

Linköping Flight Test Centre Sweden



The date is 24 August 1910

Carl Cederström is the epitome of concentration as he gives full throttle to his "Bil-bol". His Blériot type XI aircraft is powered by a modified Lamanche-Picquer water-cooled marine engine developing 42 horsepower. A year has passed since he took the first Swedish pilot's licence at the Blériot School of Aviation, after a risky training course. Within a couple of hours, he flew 140 kilometres, beating all earlier Scandinavian records.

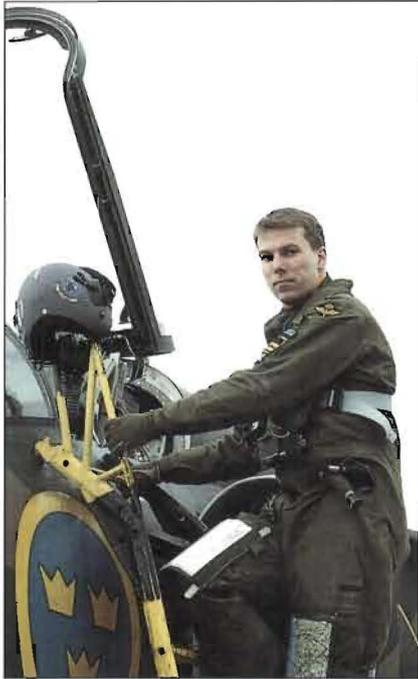
Carl Cederström was a true pioneer, with a consuming interest in flying. He was also very popular as a person, and his winning ways enabled him to communicate his enthusiasm to others. New aircraft, new records and new ideas took him from strength to strength.

In June 1911, Carl Cederström flew his Blériot XI "Nordstjernen" for the first time over the Malmen drill ground, and in the summer of the following year, the Military School of Aviation in Malmslätt became a fact, with Carl Cederström himself in charge.

Although undoubtedly far-sighted, Carl Cederström could never have imagined, even in his wildest dreams, how aviation would develop in years to come. Carl Cederström's flying days were long before the advent of the jet engine, composite materials, the G suit, computers and intelligent weapons systems.



Demands change with changing times



Linköping Flight Test Centre

Most of the flight testing undertaken by the Swedish Defence Materiel Administration (FMV) is managed from the Linköping Flight Test Centre. The testing work covers the aircraft itself, as well as the weapons, electronics, countermeasures, and the control and communications systems. The Production Management unit of the Testing Directorate is also located in Linköping.

The operations of the Testing Directorate are located at the Linköping Flight Test Centre and the Karlsborg and the Vidsel Test Range. Testing is also carried out at the Älvdalen and Torhamn firing ranges. The Testing Directorate has around 500 employees.

What may have been Carl Cederström's dreams many years ago are hard realities to today's pilots. The military systems are becoming increasingly complex and more costly to develop. The performance demands are steadily growing, in pace with new technical advances and new tactical needs.

The opportunities available for developing systems that meet the requirements are largely dependent on the ability to examine, test and evaluate the systems in a consistent way, in order to guide the development work steadily along the right path.

The FMV Testing Directorate is entrusted by the Swedish Armed Forces with the task of testing and verifying technical systems for the Army, Air Force and Navy. The objective is to safeguard the expected technical quality of the materiel systems, and to provide the prerequisites for tactical use of the materiel in the various units.

The theories that serve as the basis for system development are tested in preparatory studies. Testing activities are continually pursued during the design and manufacturing phases, and also continue after regular deliveries. System tests with tactical orientation provide an overall picture of the functionality and effectiveness under realistic conditions. The test results are compared with the technical

specifications and may also serve as a basis for design modifications by the supplier.

Safety in peacetime is extremely important to aircraft, helicopters, missiles and other weapons. During the testing work, special attention is devoted to air and munitions safety.

Many military systems are repeatedly modified during their life cycle and are developed further to achieve higher performance or improved operation and safety. All modifications are subjected to thorough testing. As an example, a simple software change in a computer may require extensive system testing in order to verify the new function.

In certain cases, the Swedish Armed Forces purchase existing systems, often from foreign suppliers. Before the purchase is concluded, the Testing Directorate undertakes comparative studies of alternative systems on the basis of the technical specifications.

With licence to test

FMV supplies the military defence system with basically all of the materiel needed for the wartime organization.

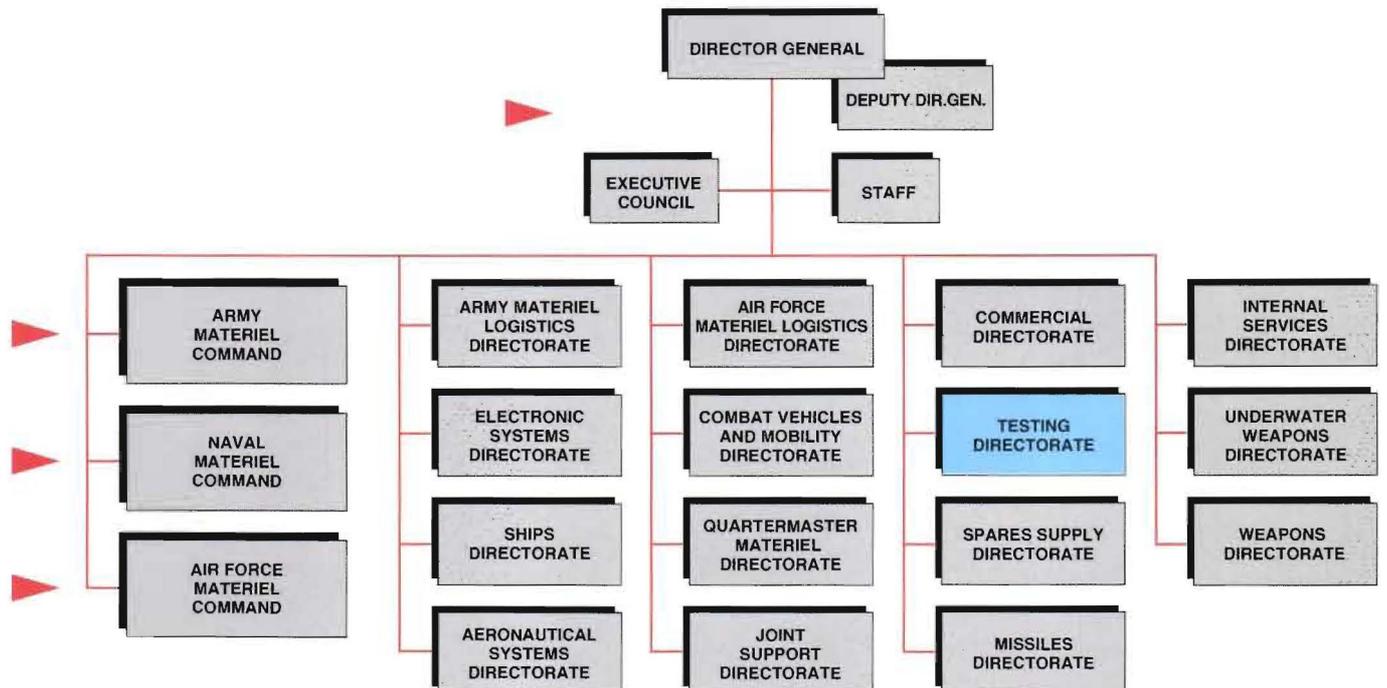
The operations are entirely guided by the assignments received, with the Production Management Divisions for the Army, Navy and Air Force and, in certain cases, for the Commander-in-Chief (Swedish Armed Forces) as the dominating assigners. FMV also cooperates with other State authorities and bodies such as universities of technology.

Assignments involving materiel procurement are handled at FMV by the three Materiel Commands for the Army, Navy and Air Force. The Director

General deals with assignments of a general nature, such as warfare planning, technical forecasts and research projects.

The assignments are forwarded to one or more of the FMV directorates, which then plan and estimate the assignments. After receipt of order, the assignments are implemented by the same directorates, in cooperation with industry and other suppliers.

The Testing Directorate is the FMV resource that bears the main responsibility for testing and verifying technical systems. If capacity is available, the Directorate also sells its testing services to foreign authorities and to the defence industry in Sweden and abroad.



Our collective strength



The Management Support Division is responsible for the central administration of the Testing Directorate. The Division includes units for personnel matters, training, economics, quality and administrative computer support.

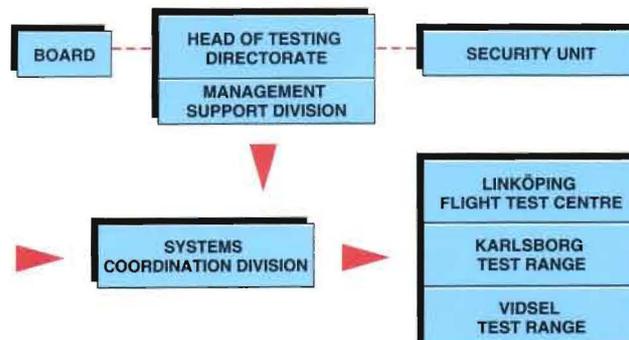


The Systems Coordination Division handles testing assignments that are distributed to the various test centres. The Division follows up the test assignments in cooperation with the FMV Air Force Materiel Command, the materiel system manager and the person in charge of the current assignment. In-house development of testing methodology and systems, and the airworthiness work are also coordinated here.



The Linköping Flight Test Centre uses its personnel and equipment for carrying out its testing assignments in accordance with the predetermined plan. The internal organization of the Flight Test Centre comprises Service, Test Conducting, Flight Testing, Engineering, Measurement DP Systems, Production, Electronic Warfare Simulation and Environment Testing sections, and the Aeronautics Physiology Laboratory and Electronics Laboratory.

The Strategic Specialist Board for the Testing Directorate is an advisory body in FMV in matters related to investments in new testing systems, assignment of priorities to testing resources, etc.



The right resources

The Linköping Flight Test Centre has vast resources for flight testing with advanced systems in a variety of environments, and has more than 20 aircraft and helicopters at its disposal.

The air crews at the Test Flight Section come from the Air Force, the Army and the Navy, and fly all of the aircraft and helicopter types used by the Swedish Armed Forces and other Government departments.

The pilots are highly competent test pilots, and several of them have international training. The Test Flight Section cooperates closely with *Saab Aircraft* and has an extensive international contact network, principally in the USA, Great Britain and France, for the exchange of experience in modern aeronautical engineering and testing methodology.

Flight testing demands in-depth competence in a number of areas during preparations, implementation and evaluation. The testing team includes test engineers, installation technicians, metrology technicians and mechanics.

Aircraft and helicopters are used for a variety of tasks in conjunction with the testing work. Testing is focused on aircraft or helicopters, either separately or in combination with other systems. Aircraft and helicopters are also used as flying platforms for test objects or for assistance and transport during testing. The Linköping Flight Test Centre has vast resources for measurement installations, acquisition of measured data and analysis of test results.

For special tests, aircraft and helicopters over and above those at the Linköping Flight Test Centre are available on loan to the Testing Directorate.



Aircraft and helicopters available at the Linköping Flight Test Centre



JAS 39 Gripen aircraft



Type 37 Viggen aircraft



Type 35 Draken aircraft



Type G4 (S102) aircraft



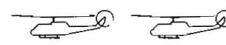
Type TP86 Sabreliner aircraft



Type 340 aircraft



Type SK60 aircraft



Helicopter 3



Type SK61 aircraft



Helicopter 4



Testing yields knowledge

FMV works on tomorrow's military systems. These systems are technically very complex and must have a lifespan of many years, often under difficult conditions. In conjunction with procurement, it is therefore important to assess the materiel from all conceivable aspects – technical, tactical and economic.

The task of specifying, procuring and evaluating new weapons systems is a vast process that extends over several years. The Testing Directorate carries out flight testing in order to verify the integration of systems into the aircraft and evaluating the performance under realistic conditions.

The JAS 39 aircraft is built for tomorrow's demands. It is only when combined with advanced weaponry that this high-performance aircraft is of interest to Swedish defence and on the export market.

Flight testing of the M90 dispenser weapons system for the JAS 39 aircraft

The M90 dispenser weapons system is a German-made weapons system for the JAS 39 aircraft. The system is built as a flying body, with its own navigation system and multiple parachute-borne submunitions which are fired when the target area is passed. Firing of the submunitions is controlled by individual radar fuzes.

1. The type 37 aircraft as a test platform

Tests on the M90 system are in progress at the Linköping Flight Test Centre in parallel with the testing of the JAS 39 aircraft at *Saab Military Aircraft*. The type 37 aircraft then serves as a platform for the flight testing.

2. Installation of measurement systems

For flight testing of the M90 system, the computer in the type 37 aircraft is equipped with appropriate software for the dispenser weapons system functions.

Throughout the testing process, data from the measurement systems and data bus installed is recorded by a tape recorder. Camera pods are used for filming the separation of the dispenser weapons system.

3. Final mounting of dispenser weapons system

The submunitions with their parachutes have been fitted into the launching tubes. The various subsystems are checked for the last time by the engineers.

Airworthiness approval

After analysis, testing and examination, a limited-duration flight testing permit is issued for the relevant aircraft. Once valid airworthiness approval has been received, flight testing can be started.

4. The M90 system on the type 37 aircraft

The dispenser weapons system is mounted in place on the type 37 aircraft. Ready for testing.

5. Separation

Separation from the aircraft is a critical phase. The dispenser weapons system must be given the right initial course and must not jeopardize the safety of the aircraft. The camera pod records how the dispenser weapons system behaves during the first seconds of its flight.

6. Firing of submunitions

The dispenser weapons system is steered independently over the target area. The submunitions are fired in a matrix pattern. The spread over the target area is recorded and represents the basic data for calculating the effect achieved.

Telemetry and aircraft data

Large quantities of data from the aircraft and the dispenser weapons system are recorded during the approach, separation and launching. The movements and sequence of events can subsequently be accurately reconstructed.

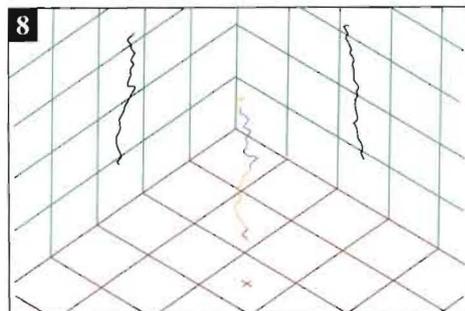
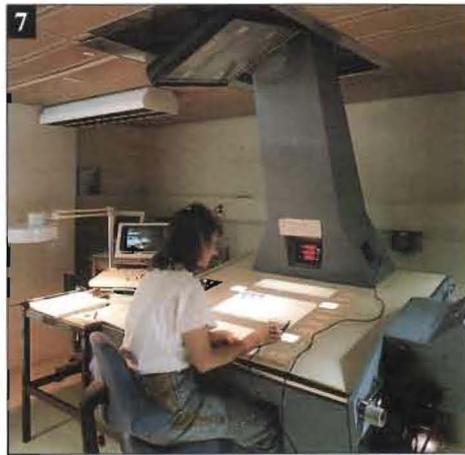
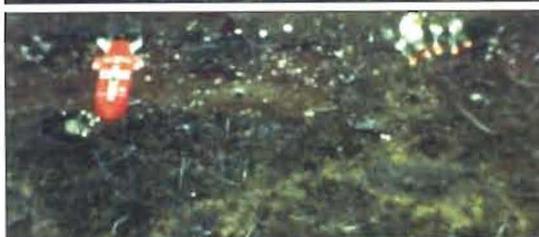
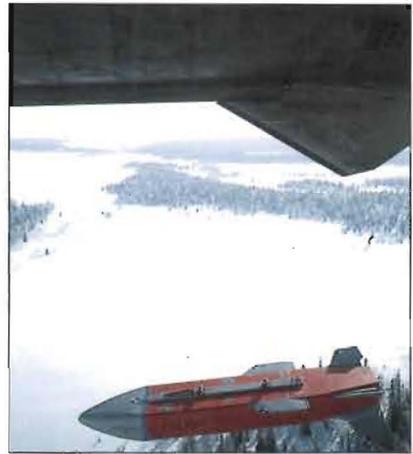
7. Film evaluation

High-speed cameras in several positions around the target area are used for filming the test. In the evaluation, the films from the various cameras are synchronized in time. The positions of the dispenser weapons system and the submunitions are recorded frame by frame for further processing by computer.

8. Compilation of the test results

The test results describe in graphic form how the individual submunitions have moved in three dimensions and at what altitude they have been launched. The compilation of all of the results serves as a basis for evaluating the performance and continued development towards a new weapons system which is ready for delivery.







A life-long involvement for defence and industry

The strength of the Swedish defence system is based on competent personnel and materiel systems which are appropriate, safe and effective. The Armed Forces draw up and authorize the materiel supply plan which serves as a basis for placing orders for assignments with FMV.

The procurement of a new materiel system extends over a long period of time. The involvement of the Testing Directorate permeates the production process and follows the system throughout its life cycle.



STUDIES

The study phase is aimed at testing proposals for new materiel systems and establishing the tactical, technical and economic targets. The work is led by the Swedish Armed Forces assigners, in cooperation with FMV and the National Defence Research Establishment (FOA).

PREPARATION, PROCUREMENT

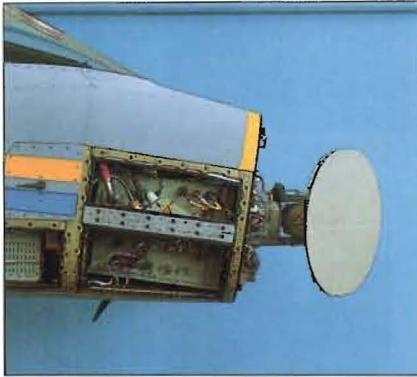
The objective of the development work is determined in the introductory study and project definition.

Material tests and experiments on sub-systems or entire systems are carried out at an early stage of the development work. Prototypes for accurate testing and verification of performance are made prior to regular production.



The Testing Directorate is entrusted with the task of examining the materiel system with regard to performance, operation and safety, and to follow and participate in the testing pursued in industry. As an example, several of the test pilots and engineers at the Linköping Flight Test Centre participate in flight testing of the JAS 39 aircraft at *Saab Military Aircraft*.





PRESERVATION AND SUSTAINED ENGINEERING

Regular production begins only after the new system has been found to conform to the technical specification. At the same time, the introduction of the new system and training are started at the various units of the Armed Forces. For airborne systems, the Linköping Flight Test Centre is responsible for the introductory training of air crews. This gives continuity in testing and enables the experience gained to be incorporated directly into the training.

Procurement is concluded when the materiel is taken over by the units.

The Testing Directorate also participates in follow-up of the materiel in service and in the stores of the various units.

This phase also includes modifications and modernization of the materiel systems to meet new threat patterns.

DECOMMISSIONING

Follow-up during the decommissioning phase is aimed at determining when the materiel should be taken out of service.



Environment Testing Section

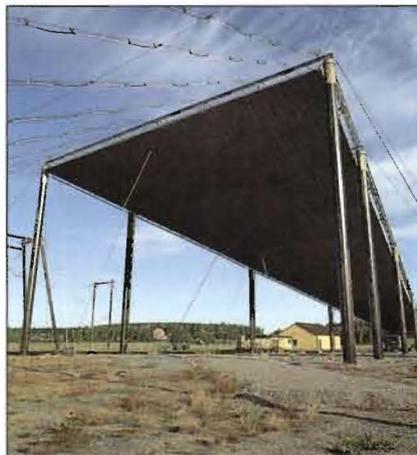
The Environment Testing Section is engaged on assessing the environmental properties of equipment. The tasks of the Section include providing support for projects by drawing up specifications and carrying out examination. The Section assists in the planning of tests and carries out testing in cooperation with assigners both within the Armed Forces and externally.

The Environmental Laboratory tests the tolerance of equipment to kinetic and climatic stresses. The Laboratory includes extensive machinery with recording equipment for standardized testing of apparatus.

The Electrical Environment Laboratory tests the tolerance of equipment to electrical disturbances and the nature of the emitted disturbances that may affect other equipment. The Laboratory uses a shielded anechoic chamber with absorber material of very high standard to provide an effective EMC test and measurement environment. Joint operation testing is used for verifying that various items of equipment perform well together in larger systems.

The EMP (Electro-Magnetic Pulse) Laboratory operates the EMP simulator system of the Armed Forces. The Laboratory tests the tolerance of equipment to electro-magnetic pulses that occur in the event of a high-altitude explosion of a nuclear weapon. The Laboratory also has comprehensive equipment for EMP testing of large stationary installations.

The Arboga antenna measurement station is located adjacent to an airfield. The measurement station undertakes evaluation of the properties of antennas, and of complete telecommunication systems in aircraft, vehicles or ships.



Electronic Warfare Simulation Section

The principal task of the Section is to undertake testing of electronic countermeasures by simulating the duel between the threatening systems and the countermeasures. This is carried out mainly by testing actual or simulated disturbance forms against simulated radar systems in "hybrid simulators".

In rig testing of countermeasures pods, the analysis capability of the pod is tested by means of synthesized, radar-like microwave signals. Similar simulations are used for evaluating the technical and tactical performance of the JAS radar warning system. Pure software simulations between measures (IR or radar) and countermeasures are also carried out.

Important working areas are programming, electronics, systems engineering, microwave technique and radar technique. The tasks of the Section also include the provision of competence support to other sections within the technology areas mentioned above.

Electronics Laboratory

FMV specialists in electronic components are assembled at the Electronics Laboratory. The Laboratory is engaged on component matters throughout the life cycle of the materiel systems – from project design and procurement, to operation and maintenance.

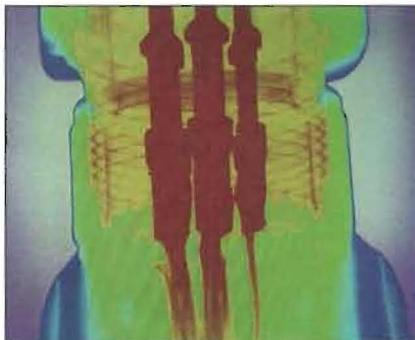
Component standard. Components for defence duties are qualified and selected in cooperation with the defence industry and FMV project leaders. One important task is to cooperate in national and international standardization work, jointly with military standardization organizations in Europe and the USA.

Examination and advisory service. The Electronics Laboratory assists in the procurement and modification of defence materiel by providing an advisory and examination service in component selection. The Laboratory also assists in solving component problems in electronic equipment by testing and analysis, and submits proposals for replacement components.

Technical development. We continually follow technical developments in areas such as assembly methods, VHDL and device architectures, in order to be able to provide the best support in the selection and the verification and validation of functional implementations in future defence projects.

Failure analysis and testing.

The Electronics Laboratory has good resources for failure and design analysis, including X-ray microscope, scanning electron microscope and optical microscopes, as well as equipment for thermography, plastics analysis and tensile testing. The Laboratory also has equipment for electrical and optical measurements, environmental testing and simulation of components.



Aeronautics Physiology Laboratory

The main task of the Aeronautics Physiology Laboratory is to test flying suits and air crew equipment, and equipment for the rescue of persons in distress. Moreover, the Laboratory provides support for routine tests and certain training for the air crews of the Armed Forces. Planning of tests and testing are carried out in cooperation with the assigners, both within and outside the Armed Forces.

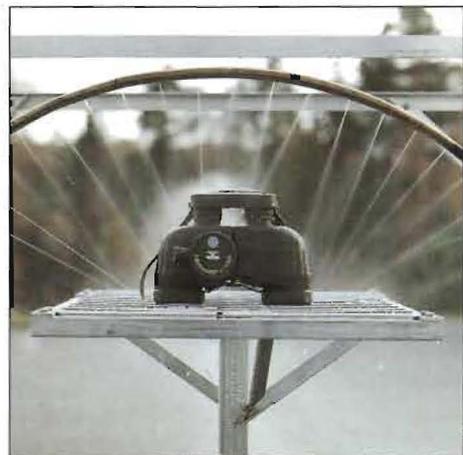
The testing resources include vacuum chamber, climate chamber, pressurized chamber, test pool and fire testing station. As from 1997, resources will also be available for practising flying at high g loads. The tasks of the Laboratory also include the provision of competence support to other units.

Important work areas at the laboratory are vacuum chamber tests for air crews, testing of flying suit systems, testing of medical equipment for rescue helicopters, support for research into breathing at high g loads, testing of the properties of various flying suit systems in flammable environments, and participation in the training of air crews.

The Laboratory also includes a comprehensive library with aviation medicine literature.

Revenue-financed operations

If capacity is available, the Testing Directorate sells its services to external assigners. This also applies to operations that are not directly related to the procurement of materiel for the Swedish Armed Forces, but in which we have suitable resources and competence. Such services include flight testing in aircraft or helicopters, and testing in various types of laboratories or simulators.

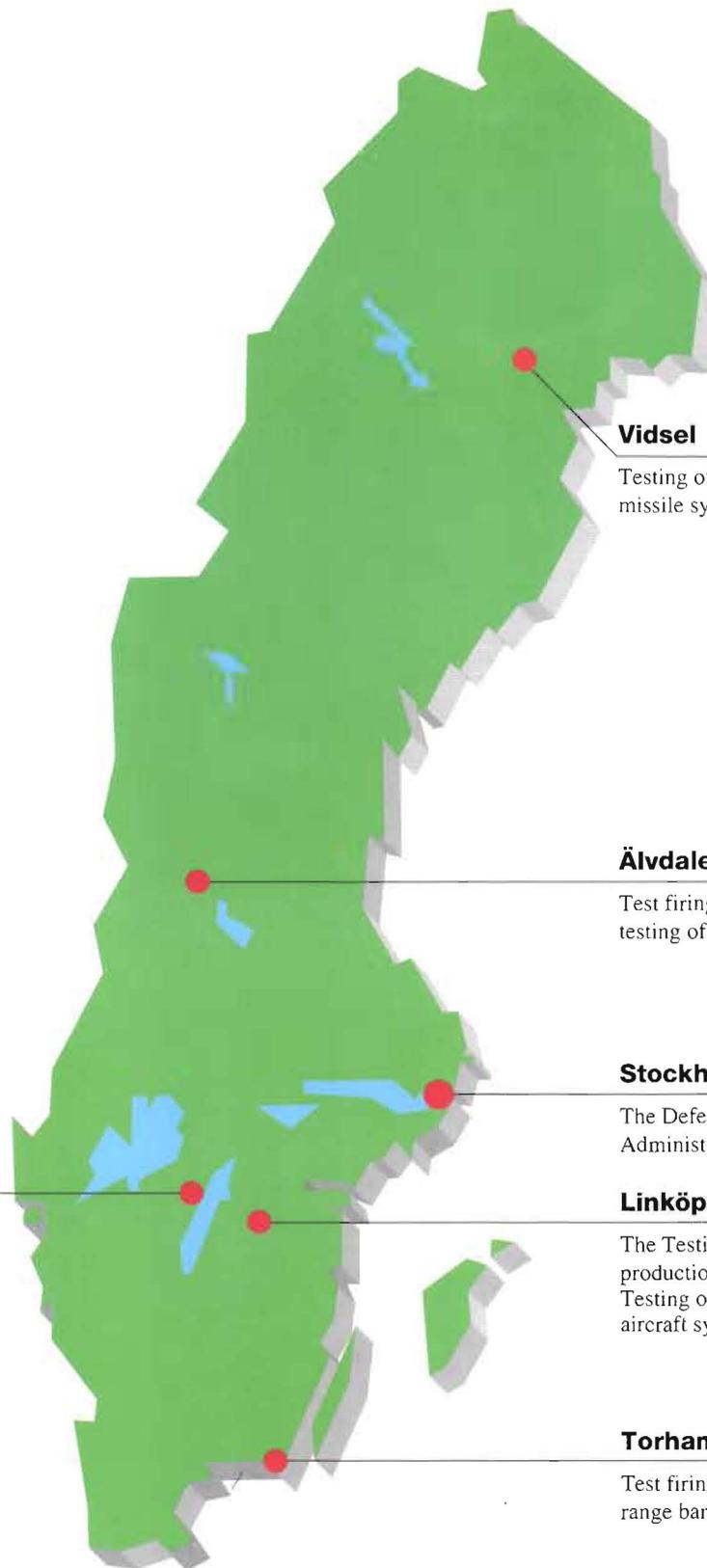




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Vidsele

Testing of aircraft and missile systems over land.

Älvdalen

Test firing range for total testing of multiple weapons.

Stockholm

The Defence Materiel Administration, FMV.

Linköping

The Testing Directorate production management. Testing of complete aircraft systems.

Torhamn

Test firing range for long-range barrel systems.

Karlsborg

Testing of barrel systems and ammunition. Testing of aircraft and missile systems over water.

FMV



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