Automatic Weather Stations and METAR AUTO

Automated METARs (METAR AUTO) at domestic aerodromes in New Zealand deliver a wealth of real-time weather information, and it is important that pilots acquaint themselves with how these observations are made and how they differ from manual METARs. The following explains the measurement techniques involved, how METAR AUTO are produced and how pilots can make best use of them.

The Technology

MetService currently operates a network of 70 automatic weather stations (AWS) across New Zealand and its offshore islands, including 28 at aerodromes. Further aerodrome AWS will be added before the end of 2009. These are sophisticated and highly reliable systems built up of high quality sensors from respected international suppliers, coupled with proven MetService processing systems and communication arrangements, and supported by experienced engineers. The key elements of a fully equipped aerodrome AWS are:

A laser **Ceilometer** is used to determine the *State of the Sky*. This is achieved by recording extremely accurate laser signal echoes reflected from clouds, and sorting these into layers. Although the ceilometer laser has a narrow beam and only 'sees' directly above the weather station, the movement of cloud across the beam, averaged over 30 minutes and with a strong bias towards data for the 10 minutes preceding each METAR AUTO, produces a very accurate picture of the extent of each cloud layer over an aerodrome. MetService uses the internationally-recognised United States National Weather Service "State of the Sky" algorithm for this computation.

Visibility (or *Meteorological Optical Range*) is a measure of the clarity or transparency of the air. Visibility sensors utilise an infrared light transmitter and receiver to measure the amount of light scattering caused by obscurations such as rain, fog, dust and haze. The sensor makes a spot measurement at a representative site on the aerodrome – it cannot identify adjacent visibility reductions such as fog in a nearby valley. The visibility data presented in an automated METAR is averaged over the 10 minutes prior to the observation. It is important to note that the ICA definition of visibility is *"The greatest distance at which a black object of suitable dimensions, situated near the ground, can be seen and recognized when observed against a bright background"*. Simply being able to see a mountain range 80km away does not imply that the visibility is 80km.

The **Present Weather Sensor** combines data from the visibility sensor and a precipitation detector, which measures liquid and solid precipitation falling onto a flat plate, to identify various liquid and solid precipitation types as well as fog, mist and haze. This information is averaged over the 15 minutes leading up to METAR time. Weather occurring during the previous 15 minutes (i.e. the 15 minutes back to the last METAR) is coded as 'recent' weather, using the qualifier 'RE'. Because the sensor makes a spot measurement, 'VC' (vicinity) weather is not reported.

Thunderstorm data is determined from an extremely effective *Lightning Detection Network* operated by MetService. This system collates data from a network of 10 sensors, located at Kaitaia, Auckland, Gisborne, New Plymouth, Masterton, Motueka, Christchurch, Dunedin and Manapouri aerodromes, and at Whataroa on the West Coast, and determines – with considerable accuracy – the location of every thunderstorm affecting New Zealand. Whenever a thunderstorm is detected within 8km of the aerodrome Reference Point, the present weather condition 'TS' is added to the weather reported by the automatic weather station, while thunderstorms between 8km and 16km from the aerodrome are reported as "VCTS'. RETS is also reported.

Wind data comes from an anemometer, either of the mechanical cup and vane type or the more modern ultrasonic sensor. These sensors are normally mounted on a 10 metre mast to give good representation of the wind affecting the runway.

QNH is measured by an electronic barometer that utilises 3 independent pressure sensors to ensure the accuracy of this most critical measurement and to provide redundancy in the event that one of the sensor elements failing. All aerodrome barometer heights (above runway level and above sea level) are accurately surveyed to ensure that the reduction to sea level (QNH) is absolutely correct.

Temperature and Dew Point Temperature are also measured electronically, by a combined sensor unit mounted in a standard 'Stephenson' meteorological temperature screen.

The **iSTAR Automatic Weather Station** that collects and processes the sensor data at each aerodrome was developed by MetService engineers specifically for aviation weather reporting and other high-end applications. iSTAR is capable of advanced data processing (for example the State of the Sky computation); readily configurable for new sensor types and updated algorithms; and allows the use of multiple communication methods, including data feeds to local services such as AWIBs and the MetDisplay system used in ATC towers.

To minimise downtime, AWS used to produce METAR AUTO utilise two, essentially independent communication channels. The primary method is half-hourly messaging via broadband internet, but the AWS also send GPRS cellular data messages every minute. In normal operation MetService is receiving data via both methods, and METARs are constructed from the half-hourly reports. In the event that the internet service fails the system automatically switches to creating METARS from 1 minute data.

The New Zealand AWS network is strongly supported by MetService's engineering and IT teams, technical workshop and calibration laboratory. A team of 5 Systems Engineers, mostly based in Wellington, is responsible for the AWS system architecture including new capabilities and enhancements. At the Paraparaumu technical workshop, a team of 13 engineers provides calibration and field maintenance services, including scheduled annual maintenance at all sites, on-call fault response services, and periodic laboratory overhaul and calibration of sensors.

Interpreting METAR AUTO

Although the code forms are very similar, there are some important differences that pilots should note in the METAR AUTO code.

Firstly, because AWS visibility is a spot measurement, directional visibilities are not reported. METAR AUTO visibility is therefore suffixed by the code 'NDV' (Non-Directional Visibility) to make this very clear.

Similarly, because ceilometers do not view the whole sky, AWS observations cannot state categorically that the sky is clear and therefore report 'NCD' (No Cloud Detected) instead of 'SKC' (Sky Clear). And, because ceilometers cannot determine cloud type, three strokes "///" are placed at the end of each cloud layer group to indicate that the AWS cannot identify TCU or CB cloud types. Aside from their measurement accuracy, an important advantage that ceilometer cloud base measurements have over manual observations is that they are taken *over* the aerodrome, whereas manual observations are largely based on cloud heights against nearby hills, which may be quite different to cloud bases above the aerodrome.

The situation with present weather is similar. The fact that 'weather' is not detected by the sensor is not an absolute guarantee that there is no precipitation, fog or other weather phenomena affecting some part of the aerodrome, so, when the AWS does not sense a reportable present weather condition, rather than the field being left blank, two strokes "//" are inserted in the present weather field.

Advantages of METAR AUTO

Although some pilots may consider automated METARs an inferior substitute to traditional, visual observations, they actually provide a number of significant advantages:

- Full 24/7 coverage at 30 minute intervals. Except at the international airports, manual METAR programmes were limited to the operational hours of ATC towers and a few other suppliers.
- Quality is totally objective and consistent, and not influenced by human factors.
- The METAR automation programme is introducing full 24/7 METAR reporting at aerodromes that hitherto had few if any METARs (e.g. NZWR, NZPP)

- Improved TAF and ARFOR quality. Aerodrome AWS actually report once a minute to MetService, and forecasters have found that having such frequent updates has greatly improved their ability to detect the early signals of the onset of fog and other disruptive weather conditions. This level of observation detail was never available in manual METARs.
- The same 1 minute data updates that forecasters receive are available (potentially in the cockpit) to pilots by commercial arrangement.