Air navigation services
Air traffic

Air traffic control: an important economic factor
From Sydney to Hong Kong. From Buenos Aires to Mexico. From Zurich to Chicago with a connection to Saint Louis or Santa Fe. From Dakar to Geneva and from there to Amsterdam. Many people take it for granted that they can fly great distances in aircraft rapidly and safely, from country to country and from continent to continent. Worldwide, close to 2 billion passengers travel on commercial aircraft and 30 million tons of freight and mail are transported by air annually. Air transport not only speeds up the exchange of goods, it also generates hundreds of thousands of jobs. In order for air traffic to circulate in an orderly manner and to prevent aircraft colliding with one another in the densely populated airspace, we need air traffic control or air navigation services. This brochure will explain to you what air traffic control from the Swiss point of view is and what the tasks of skyguide, the Swiss limited company for civil and military air navigation services, are.

Skyguide along the timeline
In Switzerland, the age of flight began in 1909. The first successful flights with motorised aircraft took place that year. The first Swiss airline, Ad Astra Schweizerische Luftverkehrs AG, was founded in 1919. In its first year of operation, it flew 4700 flights and transported 7384 passengers. The increasing number of movements created the need for navigational assistance for the pilot in flight. Because pilots had hardly any navigational instruments on board, apart from an altimeter and a compass, and had to work out their own course from landmarks on the ground, they needed ground centres to provide them with meteorological information and goniometric measurements to find their positions. At first, there were several different groups who performed this function until, in 1931, they came together as Radio-Schweiz AG. Radio-Schweiz AG, a Federal mixed economic company, fulfilled its challenging navigation and communications tasks in the service of air traffic until 1988, when the air traffic control business division, with all its personnel and infrastructure, was taken over by the newly formed swisscontrol, the Swiss air navigation services company ltd. On August 18, 1999 the Federal Council decided to unify civil and military air navigation services. At the beginning of 2001, the then swisscontrol was merged with parts of the Air Force in a further newly formed company, skyguide. For the first time in the history of European air traffic, civil and military air navigation services were provided by a single company. In 2005, skyguide was one of the first European air navigation service providers to be certified under ISO Norm 9001:2000 for all business areas. At the end of 2006, skyguide was awarded certification, and thus the right to provide air navigation services, for the Single European Sky (SES) by the Swiss Federal Office of Civil Aviation (FOCA).
The skyguide company

**Organisation and locations**
Skyguide is an autonomous service company with headquarters in Geneva, whose share capital is owned to more than 99% by the Confederation. On behalf of the Confederation and its Federal Office for Civil Aviation (FOCA), skyguide is responsible for the safety of civil and military air traffic in Swiss airspace and that of the neighbouring countries that has been delegated to it. Skyguide fulfills this task at Bern, Geneva, Lugano and Zurich airports, at Buochs, Grenchen, St. Gallen Altenrhein and Sion regional airports and on military airfields and the military air defence and direction centre. At the regional airport Les Éplatures (La Chaux-de-Fonds), air navigation services are still delegated to the airport operator by skyguide. Skyguide is also entrusted by the High Command of the Air Force with carrying out tactical missions. Skyguide is the only air navigation service provider in Europe that can fulfill this task and can, therefore, manage its airspace particularly efficiently.

**Skyguide as employer**
Skyguide employs around 1400 people, of which more than 450 are civil and military air traffic controllers. More than 300 engineers, technicians and computer specialists are responsible for the development and maintenance of its complex technical installations. Air navigation services employees process the information that is required for safe and orderly air traffic movements. Various experts are engaged in planning and development. And there are administrative personnel and many instructors responsible for the training and education of the operational personnel at the Skyguide Training Center.
Financing
Skyguide’s expenses are borne by the users of its air navigation services on a fee scale authorised by the Federal Office of Civil Aviation. For over-flights, the fees are collected by Eurocontrol (European Organisation for the Safety of Air Navigation), and for landings and take-offs by the relevant airport authorities. Services provided to the Air Force are paid annually at cost by the Confederation. The principle of maximum cost transparency with no cross-subsidising is applied.
The mission of air navigation services

Safety separations
A passenger jet flies at a cruising speed of 800 to 900 kilometres an hour. To avoid collisions or near-misses it needs an internationally defined area of clear airspace around it. Horizontally, this is at least 9 kilometres ahead and behind and 9 kilometres to either side. Vertically, it is at least 300 metres. This clear airspace may not be penetrated by another aircraft under any circumstances. Air traffic control monitors compliance with these distances, even in the heaviest traffic and worst weather conditions.

Aeronautical Information Management (AIM) ...
and other duties
The primary task of air navigation services is the prevention of collisions in the air and in the vicinity of airports and ensuring a safe, smooth and efficient flow of air traffic. In addition, skyguide is also responsible for the aeronautical information management service (AIM). This issues information required for the safety, regulation and management of air traffic. It also gathers all the information required for a flight, processes it for the benefit of the crew and passes it on to the crew before the flight. Skyguide is also responsible for the alarming and support of the search and rescue services if an aircraft needs assistance. Because skyguide is responsible for civil and military air navigation services, it undertakes tactical exercises with the Swiss Air Force, supports the Air Force in its daily duty of policing the airspace and guides military jets on exercise through the Swiss airway system.
Flight rules

For the air navigation services, there is a fundamental difference between flights under visual flight rules (VFR) and instrument flight rules (IFR).

Visual flight rules (VFR)
When flying under VFR, precisely defined minimum distances for visibility and proximity to clouds must be maintained. VFR pilots orient themselves mainly by prominent landmarks, with the natural horizon as their reference point. In this category, the «see and avoid» principle is applied. Each VFR pilot is solely responsible for avoiding collisions and near-misses. However, air traffic control does assist VFR pilots in their task with precise traffic information from the Flight Information Center (FIC).

Instrument flight rules (IFR)
In contrast to VFR movements, IFR flights can operate in all weather conditions. As a consequence, there are normally no regulations laid down in relation to the visibility required to manoeuvre. Aircraft flying under IFR are equipped with instruments and navigation devices which, in conjunction with ground installations and satellite navigation aids, allow non-visual orientation. For these flights, air traffic control is responsible for preventing collisions.
Organisation of air traffic

International
Operational and technical procedures are mandatory for air traffic all over the world. These are developed and issued by the International Civil Aviation Organisation (ICAO), a sub-organisation of the UN with headquarters in Montreal. The ICAO is active in all areas of air travel and establishes regulations for air traffic, meteorology, the operation and registration of aircraft, air navigation services, flight information services, aeronautical information services, search and rescue services, exhaust and noise emissions and competency certification of aviation personnel.

In Switzerland
In Switzerland, civil air traffic is under the control of the Federal Office of Civil Aviation (FOCA), an organ of the Federal Department of Environment, Transport, Energy and Communications (DETEC).

Skyguide’s mandate
Skyguide is charged with the organisation and implementation of civil and military air navigation services. Skyguide works in close cooperation with the European authorities responsible for managing traffic flows and is a member of the most important international air traffic control bodies. A highly developed infrastructure of radar, navigation, radio and data processing installations is essential for the efficient performance of its tasks.
One of the most important tasks of air navigation services is the organisation and management of airspace. The whole world is divided into precisely defined geographical flight information regions (FIR).

**Swiss airspace**

Switzerland is such an FIR, whose area approximates the national borders and is divided into two zones. The dividing line between the zones, known as terminal control zones Geneva and Zurich (TCG and TCZ), runs through Le Noiremont, St. Peter’s Island, Bern, Niesen and the Wasenhorn. FIRs reach vertically from the earth’s surface up to 19,500 feet or around 6000 metres. Above that is what is known as the upper flight information region (UIR), reaching up to 66,000 feet or around 22,000 metres, to take account of the flight characteristics of higher-flying machines. In Switzerland, the UIR covers the whole national territory and the delegated foreign airspace. Air traffic in the UIR, which is mainly composed of transit flights, is controlled and directed in Switzerland by the Upper Area Control Center (UAC) Switzerland.
Demands
The airspace is so organised and divided that IFR flights are continuously monitored by the air traffic control service and pilots can call on its services at any time. Because the demands of take-off and landing are very different from cruising flight, airspace is divided into various zones.

Control zone
In the immediate vicinity of the airport is the control zone (CTR), which takes the shape of a prism. It reaches from the earth’s surface up to a defined altitude: in Zurich 1350 metres and in Geneva 1200 metres. Its horizontal spread is dictated by the runway system and the take-off and landing procedures at the airport.

Terminal manoeuvring area
Above this is the slightly wider Terminal Manoeuvring Area (TMA). This covers the space required for take-off and landing manoeuvres and holding patterns. The airways that aircraft follow in flight take the form of direction-separated axes, 10 nautical miles or about 18 kilometres wide that form a network. Aircraft proceed from the TMA of their departure airport to that of their destination along these axes, defined by navigation aids or waypoints which can be precisely over-flown by pilots with the aid of their on-board instrumentation.

Airways
The airways are named in compliance with an internationally applicable system and provide connections right across Europe and the neighbouring regions.

VFR flights, such as hobby, tourist, glider and balloon flights, and part of the military air traffic usually fly outside of the airspace dedicated to IFR flights as their separation is advantageous for reasons of safety and capacity. In Switzerland, the integrated civil and military air navigation services allow dynamic management and most effective use of available airspace.
The air traffic control service is responsible for the safe and smooth flow of traffic through the airspace it controls. It is divided into various service areas defined by the different demands on controlling the individual phases of a flight.

Tower Control, Apron
supervises taxiing, take-offs and landings and controls traffic in the immediate vicinity of the airport.

Approach Control
controls take-offs and landings within a defined area of the control zone. This normally stretches to a distance of around 60 kilometres around the airport.

Terminal Control
ensures the safe and smooth flow of traffic within the airways and in parts of the terminal manoeuvring area. Depending on the density of traffic, the wide horizontal and vertical spread of the area under its control may require its division into different working sectors. This division may be geographic or by altitude area.

Upper Area Control
fulfills the same responsibilities as Terminal Control for upper airspace throughout Switzerland and the delegated airspaces. This area is also divided into different working sectors.

Fighter Control
is delegated by the Air Force to skyguide and is carried out by specially trained tactical controllers in the Air Defence and Direction Center (ADDC). As members of a military fighting unit, the tactical controllers analyse the situation in the air in which the unit is flying and transmit their assessments, backed by military monitoring systems such as FLORAKO, in a constant stream to the crew.
Areas of responsibility and communication

Area control centres
The area of responsibility of each area control centre is precisely defined. In many cases, it may not coincide with national borders. The procedures for the handover of aircraft from one centre to the other are regulated by international bilateral agreements. At least ten minutes before handover, the flight’s current data, including call sign, altitude, type of aircraft, are transmitted along direct data transmission lines.

Planning
The basis for controlling IFR flights is the flight plan, which the pilot must submit before take-off and which contains all the data relating to the planned flight. The flight plan data allow air traffic controllers to plan traffic movements in advance and optimum and intensive collaboration between all the control centres involved in the flight. Thus, every flight, after it leaves the care of the control tower and approach control, is passed from one area control centre to the next until it is taken over by approach control and the control tower at its destination airport.

«Voice»
In all air traffic control centres, the air traffic controllers are in constant radio contact with the pilots. Only the languages recognised by the ICAO may be used. The most commonly used in Europe is the aviation English known as «voice». This is a precisely defined, greatly simplified form of English using internationally valid, clearly understandable traffic terminology.
Separation
Air traffic controllers have various sources of information (such as flight plans and radar displays) at their disposal. These enable them to organise the traffic in their sector so that the aircraft are always kept at a safe distance from each other and a smooth flow of traffic is constantly maintained. Keeping aircraft safely apart is known as «separation». All aircraft maintain a minimum vertical separation of 1000 feet (300 metres) and a minimum lateral separation in all directions of 5 nautical miles (about 9 kilometres).

Flow management
Irregularities or delays occur time and time again in air traffic operations. Even if these are of a local nature, they can have repercussions throughout Europe’s airspace. To keep air traffic moving as smoothly and efficiently as possible, every air navigation service provider will strive to maintain an optimum balance between its capacity and the volumes of flights it handles. Eurocontrol’s Central Flow Management Unit (CFMU) coordinates traffic flows for all European airspace combined.
Air traffic control technology

Every air navigation service provider maintains a technical service that installs, operates, monitors and services the necessary technical systems. These include radar and navigation installations, instrument landing systems, telecommunication networks, radio and data processing equipment.

Radar
At current traffic densities and the speed of commercial aircraft, the smooth flow of air traffic would be impossible without radar. A basic distinction is drawn between primary and secondary radar. Primary radar works on the principle that the impulses transmitted by the radar antenna, as it revolves around its own axis, is reflected by the aircraft and received by the antenna. The distance from antenna to aircraft is calculated on the basis of the time that the impulse took to travel to the reflecting object and back again. The direction of the radar target is determined by the position of the antenna at the time. After processing, radar echoes are displayed on the air traffic controller’s screen. In order to determine the precise geographic position of the aircraft, further information, such as a geographical chart, is also overlaid. In contrast to civil air traffic control, where primary radar is usually only used for approaches, it plays a significant role in the gathering of information for military airspace monitoring and fighter control. Secondary radar provides additional information that the primary system cannot provide. If the pilot of an aircraft enters the code assigned to him in what is known as a transponder, this sends the appropriate code back to the radar antenna whenever requested. The code is used to display flight number, altitude and speed on the air traffic controller’s radar screen. Since 2007, skyguide has been steadily introducing Mode S, the new format for data coding. This technology constitutes a major progress in terms of data exchange between aircraft and ground stations.
Radio navigation aids
Radio navigation aids serve, so to say, as the signposts of the air and allows IFR pilots to follow the right course whatever the weather conditions. The three most important navigation aids are VOR, DME and ILS.

VHF Omni-Directional Range (VOR)
A VOR installation is an ultra-short wave navigation aid, mainly used in airways and in the vicinity of an airport. Equipment on board determines the course to or from the VOR.

Distance Measuring Equipment (DME)
DME displays to the pilot the distance to a certain landmark such as the landing point on the runway or to a navigation transmitter.

Instrument Landing System (ILS)
Instrument landing systems allow safe landings even in bad visibility. An ILS comprises a landing course transmitter, the localizer, a glide-path transmitter and a DME. During the final stages of approach, from about 15 kilometres, a crosshair display instrument provides IFR pilots with precise data on the aircraft’s position in relation to the ideal approach axis, the optimum glide-path and the distance to the threshold of the runway.
While radio and navigation equipment show a certain independence from the other systems, in the field of the recording, processing, distribution and display of data, all systems are networked together, internationally as well as nationally. The following sub-systems are of vital importance:

**Radar data processing**
This brings together the position reports from several radar installations and calculates an optimised overall picture of the current situation in the air.

**Flight data processing**
It processes and distributes the data for each flight in relation to the planned flight path, flying time and so on, and, in conjunction with the actual radar data, allows any variations from the plan to be identified and corrective measures taken.

**Environmental data processing**
This covers the processing of all static data, such as coordinates, airways and procedures and all dynamic data, such as the weather, runway conditions and airspace clearances. Although the processing and display of all relevant data has been accomplished technically, fully automated air traffic control is not yet within the realms of the possible. Air traffic controllers use the technical systems available to them, but they are individually responsible for the safe course of a flight and cannot be replaced by any technology yet available.

**Aeronautical telecommunications**
The aeronautical telecommunications service has the task of exchanging data on a flight between all the control centres along a flight path and to communicate information and reports related to air travel safety and the orderly, efficient and economic operation of air traffic quickly, completely and reliably. The service encompasses a worldwide telecommunications network, point-to-point telephone connections, digital data transfer networks and the like. The aviation is served by several telex networks. One of these, the «Aeronautical Fixed Telecommunication Network» (AFTN) is specifically tailored to the needs of air traffic control. This is a worldwide system of fixed telecommunication links over which flight data can be exchanged between air navigation service centres.
Aeronautical Information Management (AIM)

The aeronautical information management service gathers and processes all reports that are significant for the safety, orderliness and operation of air travel. It also gathers information precisely tailored to the flight to be flown. This serves:

– pilots for the planning of their flights
– briefing the crew during their preparations for the flight
– the different air traffic control centres in the fulfillment of their many-sided information tasks.

Each country maintains an aeronautical information management service that gathers, edits and distributes nationally and internationally all reports from its own sovereign airspace. These reports concern the installation, operational status and modifications of aeronautical equipment, services available, procedures and risks, whose timely knowledge is important for the crew and air traffic controllers. During the winter months, when there is snowfall or the risk of icing, runway status reports are also issued for all major airports. Each country also publishes an aeronautical information publication (AIP) that contains all the information of permanent or longer-term application and mandatory regulations and procedures. The Swiss AIP is published by skyguide on behalf of the Federal Office for Civil Aviation.
Skyguide has integrated civil and military air navigation services and thus brought the plans for a unified Swiss airspace – a large step forward. The European Commission is also striving to manage airspace more flexibly. In the near future, the so-called Single European Sky should help to prevent bottlenecks in the airways and avoid delays. Reduced fuel consumption will relieve the environment and cut costs enormously, to the good of the airlines and, therefore, their passengers. Skyguide is working in the vanguard of this programme.

If you want to know more about the very varied activities of skyguide or the profession of air traffic controller, you can visit our website under www.skyguide.ch.
## Acronyms and technical terms

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<th>Acronym</th>
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<tr>
<td>ACC</td>
<td>Area Control Center</td>
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<td>ADDC</td>
<td>Air Defence and Direction Center for the surveillance of military missions</td>
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<td>AIM</td>
<td>Aeronautical Information Management, Service handling aviation information flow</td>
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<tr>
<td>AIP</td>
<td>Aeronautical Information Publication, Basic manual for pilots, air traffic controllers, airlines, airports, etc.</td>
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<td>Apron Control</td>
<td>Coordination of the traffic on the tarmac (parking strips and taxiways)</td>
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<td>Approach Control</td>
<td>Service which directs flights at and departing from an airport</td>
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<td>CFMU</td>
<td>Central Flow Management Unit, Eurocontrol’s unit for regulating traffic flow in European airspace</td>
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<td>CTR</td>
<td>Control Zone, Control area at immediate proximity of an airport</td>
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<td>DETEC</td>
<td>Federal Department for Environment, Transport, Energy and Communication</td>
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<td>DME</td>
<td>Distance Measuring Equipment, Navigational aid</td>
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<td>Eurocontrol</td>
<td>European Organisation for the Safety of Air Navigation</td>
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<td>FIC</td>
<td>Flight Information Center which provides pilots with information on air safety</td>
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<td>Fighter Control</td>
<td>Tactical control (see ADDC)</td>
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<td>FIR</td>
<td>Flight Information Region</td>
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<tr>
<td>FOCA</td>
<td>Federal Office of Civil Aviation, Official Swiss aviation monitoring authority and skyguide’s regulator</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organisation</td>
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<td>ILS</td>
<td>Instrument Landing System, consisting of a localizer and a glide path</td>
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<td>NM</td>
<td>Nautical Mile (approx 1.8 km)</td>
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<td>Terminal Control</td>
<td>Control centre for the lower airspace</td>
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<td>TMA</td>
<td>Terminal Manoeuvring Area, Area of controlled airspace around an airport</td>
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<td>UAC</td>
<td>Upper Area Control Center, Control centre for the upper airspace</td>
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<td>UIR</td>
<td>Upper Information Region</td>
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<td>UIR</td>
<td>Upper Flight Information Region</td>
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<td>VFR</td>
<td>Visual Flight Rules</td>
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<td>Voice</td>
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