

# Safe Solutions for Aviation Weather Observation

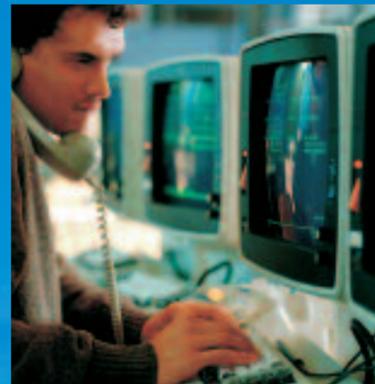


# The World's Most Trusted Provider of Aviation Weather Observation Solutions

Vaisala is the world's most trusted provider of sensors, instruments, systems and consulting services for measuring the weather in the airport environment. Our track record covers dozens of successfully completed projects all over the world, and decades of accumulated experience.

## Knowing how to assemble the right solution

Every airport building project is an evolving case with unique regulatory and economic constraints and opportunities. Through long experience, Vaisala has developed an ability to match the performance strengths of our offering to the customer's unique composition of weather observation requirements. Vaisala solutions are always designed to fulfill ICAO requirements and follow WMO recommendations.



## One strength is the product portfolio

One of the strengths of Vaisala's offering lies in the breadth of our solution portfolio. It covers every weather parameter that has a bearing on passenger safety within the economic context of increasing aircraft spacing requirements.

The heart of our offering for aviation weather observation is the Vaisala MIDAS IV Automated Weather Observing System (AWOS), the standard by which many airport authorities set their specifications for weather observation. When a customer purchases a MIDAS IV AWOS, it is always with the assurance that the system can be upgraded economically.

## The sensors and systems: our greatest strength

In the pages that follow, we invite you to isolate and analyze any part of our solution portfolio. By doing so, we believe you will come to appreciate the greatest strength of Vaisala's offering for aviation: the perfect compatibility between our sensors and AWOS solutions. Worldwide, meteorologists who value data accuracy and availability above all else specify Vaisala meteorological sensors and systems when they acquire a new system or upgrade an old one.

## In this brochure:

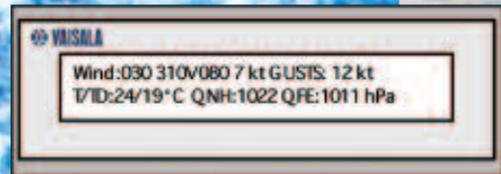
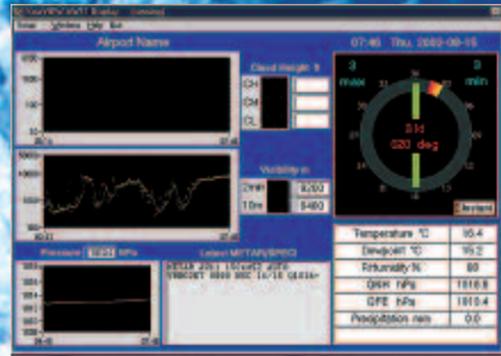
Automated weather observing systems

Aviation weather observation sensors

Protection against severe weather hazards

Improving winter maintenance

# Weather Observation for Regional Aviation Facilities



## Vaisala wind systems

Vaisala's wind measurement systems comprise opto-mechanical and opto-electronic anemometers and wind vanes, combined wind speed and direction sensors, an ultrasonic wind sensor with no moving parts, and digital displays that are specially designed for aviation applications.

### Vaisala Aviation Barometer PA50

The PA50 is a small, dedicated system that provides accurate barometric data. It consists of a digital barometer, a humidity and temperature probe and a digital display. The PA50 provides temperature, humidity and dewpoint information and QNH, QFE, QFF values and transition levels.



## Mid-sized Vaisala MIDAS IV AWOS

Vaisala can deliver a mid-sized MIDAS IV AWOS to airport authorities requiring an economically priced AWOS that can easily be expanded in future. To begin with, the solution can cover the basic set of aviation weather parameters – wind, temperature, humidity and air pressure – with METAR coding and report distribution via AFTN. Later it can be upgraded to measure rain, present weather, visibility and cloud height economically in step with the airport's weather observation requirements.

### Vaisala Aviation Weather Reporter AW11

The fully automatic AW11 is a stand-alone weather observation and reporting system for small airports, heliports and unmanned airstrips. Easy to install, configure and maintain, the AW11 measures all standard aviation weather parameters, processes the meteorological data, and presents it in weather reports that clearly and concisely describe the prevailing weather conditions at the aviation site.

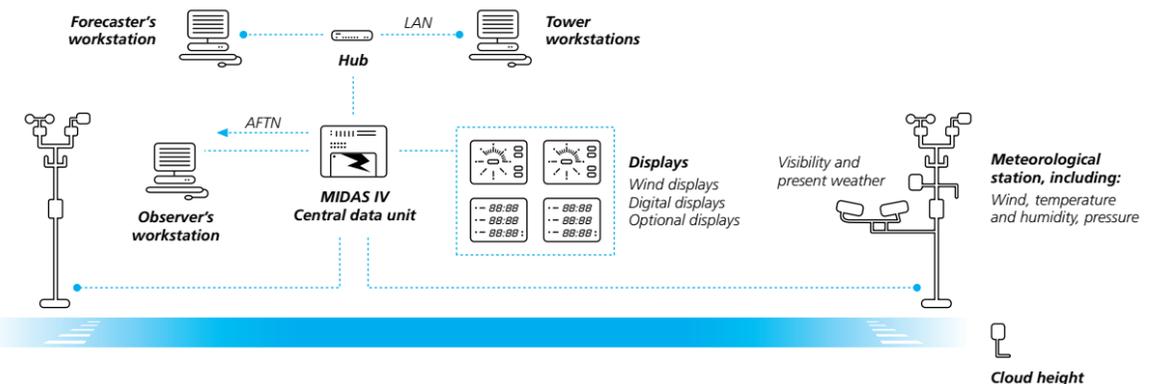
The weather information is converted into spoken messages that pilots listen to over VHF radio in the cockpit and/or land-line telephone prior to takeoff. ATC personnel can also record NOTAMs and other messages, appending them to the weather report that is distributed to pilots.



## Copterline, Helsinki, Finland

Copterline Oy, founded in 1990, is Finland's largest private helicopter fleet operator with 11 helicopters and 70 employees. In the year 2000, Copterline purchased two Vaisala Aviation Weather Reporter AW11s to gain an added safety dimension that has helped the company to reach its growth objectives. Copterline earns its revenues from regularly scheduled business flights between Helsinki and Tallinn, Estonia, heli-ambulance chartering, flight training and helicopter maintenance.

An example of a mid-sized Vaisala MIDAS IV AWOS.



# Weather Observation for National and International Airports



## Gardermoen International Airport, Oslo, Norway

Air travel in Norway was vastly improved when Gardermoen International Airport opened in 1998. With a Vaisala MIDAS IV AWOS fulfilling stringent requirements for weather observation, Gardermoen's two runways could handle 80 flights an hour including 747 jumbo jets. Gardermoen's MIDAS IV AWOS has since been upgraded to ensure compliance with ICAO standards. Among other things, the duplicated servers have been upgraded from Windows NT® to Windows® 2000. The AWOS upgrade went smoothly and did not require changing the workstation operating systems.

## Expandable in every dimension

If the decision is made to build another runway in the future, the MIDAS IV AWOS can be expanded in every dimension: the number and type of sensors, the sensor measurement range, the number of report types produced, and the number of centralized information processing units and workstations.

## Pudong International Airport Shanghai, People's Republic of China

Administered by the Shanghai Airport Authority, Pudong International Airport opened in 1999 to be a modern port of call for an ever-growing number of international and domestic flights. A Vaisala MIDAS IV AWOS was delivered in the year 2000 to fulfill the new airport's demanding weather observation requirements. The first priority of installation was integration of the existing sensors and displays. However, traffic is expected to increase significantly at Pudong. The MIDAS IV AWOS architecture will allow the Shanghai Airport Authority to economically expand its weather observation capability as part of any future expansions.

## Vaisala MIDAS IV workstations and software

MIDAS IV allows several screens of data to be displayed on one workstation for various purposes. The system makes full use of Windows NT®, Windows® XP/2000 security features and offers different security levels to protect the weather data and coded weather messages against accidental editing. There is no practical limit to the number of workstations allowed, but the four workstation types are: Observer, Forecaster, Weather View and Remote Control and Maintenance.

## Observer & Forecaster

The Observer workstation displays the real-time weather data and the values derived therefrom, and allows the meteorological observer to manually edit the data to be viewed and used in the meteorological calculations. Additional values, such as cloud amount, can be entered manually to complement the automatic observations. An observer with sufficient privileges can edit the METAR, MET REPORT and SYNOP messages before they are disseminated throughout the airport.

The Observer and Forecaster applications can be consolidated in one workstation, or kept separate in two workstations. The Forecaster application is used to input the trend information for METAR and METREP messages and edit TAF and SIGMET messages.

## Weather View

The Weather View workstation is installed in places where airport personnel need to view weather data in real-time such as ATC facilities, weather offices and meteorological briefing rooms.

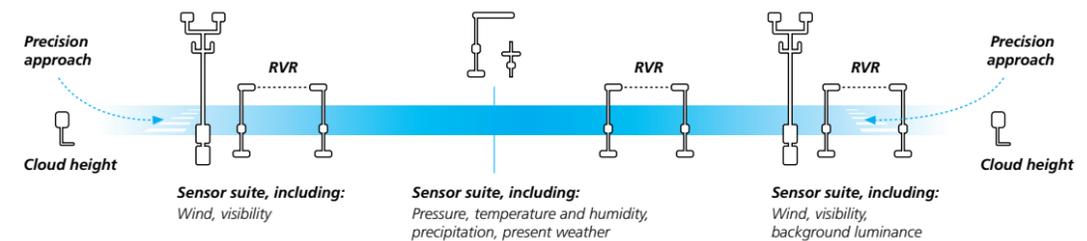
## Remote Control & Maintenance

The MIDAS IV central data unit (CDU) stores log files for each system event tracked by the self-diagnostic and validation processes, and issues an alarm if a problem occurs. The Remote Control and Maintenance workstation presents the log files to technical personnel in plain language, and allows them to acknowledge alarm conditions so they can be acted upon before problems arise.

## Calculating RVR

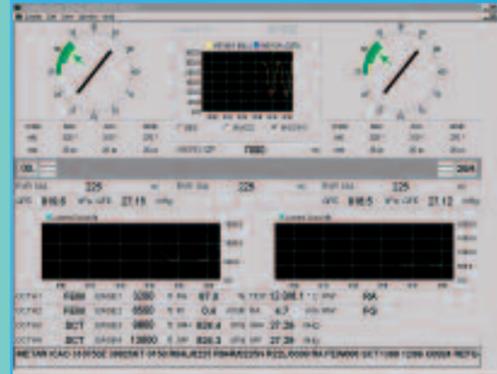
MIDAS IV calculates Runway Visual Range (RVR) from three variables: visibility (transmittance, extinction coefficient, meteorological optical range), background luminance and runway light intensity. Vaisala offers a field-proven transmissometer, a forward-scatter visibility sensor and a present weather sensor as complementary technologies for this critical application.

An example of a one-runway Vaisala MIDAS IV AWOS CATII system.



**Athens International Airport, Greece**

The Athens 2004 Olympic Games are fast approaching. Athens International Airport, Eleftherios Venizelos, will handle the arrivals and departures of Olympic visitors with a Vaisala MIDAS IV AWOS performing as a cornerstone of passenger safety. Installed in the year 2000, Athens' MIDAS IV utilizes fiber optic data communication links to the sensor sites, LAN-based time synchronization and includes a runway lighting interface. It supplies meteorological data to an information display system and to integrated data displays in the ATC, giving air traffic controllers a window into current weather conditions. The MIDAS IV software runs on Windows NT® and the servers are duplicated to ensure that data distribution is not interrupted. Workstations are also provided for weather observers/forecasters and maintenance personnel.



**Ensuring an Uninterrupted Flow of Weather Data**

Since the requirement for weather data availability rises in step with traffic volume at large airports, the Vaisala MIDAS IV hardware and software system architecture allows all mission-critical components to be duplicated.

Redundancy is ensured by various means: critical computing components can be duplicated (hard disks, power supplies, network adapters, etc.), and the computers themselves can be duplicated using automatic switch-over units.

The Vaisala MIDAS IV workstation roles (Observer, Forecaster, Weather View, Maintenance) can be interchanged in case of equipment failure. A Weather View workstation, for example, can be switched to Observer workstation functionality at the press of a button.

**Ensuring data availability with redundant sensors**

Every airport experiences unique weather according to its geographical location, microclimate and the changing seasons. A MIDAS IV sensor suite can be customized for your airport to meet ICAO requirements and measure any particularly problematic weather parameters with redundant sensors.

**MIDAS IV development philosophy: true modularity**

Modularity is a fundamental principle of Vaisala MIDAS IV AWOS design. If the category of your airport is to be upgraded or a new runway is to be built, you can easily upgrade your current MIDAS IV RVR system or MIDAS IV AWOS with

new sensors, workstations and software. Certain upgrades are safely carried out even while the system is running. Customizing a sensor set-up is usually a matter of setting up the sensor configuration and airport-specific parameters.

**Open software and system architecture**

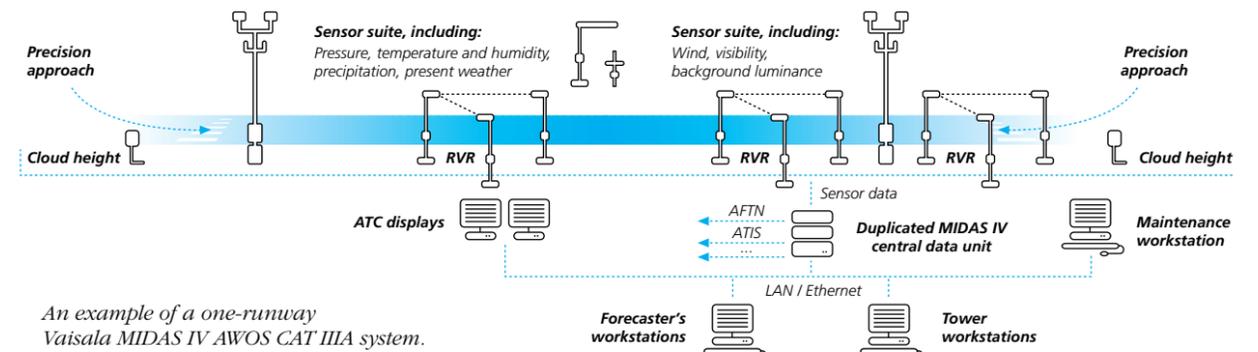
Ensuring smooth system integration is another fundamental principle of Vaisala MIDAS IV software development. The open system architecture simplifies the integration of meteorological data into ATC systems, other meteorological systems and airport-wide service and maintenance systems.

MIDAS IV servers run on Windows NT® and Windows® 2000, the workstations on Windows NT® and Windows® XP. Commercial off-the-shelf computers and network components are used wherever possible. TCP/IP is used as the communication protocol, and an Ethernet Local Area Network ties all the computers together.

**Ensuring data accuracy and consistency**

Ensuring data accuracy and consistency is yet another fundamental principle of MIDAS IV development. Every MIDAS IV system employs validation algorithms that are reassessed when ICAO issues new measurement regulations.

Cross-checking rules ensure that the data read from the sensors is valid for further processing and dissemination. Powerful internal diagnostics analyze the data as well as the well-being of the MIDAS IV system itself and the hardware that runs it.



An example of a one-runway Vaisala MIDAS IV AWOS CAT IIIA system.



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#### Solutions for RVR assessment

Runway Visual Range (RVR) is the single most important parameter affecting safety in aviation. Vaisala provides both transmissometer and forward scatter solutions for RVR assessment at airports of every size and category.

#### Vaisala MITRAS Transmissometer

The Vaisala MITRAS Transmissometer has stood the test of time in the field: it is the world's most popular transmissometer for RVR and Meteorological Optical Range (MOR) measurement. It provides an uninterrupted flow of highly accurate visibility data, and conforms to all ICAO requirements and WMO recommendations for RVR and MOR measurement. The standard MITRAS configuration consists of a light transmitter and receiver installed at a suitable distance from each other. A single baseline MITRAS can be easily and economically upgraded to a double baseline system when a greater measurement range is needed for CAT IIIB applications.

#### Technologies for RVR applications

When comparing forward-scatter and transmissometer technologies for RVR applications, the characteristics of your runway configuration and local weather conditions should be taken into account. Whichever route you decide to take, with the MITRAS Transmissometer and FS11 Visibility Sensor Vaisala offers the world's most accurate sensors for RVR measurement.

## Measuring Visibility, Cloud Height and Wind

#### Vaisala Visibility Sensor FS11

The FS11 is our latest forward-scatter visibility sensor for RVR applications. With a range of 5 m – 75 km, it meets FAA and ICAO specifications for visibility measurement and can also be used for aeronautical and SYNOP visibility measurement.

The FS11 incorporates a new technique that measures and compensates for the attenuation effect of window contamination, and a number of special design features which ensure reliable operation in the harshest weather.

#### Vaisala Laser Ceilometer CT25K

With over 1,400 installed worldwide, the fully automatic CT25K is the world's de-facto standard for measuring cloud height and vertical visibility. It employs pulsed diode laser Light Detection and Ranging (LIDAR) technology to detect clouds, precipitation and other obstructions to vision, and can be used stand-alone or as an integrated AWOS sensor.

The CT25K's unique, single-lens design ensures excellent performance at low altitudes – a critical safety factor in aviation. Starting at a height of virtually 0, the CT25K measures cloud height (or vertical visibility if the cloud base is obscured) with unmatched accuracy. The single-lens design also ensures reliable measurement in all weather including fog, rain, snow and haze without field adjustments.



#### Vaisala Ultrasonic Wind Sensor WS425

The Vaisala WS425 Ultrasonic Wind Sensor is a valuable alternative for aviation authorities with a special need for virtually maintenance-free wind measurement. The WS425 eliminates the need for on-demand and periodic maintenance and offers excellent wind measurement accuracy in all wind conditions and climates.



#### Vaisala Weather Sensor FD12P

The FD12P will interest aviation authorities that are exploring automated weather observation. As part of a fully automatic or semi-automatic weather station, the FD12P offers accurate MOR visibility measurement and versatile present weather codes for METAR messages. It can detect over 50 different types of weather, and can be used as a visibility sensor in a Vaisala RVR system.



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# Lightning Detection for Nowcasting and Early Thunderstorm Warning

Thunderstorms are a major hazard to aviation. Their intense convective activity can generate lightning, updrafts of up to 200 km per hour and high concentrations of hydrometeors, particularly ice and supercooled droplets. En-route traffic is vulnerable to cloud lightning activity, intense turbulence, hail and icing. Airport and terminal operations are vulnerable to gust fronts, wind shears, microbursts, cloud-to-ground lightning, hail and heavy rainfall. Lightning is a major hazard and a leading indicator of these dangerous conditions. When up-to-the-minute lightning data is placed at the disposal of air traffic controllers and operations managers, they can identify convective cells quickly and judge their severity accurately.

### Vaisala SAFIR Total Lightning Localization and Thunderstorm Forecasting System

Air traffic controllers use the Vaisala SAFIR Total Lightning Localization and Thunderstorm Forecasting System for early thunderstorm detection and nowcasting. The SAFIR system is built around Vaisala SAFIR 3000 lightning detection stations that track the internal electrical activity of thunderstorms. The SAFIR 3000 uses the very high frequency (VHF) interferometric localization technique for lightning localization and characterization.

VHF interferometry offers excellent localization accuracy, especially for cloud lightning. Detection efficiency is better than 90% for cloud and cloud-to-ground lightning. SAFIR continuously displays the current position of storm cells on user workstations; their forecasted positions are continuously displayed at 10-minute intervals.



### Vaisala IMPACT Lightning Information System

The Vaisala IMPACT Lightning Information System locates cloud-to-ground lightning with great accuracy using Vaisala IMPACT ESP™ lightning sensors, which bring together the proven accuracy of magnetic direction-finding and time-of-arrival technology. IMPACT ESP detects lightning using electric and magnetic field sensing at low frequency for wide-area, cloud-to-ground lightning tracking. Cloud-to-ground detection efficiency exceeds 90% with a median lightning location accuracy of 500 meters or better.



### Lightning information on ATC displays

SAFIR or IMPACT lightning information can be superimposed on ATC displays to optimize its availability and visibility for operational decision making. SAFIR and IMPACT lightning data can also be displayed independently using Vaisala lightning tracking software.

### Protect ground personnel and equipment

The Vaisala Precision Lightning Warning System (PLWS) is used by major airports to communicate objective lightning warnings, alarms and all-clears to ramp operators and fueling/maintenance personnel. The Vaisala PLWS combines lightning data from IMPACT ESP and EFM II sensors to detect lightning activity as it approaches and develops in the airport environment. It provides sufficient advance warning to protect valuable equipment from lightning strikes. Regional and community airports rely on the Vaisala Lightning Sensor TSS 928 to detect lightning within a 56 km radius and Vaisala ALARM software to automate alarms, warnings, all-clears and switches.

Handle the striking force of nature



**Austro Control GmbH, Austria**  
 Air traffic control personnel at Austro Control GmbH employ a network of Vaisala LAP®-3000 wind profilers at three airports – Vienna, Salzburg, and Innsbruck – to monitor winds in the take-off and approach corridors. Austro Control has developed a proprietary graphical display that identifies zones of potential adverse wind shear, and alerts controllers so they can warn pilots flying aircraft in these zones. This network of wind profilers was built in 1997 and there are plans to expand to other airports.

*Low level windshear is the rapid change of wind speed or direction over a short distance. If an aircraft unexpectedly encounters low level windshear on its landing approach, a sudden loss in headwind may result, leading to a loss of lift and possible stalling. Preventing such a loss of lift can make all the difference in preventing the loss of lives.*

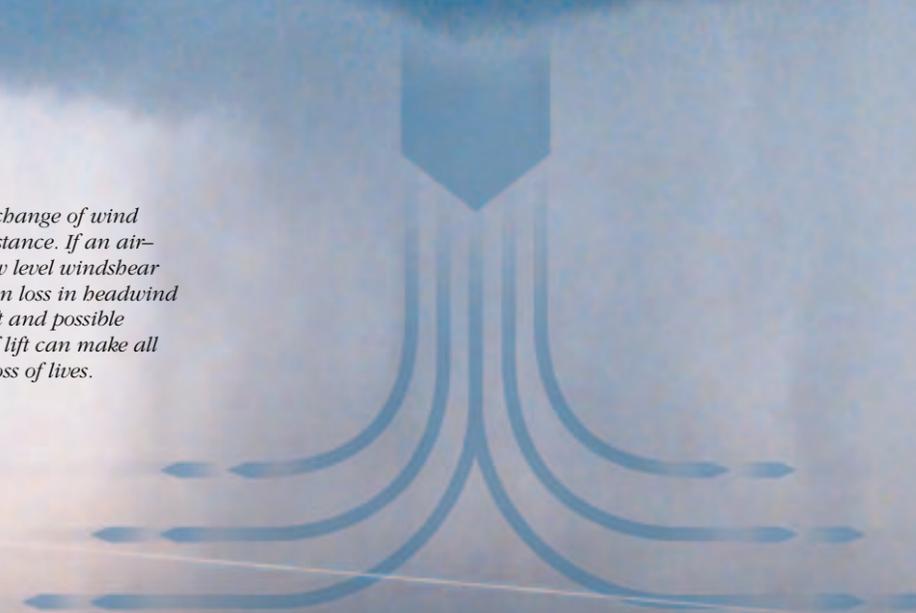


Illustration based on weather photo courtesy of Michael Babo and Jimmy Daguana www.AustralianSevereWeather.com

## Handle the Hazard of Wind Shear

Studies and experience have shown that moderate-to-strong vertical wind shear and low level, horizontal wind shear events are hazardous to aircraft during take-off and final approach. With a better understanding of the vertical and horizontal structure of wind, the airport authority gains a critical extra margin of safety and can increase the efficiency of its operations.

### Vaisala LAP®-3000 Lower Atmosphere Profiler

The Vaisala LAP®-3000 Lower Atmosphere Profiler is a clear-air remote sensing Doppler radar, developed in partnership with the U.S. National Oceanic and Atmospheric Administration (NOAA).

The LAP®-3000 produces a profile of the vertical and horizontal wind speed and direction in clear air that extends up to 3 km or more above ground level depending upon atmospheric conditions. With vertical wind profiles at their disposal, ATC personnel can warn pilots when their aircraft are susceptible to moderate-to-strong vertical wind shear events during take-off and final approach.

The LAP®-3000 incorporates new digital IF (intermediate frequency) technology that reduces the effects of interference and ground clutter. The atmospheric signal is selected automatically with great accuracy.

### Vaisala LAP-XM® software suite

The LAP®-3000 is controlled by the Vaisala LAP-XM® software suite. LAP-XM® allows the aviation authority to optimize the wind profiler's performance according to the installation site. The variable temporal and vertical range resolution can be adjusted to suit the airport's physical characteristics. The operator can select the signal processing parameters, quality control features and data formats.

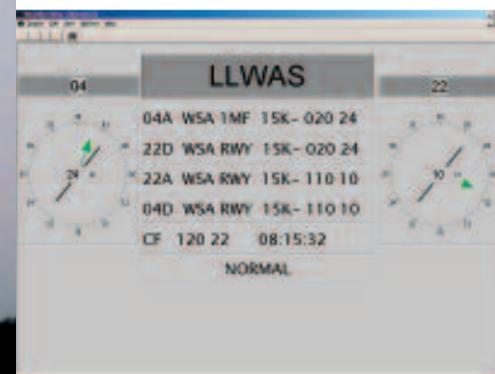
### Vaisala MIDAS IV LLWAS

The Vaisala MIDAS IV Low Level Windshear Alert System (LLWAS) is a ground-based system that detects low level, horizontal wind shear and microburst events in the runway corridors. The system gives ATC personnel the advance warning they need to tell incoming pilots to take precautionary measures. At airports that regularly experience low level wind shear, the MIDAS IV LLWAS can be fundamental to improving basic safety.

### Wind shear algorithm

The Vaisala MIDAS IV LLWAS incorporates the latest version of the phase III wind shear algorithm developed for the U.S. Federal Aviation Administration (FAA) and patented by the University Corporation for Atmospheric Research Foundation (UCAR).

The MIDAS IV LLWAS retrieves constantly updated wind data from an array of wind sensors, sited for optimum runway coverage. Using the wind shear algorithm, the system detects low level wind shear and microbursts as they occur, and generates alerts and warnings that are conveyed unambiguously to ATC personnel on numerical and graphical computer displays.



*For each touchdown zone, the Vaisala MIDAS IV LLWAS alert screen displays the threshold wind shear alerts and wind speed/direction. It also displays the center field wind speed/direction and the LLWAS system status.*



#### Copenhagen Airport, Denmark

In the International Air Transport Association's (IATA) 2002 annual survey of passengers, Copenhagen's Kastrup international airport was voted the world's best. Kastrup handles some 18 million passengers annually, with 350 daily departures. In 1999 Kastrup installed a Vaisala IceCast Ice Warning and Prediction System after a successful trial. Since then, the system has been expanded a number of times. The hardware now comprises 9 "master" runway weather stations, 12 "slave" runway weather stations, 28 road/runway sensors and 2 FD12P Weather Sensors. Running on Windows NT®, the software includes the NowCast Controller, Forecast Controller, IceAlarm, IceView and IceCast Server modules.

## Runway Ice Detection and Prediction

When ice forms on runways, ice-clearing activities can cause costly delays. It can take up to four times more de-icer to remove ice once it has formed than it takes to prevent ice from forming in the first place.

When time is money, the Vaisala IceCast Ice Warning and Prediction System gives the critical runway information in a glance so better maintenance decisions can be made. When anti-icing chemicals (e.g. Clearway, Safeway) are applied to runways and taxiways at correctly anticipated times, safety is ensured, operating costs are reduced, and the airport stays open.

#### Airport-wide forecasting of pavement surface temperature

There is virtually no limit to the number of possible IceCast configurations, but a typical system will comprise Vaisala ROSA Road Weather Stations and the Vaisala IceCast Ice Warning and Prediction System. This configuration brings together runway/taxiway surface measurements and meteorological information to deliver early warning of hazardous surface conditions.

IceCast collects and processes pavement and atmospheric data and displays it with the IceView software.

Finally, the optional Vaisala NowCasting and 24-hour Forecasting software modules give the advance warning needed to ensure that runways and taxiways are treated well before problems reach the surface.

#### Thermal Mapping

The Vaisala Thermal Mapping service, a method of quantifying temperature differences across a runway network, locates ROSA weather stations and pavement sensors in the optimum locations. It also provides a solid foundation for airport-wide nowcasting of pavement surface temperature with the Vaisala IceCast Ice Warning and Prediction System.

#### Accurate measurement of runway surface conditions

Vaisala's solution for runway ice detection and prediction begins with our patented Road/Runway Sensor DRS511, which provides accurate measurement of runway surface temperature, surface state and the effectiveness of anti-icing materials (depression of freezing point).

When connected to a Vaisala ROSA weather station, the Vaisala Road/Runway Sensor DRS511 reports the presence of ice (including black ice), measures surface and ground temperature, calculates the quantity of de-icing chemical and depression of freezing point, and directly measures water layer thickness with patented optical fiber technology. The direct measurement of water layer thickness is the key to accurately calculating the concentration of de-icing chemical, and also the key to correctly determining surface state (dry vs. wet vs. icy vs. frosty vs. snowy etc.).

## We Finish What We Start

Good past performance is the only assurance that a company will perform well in the future. Take Vaisala's track record of completed aviation weather observation projects. Hold it up to the light. You will see clear evidence of Vaisala's ability to deliver a solution that fulfills ICAO requirements, follows WMO recommendations and meets your unique needs. Tell us what you need. Let the process begin by which you will receive the safest possible aviation weather observation solution – in terms of both passenger safety and the efficiency of your operations.

### Turn-key project management

Vaisala can oversee every aspect of aviation weather observation at your airport – from construction planning to sensor installation to telecommunications and IT networking, to software integration and the training of ATC and runway maintenance personnel.

### On-site consulting

At an early phase of your airport building project, call upon a Vaisala engineering team to provide an expert assessment of the unique wind and visibility patterns associated with your airport's microclimate. For example, a runway sensor siting plan can swiftly be drawn up for runway visual range (RVR) assessment within the framework of ICAO regulations and the latest WMO recommendations. If horizontal wind shear is a hazard, Vaisala wind experts can draw up a siting plan for runway wind sensors as the first step to delivery of a Vaisala MIDAS IV LLWAS solution.

### Theoretical and hands-on training

As your aviation weather observation solution is installed and tested, Vaisala provides a customized training program that covers theory and practice. The goal is to ensure a smooth hand-over to your personnel at the conclusion of the final site acceptance test. Vaisala aviation weather experts conduct the training at our aviation weather training facility in Helsinki, Finland, and on-site with the actual hardware and software.

### Global reach, local presence

The installed base of Vaisala automated weather observing systems (AWOSs) spans the five continents of the globe. Vaisala will support your aviation weather observation solution and sensors in every respect, either directly or through local organizations certified by Vaisala.

### Maintenance and spare parts

An annual maintenance contract can be drawn up on the basis of your aviation weather observation solution, special requirements and maintenance budget. The contract can include a special provision for the supply of mission-critical components and helpdesk service ranging from technical support over e-mail to 24-hour dedicated technical support for defined periods.

### Certified quality management

Vaisala's manufacturing, assembly and delivery processes are controlled with an ISO 9001-certified quality management system. At our Helsinki corporate headquarters Vaisala's environmental management system is ISO 14001-certified.

### About Vaisala

*Vaisala sensors, instruments and systems are used the world over by organizations that need to measure the environment with great accuracy and consistency.*

*The Vaisala Group is a successful international technology company that develops and manufactures electronic measurement systems and equipment for meteorology, the environmental sciences, traffic safety and industry.*

*Vaisala employed over 1,100 skilled professionals and achieved net sales of EUR 183.5 million in 2001. Exports accounted for 96% of net sales. Vaisala's A-series shares are listed on the Helsinki Exchanges.*



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