recommend defensive action subject to the overall control of the operator. Thus, the computer frees each member of the defence team to concentrate on what the human mind does best: the making of decisions.

NADCE requires 6,500 operators, and 2,300 programmers and maintenance personnel, while 220 persons have to be trained each month for contingencies and replacements. For this purpose, a training school has been set up near Cologne. The students, who are serving military personnel, are drawn from all the NATO member countries.

Practical Testing

However, while modern equipment ensures a technically advanced system, the success of the NADCE project requires that all equipment, modern or less modern, and all the weapon systems used, should function as a whole so that data can be sent, for example, from a Dutch radar to an American computer, worked by a Belgian team with a German master controller guiding the course of a British fighter. Such a complex set-up required much preliminary testing. This was done over a period of 18 months at the Hughes Aircraft Fullerton centre in the United States, where the first simulated equipment programming and integration trials set the tune for subsequent operations. The results were highly satisfactory and it was possible to move on to the second phase, that of practical testing at sites located in various NATO European countries. Each of these countries sent top performance aircraft of the types now facing the Soviet Air Force, which were used in turn as hunters or hunted in such a way as to cover all conceivable alert and interception contingencies. The success
of these tests required sound links between the prototype computers and the radars used, integration with the existing systems, and attention to the human factor, i.e., the reactions of the pilots taking part. Generally speaking, they all responded impeccably and immediately to the orders and instructions given. Host country airfields near the stations were used to accommodate the aircraft and provide ground control and support.

Hundreds of tests were carried out over a period of about two years. An experimental site provided for flight testing based on different equipment which meant that a variety of trials could be performed and that different types of aircraft could also be put through their paces. At one site, for instance, Turkish F102s and Greek F5s were pitted against Dutch and German F104Gs, acting as the enemy, while Danish T33s, Belgian F104s and British Canberras were also to be seen. At the other site, other high performance aircraft were up against one another: French Mirage IIIIs against American F4 Phantoms, British Lightnings against Canadian CF104s, and so on.

Conclusion

The NADGE system provides a capability far beyond that of the manually operated systems, long since outdated. It is able to meet the supersonic threat to Western security and provides the means of controlling the whole range of air defence weapons available to Allied Command Europe. It largely standardizes equipment and permits bulk purchase of spares, which reduces operating costs. But the benefit it brings to the Alliance transcends the immediate military significance. The participating countries have gained invaluable experience concerning the use of advanced electronic equipment in an operational role. Notable progress has been made in countries where technological experience is comparatively recent.
NADCE represents an enormous advance in the defence of Western Europe, which is provided with an unrivalled protective system, but, because of its reserve potential, it also has other possibilities, for example, it could be a major aid to air traffic control. Finally, the close co-operation between the electronics industries in member countries has provided an outstanding example of international technical exchanges.

Photographs may be obtained from the NATO Information Service