Aeronautical & General Instruments Limited
Fleets Point | Willis Way | Poole | Dorset | BH15 3SS | UK
T +44(0) 1202 685661 F +44(0) 1202 685670 E sales@agiltd.co.uk W agiltd.co.uk

AGIVIS CAT III FSM
Forward Scatter IRVR System
Technical Description

Introduction

Runway Visual Range (RVR) is defined by the International Civil Aviation Organisation (ICAO) as:

"The distance over which the pilot of an aircraft on the centreline of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line."

Because it is not possible to measure RVR directly, an *assessment* is made, either by a human observer or using an automated system to provide what is called Instrumented Runway Visual Range, (IRVR). The reliable and accurate assessment of RVR is essential if airport operations are to run as safely and efficiently as possible.

IRVR systems are seen as an improvement over human observations due to the elimination of possible human error and because of lower operating costs. IRVR readings are also available 24 hours a day. The first generation of Aeronautical & General instruments (AGI) IRVR systems were developed in co-operation with the UK Met Office and Civil Aviation Authority (CAA); AGI have supplied IRVR systems to UK and international airports for over 25 years.

AGIVIS CAT III Forward Scatter Meter (FSM) is AGI's second generation forward scatter based IRVR system. It complies with all relevant CAA, ICAO and World Meteorological Organisation (WMO) standards and regulations and is suitable for any airport up to and including CAT III. The AGIVIS CAT III FSM is the first forward scatter based system to be approved for CAT III use by the UK CAA and has been in service at Manchester Airport for over a year and approaching one year at Newcastle International. The system includes full engineering diagnostics and control, and features extremely robust self-test and monitoring functions. It offers an excellent IRVR solution with relatively low capital costs and minimal running costs. The system can also supply present weather, as well as IRVR, data.

Systems can be supplied fully installed with comprehensive engineering and operator training, and post-installation support is available worldwide.

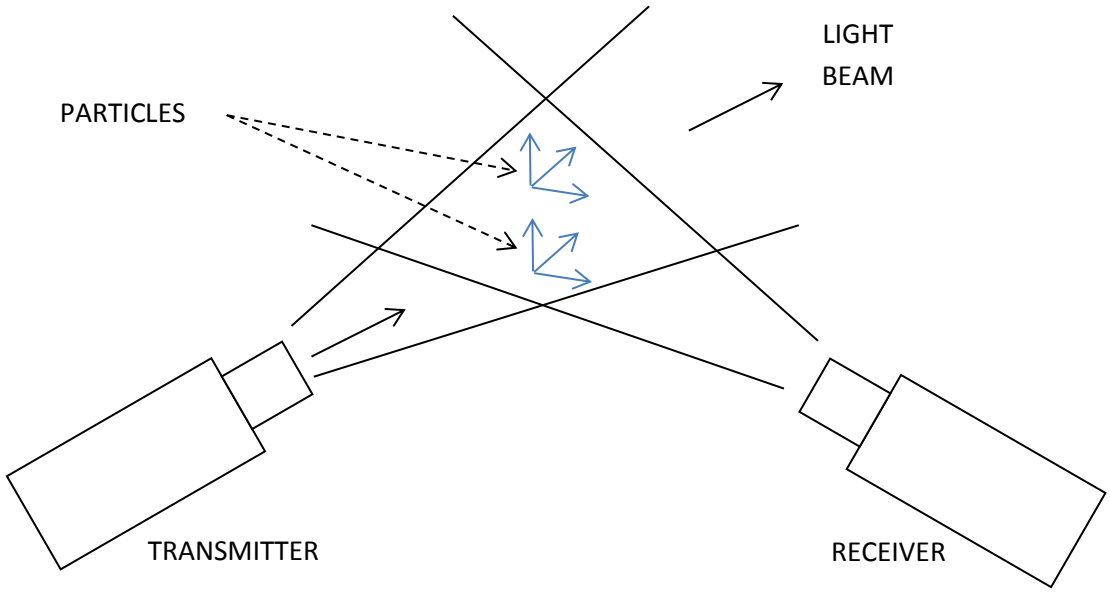
Runway Approach Lights at Dusk

Principle of Operation

The most important factor in assessing RVR is to establish the atmospheric extinction coefficient or the related value for atmospheric transmittance. The extinction coefficient represents the attenuation of light passing through air due to two effects:

- The scattering of light by airborne particles
- The absorption of light by airborne particles

Forward scatter based IRVR systems can detect extinction due to the scattering of light caused by both suspended (solid) and precipitating (water) particles. The amount of scattering is related to the quantity of particles in the volume of air being sampled.



Principle of Forward Scatter Sensor

Scattering is the dominant effect in fog and snow, whilst absorption plays a larger role for haze, dust and smoke. Transmissometers directly measure the attenuation due to both scattering and absorption. Forward scatter sensors cannot measure absorption directly; however there is a proportional relationship between the amount of absorption and the amount of scattering for different types of precipitation. Forward scatter sensors that also incorporate present weather sensing can thus add in the absorption factor when appropriate.

The AGIVIS CAT III FSM system uses Biral VPF series forward scatter sensors. These operate in the near infra-red and use intelligent sensing so that results are not affected by other nearby light sources. This range of sensors also offers the option of present weather sensing (based on back scatter techniques), which then factor in the absorption effect, as explained above. Such sensors output a 'transmissometer-equivalent extinction coefficient'.

To ensure repeatability of measurements between individual instruments, the ICAO specifies that the calibration of forward scatter sensors must be traceable and verifiable to a transmissometer comparison. This is true for the Biral sensors used for AGIVIS FSM.

Biral VPF-730 Sensor Head

Product Brochure can be found at: http://www.biral.com/wp-content/uploads/2014/09/DS-730-DOC101255.02A.pdf

Every 60 seconds the system determines a value for extinction coefficient and uses it to perform calculations according to two different equations:

- **Koschmieder's Law** is a method of assessing visibility based upon the relative luminance of a black body against the luminance of the background it is viewed against. It is principally used to assess IRVR in daylight. When calculated from the extinction coefficient using World Meteorological office (WMO) assumptions the result is known as the Meteorological Optical Range (MOR).
- **Allard's Law** is a method of assessing the visibility of sources of light (such as runway lights). It requires values for extinction coefficient, the luminous intensity of the lights being viewed and the background luminance and is principally used to assess IRVR at night.

The value of background luminance is obtained from Background Luminance Meters (BLM) mounted on two or more field sites. These are photo-detectors with a photopic response similar to the human eye, to represent what the human observer would see. Active BLMs are oriented along the runway, to measure the background luminance as seen by the pilot, with a warm standby BLM (normally oriented north) that automatically switches in if the active BLM is saturated by direct sunlight.

The value of Runway Light Intensity (RLI) is derived from the rated intensity of the runway lights at the airport where the system is installed. The nominal value for maximum intensity is usually reduced by a configurable degradation factor (typically 20%) to allow for loss of runway light performance and any contamination. The AGIVIS CAT III FSM system interfaces to the runway lighting controller, RLI value is input to the system automatically based on the electrical current presently being fed to the runway lights, as set by the ATC controllers.

Once calculations for both Koschmieder's and Allard's Laws are complete, the system selects the highest current IRVR value, which is rounded down and reported in bands as per ICAO Doc 9328 (Manual of Runway Visual Range Observing and Reporting Practices).

IRVR calculations are usually carried out using a rolling 10 minute mean of extinction coefficient. However, the system is capable of recognising what is called a 'marked discontinuity' in visibility. This is defined by the WMO as:

"…an abrupt and sustained change in runway visual range, lasting at least 2 minutes, which reaches or passes through criteria for the issuance of SPECI reports…"

If a marked continuity is detected the system automatically uses only IRVR values occurring after the discontinuity occurred.

Field Site Equipment

The number of field sites depends on the requirements and layout of each particular airfield. Usually either two or three field sites are used. Each field site is installed on to a solid concrete base, and is provided with power and communications services.

The Biral VPF sensors are constructed from hard anodised high grade aluminium which provides a long lasting superior finish. This durable metalwork is corrosion resistant and does not require painting or maintenance. They are fitted with lens heaters which keep the optics clear of moisture and cover heaters to prevent icing. There are also automatic routines that allow for fluctuations in transmitter power and for optical contamination. Each sensor is fitted to the top of a 2.3m frangible mast.

At the base of the mast, a Field Site Electronics Unit (FSEU) is fitted. This is a 316L stainless steel IP66 weatherproof housing that contains all the electronics and services necessary for the field site. The FSEU includes a heater to ensure operation even during extreme ambient conditions. A modem or fibre optic media converter for communication with the control tower equipment rack is also fitted.

AGIVIS CAT III FSM Field Site Installation

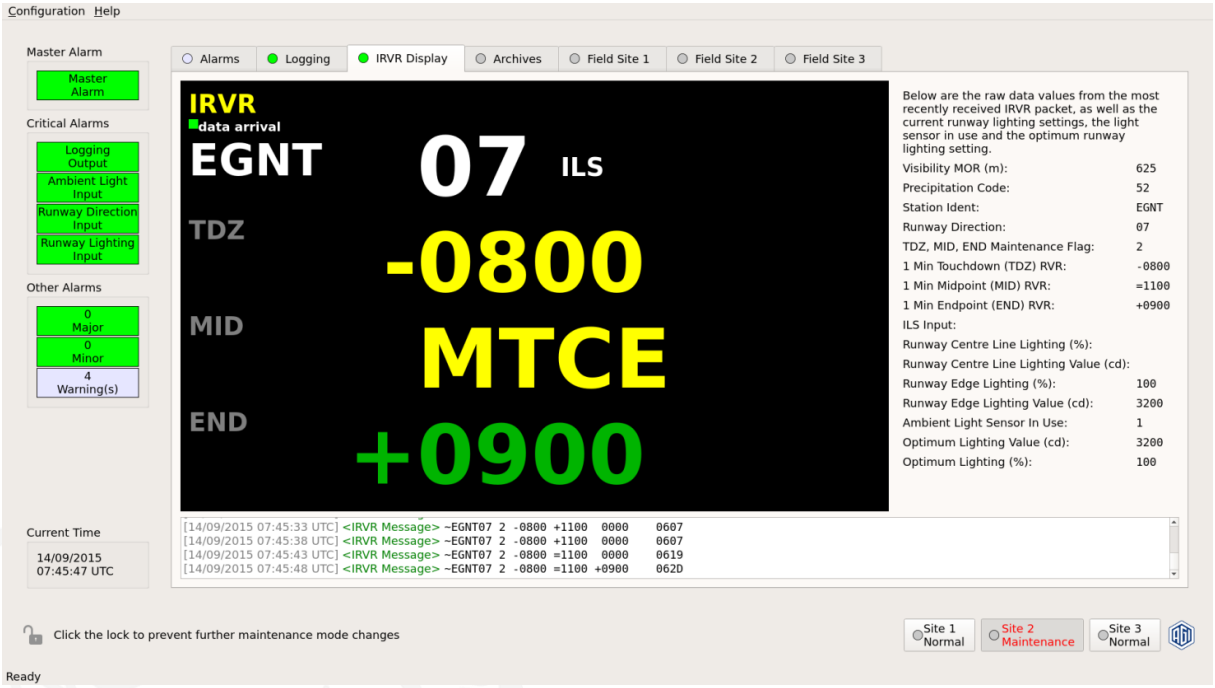
The VPF series sensors can also detect present weather through the use of an additional back scatter sensor, and a present weather data output can be provided where required.

Rack Equipment

IRVR data from each field site is reported to other system equipment, usually mounted in a 19" rack positioned in the ATC tower's equipment room. The necessary data links can be copper, fibre optic or wireless. The receiving modems and other system inputs are all contained in the tower equipment rack.

Field site IRVR data is fed to the disseminator, which acts as the central data processor and communication node for the system. The disseminator synchronises to the ATC system clock and also has an internal clock as a back-up. It also receives the runway light intensity and runway direction settings from the ATC position, which are used in RVR calculations.

The Mk. III Disseminator is AGI's 3rd generation disseminator which is controlled and configured at the rack mounted keyboard display unit by an intuitive and user friendly Graphical user Interface (GUI). The Mk. III Disseminator is based on the latest embedded technology, it features an on board hard drive that stores RVR daily archives which are also backed up to a local universal serial bus memory stick. The Mk. III Disseminator also offers 10/100/1000 Gigabit Ethernet LAN connectivity that facilitates the options of remote management and configuration should they be desired.



Mk. III Disseminator Graphical User Interface

The system also includes a local RVR display, master alarm light and external alarm relay outputs.

AGIVIS Rack Assembly

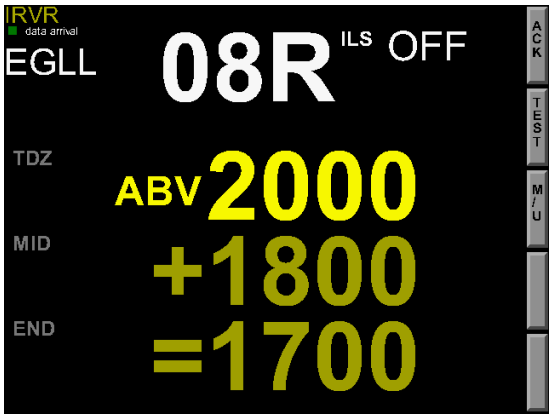
Users may interface to the disseminator via the keyboard and video display unit. This interface displays live system status along with diagnostic and maintenance information. Raw sensor data may be viewed as well as system archives, and commands sent direct to field sites. System configuration can also be reviewed and updated.

IRVR, alarm and system status information can all be supplied for integration to Automated Weather Observing System (AWOS) or other Met and ATC systems.

IRVR Displays

Multiple IRVR displays can be driven by the disseminator. These are 6.5" panel mounted Thin Film Technology (TFT) touch screens, which include self-test and data validation routines. IRVR data is displayed in bands (as per ICAO Doc 9328), colour coded and with trends and the selected runway clearly marked. As an option, ILS status can also be indicated.

The displays can trigger visual and audible alarms when fog or Low Visibility Procedures (LVP) thresholds are crossed.



IRVR Display Layout

Standards

AGIVIS FSM complies with all relevant international standards, including:

- ICAO Annex 3 (Meteorological Service for International Air Navigation)
- ICAO Manual on Automatic Meteorological Observing Systems at Aerodromes (Doc 9837)
- ICAO Manual of Aeronautical Meteorological Practice (Doc 8896)
- ICAO Manual of Runway Visual Range Observing and Reporting Practices (Doc 9328)
- WMO CIMO Guide

The system also complies with a number of national standards issued locally by countries worldwide, including:

- UK CAA CAP 746 (Meteorological Observations at Aerodromes)
- UK CAA CAP 670 (Air Traffic Services Safety Requirements)

Installation and Support

AGI offers a full installation service, which includes comprehensive site acceptance testing to demonstrate full functionality of the system. Factory-based and on-site training is available for both engineers and system users, and post-installation support can be provided worldwide. We can also offer a spares package tailored to the needs of each system.

All AGIVIS CAT III FSM systems are covered by a full 2 year warranty.

Specifications

AGIVIS FSM System	
Measurement Range	10m to 75km
Accuracy	±2%
Light Source	Near Infra-Red
EMC: Emissions	EN 61000-6-3
EMC: Immunity	EN 61000-6-1

Field Sites	
Operating Temperature	-40°C to +50°C
Relative Humidity	100%
Power Requirements	230V ±34.5V, 44Hz to 60Hz
Environmental Protection	IP66

Rack Equipment	
Operating Temperature	0°C to +30°C
Relative Humidity	95% non-condensing
Power Requirements	230V ±34.5V, 44Hz to 60Hz

IRVR Displays	
Operating Temperature	-10°C to +40°C
Relative Humidity	95% non-condensing
Power Requirements	12V DC (an in-line 90V to 264V, 50Hz to 60Hz AC PSU can be supplied)
Resolution	640 x 480
Brightness	800 cd/m^2
Contrast Ratio	600:1
EMC: Emissions	EN 55022 and EN 61000
EMC: Immunity	IEC 61000

AGI is dedicated to the continuous improvement of its products. If specific requirements exist that are not covered by this Technical Description, we are always happy to discuss developments that would allow them to be fulfilled.